Independence, Credibility, and Communication of Central Banking

Ernesto Pastén
and Ricardo Reis
editors

Banco Central de Chile / Central Bank of Chile

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The three topics covered in the title of this volume have proved to be critical in the remarkable success of modern central banks around the globe in the fight to control inflation and smooth macroeconomic fluctuations. Despite these achievements, some old challenges have come back in recent years and new ones have appeared to make *Independence, Credibility, and Communication of Central Banking* as critical as ever—perhaps, even more so. This volume collects articles contributed by distinguished scholars to the XXIII Annual Conference of the Central Bank of Chile, which coincided with the thirtieth anniversary of its independence. The chapters in this volume give a fresh new look to old lessons, discuss the latest developments, and provide new recommendations for central banks to meet some of their biggest challenges of the times.

Amanecer en Peñalolén
Benito Rebolledo
Oil on canvas, 42.5 x 55.5 cm
Collection of the Central Bank of Chile

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Independence, Credibility, and Communication of Central Banking: An Overview

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The institution of central-bank independence is often lauded as a great conquest of the accumulation of knowledge and the sensible setting of policy. The economic literature is filled with arguments for why an independent central bank would lead to better outcomes. To this prior, the experience of the last couple of decades has added the supporting data. Independent central bankers have been, for the most part, able to keep inflation under control despite shocks and macroeconomic volatility. Whether during the Global Financial Crisis, through individual country slumps, or at the trough of the pandemic recession, independent central banks were typically part of the solution rather than part of the problem. Attacks on the independence of a central bank nowadays typically generate a strong pushback from the press and civil society.

One important reason why this independence seems so solidly established is that central bankers made a priority out of having credibility in their policies. Unlike many other areas of policymaking, reneging on previous promises is rare, and there is a constant emphasis on the predictability of rules. Even changes of opinion that are justified by new data are endlessly explained and defended. Large swings in policy typically follow months of preparation, public discussion, and transparent procedures that highlight pros and cons. Like any other policymaker, central bankers sometimes make decisions that seem to be mistakes after the fact. However, they have always been able

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to point to the arguments before the fact that led to those decisions. This credibility is partly derived from technical expertise. In many countries, the central bank has earned a reputation for being the premier source of independent rigorous economic analysis, and it has opened its analysis to the scrutiny of academics and other experts.

In a democracy, it is not enough to present supporting research and to convince the experts. For a policy to be credible, the general public needs to understand it and the reasons behind its implementation. For a central bank to be independent, it must communicate citizens its mission and the way it goes about it. In the other direction, communicating a policy is the way to make it credible, and being open and accountable is the acceptable way to yield unelected power in a democracy. For an independent central bank, communication is a policy tool in itself. Through its control of future interest rates and monetary conditions, the central bank affects expectations of the future today and is able to steer the economy.

Independence, credibility, and communication are then the three legs on which the modern institution of a central bank rests on. This book collects chapters presented at the annual conference of the Central Bank of Chile, at the time it commemorated the 30th anniversary of its independence. It was fitting to devote the conference to frontier research on the three legs of central banking. Not just to reassess whether the legs remain stable and fit for their purpose, but also to reflect on how they can be improved and adjusted to the challenges ahead.

The book is structured into four blocks of chapters preceded by the opening speech given by the Governor of the Central Bank of Chile. The first three blocks follow the topics in the title of the Conference: Independence, Credibility and Communication of Monetary policy. The last block is composed of one chapter documenting an application of concepts in all other chapters to an experience of a regime change in the conduct of monetary policy in Chile.

The first block begins with a chapter which is an extended version of the keynote lecture given by Kenneth Rogoff about the main challenges he sees ahead for independent central banks from a broad perspective. This paper refers to the legitimacy of central bank independence and its interplay with other challenges, such as the role of central banks in inflation control, stabilization and whether to extend its mandate in a world with low inflation, how to deal with financial crises and large-scale fiscal policy, and to keep monetary policy effectiveness when interest rates are persistently close to or below zero.

The other two chapters in this block study specific aspects of independence about its causes and determinants. One chapter is empirical, by building new measures of independence for emerging economics, and seeing how resilient central banks were after the Great Financial Crisis. The other chapter considers fluctuations in the political pressure that central banks are subject to. These arise because the general public reacts to perceived failures and successes of the central bank, and politicians feel more or less pressured to deliver on their short-term goals. The crisis required that central banks engaged in some lender of last resort, cooperated with fiscal authorities in stimulus packages, and revised the regulation of banks by different government entities. Across all three dimensions, new lines had to be drawn in the separation between the central bank and the government. Independence was re-defined—in some ways strengthened and, in others, weakened. The pandemic recession of 2020 promises to offer new challenges to independence.

The next block is composed of two chapters focusing on the credibility of monetary policy when countries are under fiscal stress. The conference took place well before the 2020 pandemic struck and so before the large run-up in public debt in advanced and emerging economies alike. The lessons from these two chapters are today even more prominent. Highly indebted countries with dismal growth prospects can employ austerity, default, or inflation to deal with their public debt. The reality of most cases is that there is a mix of all three, used to different extents. Often, a little more of one is perceived as allowing for less of the other two, but as the chapters in this book show, the connection between the three is complex and delicate. It may well be that some policies make several of these dimensions worse, as they can trigger economic forces that feed off each other. While every economist is trained to learn that economies in fiscal trouble often resort to hyperinflation, less appreciated is that a fiscal crisis also comes with financial repression. This is because it is not only strictly monetary policies that affect fiscal resources but macroprudential policies as well. Some of the key insights that have shaped our understanding of the credibility of central banks under fiscal pressure extend to thinking of the central bank as a financial regulator. Others are more novel and point to dangers and opportunities of actively using macroprudential tools.

The next block includes three chapters devoted to communication. Economic science has made great strides in this field by going beyond whether central banks should communicate or not, to how they should do it. These chapters point to trade-offs that arise with different ways to communicate. They provide concrete ways in which communication flaws can endanger the credibility of central banks, and they show that there is a fine line between credible communication with financial markets and credible independence from them. These chapters enlarge the set of actors to be considered in these discussions, as policymakers also must communicate within heterogeneous policy committees, and the general public is diverse and has many other demands for its attention.

The last chapter applies these concepts and many others to Chile's experience with floating its exchange rate in 1999. Exchange-rate policy is a dimension of central banking in which credibility is more central, communication has to be more careful, and independence is put more to the limit. When intervening in foreign-exchange-rate markets, central banks face the consequences of their choices in real time, and instantly experience any lack of credibility. Communication slips can easily change beliefs and trigger sell-offs. Crises can quickly become the catalyst to deep recessions and revisions of the independence of the central bank. The Chilean experience illustrates well how the three legs of central banking are each complicated and nuanced, and how their soundness depends on how they interact with each other.

Our hope is that the lessons from this book both inspire future research and help to guide future policy. Several leading central banks have been going through a revision of their mandate, and as societies focus on different objectives for the medium run, there are legitimate questions on what the role of the central bank should be. These themes will surely lead to many discussions. May those discussions be independent of other interests, credible in their arguments, and well communicated.

A brief non-technical summary of the chapters in this book follows **Risks of Central-Bank Independence**, by Kenneth Rogoff. This chapter is an extended version of the Conference's keynote lecture. It argues that central banks have been victims of their own success: Because inflation has been under control for so long, society has started to question the role of central banks. The author stresses that the performance of central banks in the challenges ahead is the best argument for legitimacy of central banks, for which independence has been the institutional foundation where the central banks' success stands. The chapter reviews main challenges and proposes some ways forward.

The first of this list of challenges is the control of inflation. Traditionally, high inflation has been the problem central banks have to deal with; today it is too low inflation. This opens a question on the role of central banks in stabilization and whether the mandate of central banks should be expanded. This is the second challenge. The third is the endowment and use of emergency tools for central banks to manage financial crises. The fourth challenge is how central banks should deal with large government debt in exceptional situations in a world of low interest rates and low inflation, which may lead many to think that government spending is a cost-free lunch. The last challenge has to do with the standard policy toolkit of central banks, which is very limited when interest rates are at zero or close to zero for prolonged periods of time. This chapter elaborates on the author's views to address each of these challenges. Overall, it is a call for a delicate balance between rules and flexibility in the conduct of monetary policy.

The Transformation and Performance of Emerging Market Economies Across the Great Divide of the Global Financial Crisis, by Michael Bordo and Pierre Siklos. How does the strength of central-bank institutional development benefit the economy? To tackle this question, Professors Bordo and Siklos evaluate in this chapter the performance of a number of emerging markets before and after the Great Recession of 2008–2009 and relate it to an index of institutional resilience they propose.

This index combines information capturing the degree of central-bank independence, transparency, and governance, but also political economy indicators capturing the level of political distress that central-bank institutions must bear. As this chapter recognizes, the strength of institutions is only tested at times of questioning of their roles, during large crises and episodes of political turmoil. Some emerging economies suffered political distress before the Great Recession; others have been exposed to it to different extents in later years. This heterogeneity sheds light on the benefits of strong central-bank institutions in global shocks, financial shocks, credibility shocks, and trade shocks.

The sample covers a total of 29 advanced and emerging economies, including Chile, from 1998 to 2017. The degree of central-bank independence has not experienced noticeable changes in Chile in this time window as well as in most countries, which reflects the great consensus on the importance of independence. The degree of transparency has been changing substantially in all countries toward more openness in central-bank decision-making. The improvement is largely heterogeneous but with a similar trend for both advanced and emerging economies. In contrast, central-bank governance has shown signs of deterioration, especially for emerging economies. On a different front, most countries have moved toward exchange-rate flexibility, but very few have reached full flexibility—most notably, Chile among them.

Overall, including other seven indicators, the institution resilience index shows that developed countries tend to have higher institutional quality than emerging markets, and the gap has been slightly widening through the sample. Interestingly, resilience fell after the Great Recession in developed countries, while it increased in emerging economies, but both changes did not last long. Although there is substantial heterogeneity in the resilience index across countries, it looks more volatile in emerging economies. In turn, one dimension where institutional development may materialize is on central-bank credibility, which, according to alternative measures analyzed, has fallen after the Great Recession, but less so in countries where the index of institutional resilience is the strongest.

Inflation Targeting under Political Pressure, by Mariana Halac and Pierre Yared. In a similar vein to the chapter by Professors Bordo and Siklos but from a different perspective, professors Halac and Yared theoretically study the optimal monetary-policy implications of political pressures. Although always important and even more in recent years, this aspect of the implementation of monetary policy has rarely been considered.

Their model is a classical Barro-Gordon setup, where they introduce "political-pressure shocks" as stochastic variation in the weight on output relative to inflation in the objective function of the central bank. Realizations of larger weight on output are interpreted as the result of episodes where political authorities or the political situation make the central bank more prompted, for instance, to tolerate higher inflation in response to shocks or to accommodate fiscal stimulus. Two critical ingredients in the analysis are, first, the repeated nature of the interaction between the central bank and private agents, which takes the form of an infinitely repeated game and, second, the assumption of lack of commitment, as agents' expectations are rational and therefore must be consistent with the monetary policy implemented in equilibrium.

In this context, political pressure generates interesting aggregate dynamics. First, higher political pressure may lead to higher or lower inflation. Second, when political pressures do affect inflation, it does not need to be a monotonic relationship. In general, even in the absence of political pressure, the policy of the central bank is self-enforcing in the sense that a deviation from that policy may trigger suboptimal high inflation in the future. This works as a "threat" to the actions taken by the central bank. This threat works as an imperfect commitment device in the sense that the central bank's optimal policy is to keep inflation low, which in turn avoids expectations of future paths of high inflation, then high inflation is never observed in equilibrium.

With political pressure, this does not have to be the case. If the political shock is observable to private agents, political uncertainty may lead to higher inflation and output volatility around a single stationary path. But if political pressure on the central bank is not readily noticeable by private agents, aggregate dynamics are characterized by a rich Markov switching process, where episodes of high inflation alternate with episodes of low inflation. Switches between them are triggered when the level of political pressure reaches an endogenous threshold: If political pressure is low, the "threat" of future high inflation is enough for the central bank to resist and keep an optimal policy of inflation control. In such a case, inflation dynamics is characterized by a cap, such that stochastic variation in inflation occurs in response to shocks, but the central bank ensures that inflation does not get too high. In contrast, if the pressure is strong, the central bank may tolerate inflation higher than the cap, but not everything is lost. Private agents may understand that inflation will be high for some time, so expectations about future information are not necessarily de-anchored if high political pressure is a low-frequency event. However, if the high inflation is persistent, it creates expectations that the central bank is giving up on controlling inflation. This de-anchors expectations for longer than the political pressure actually lasts, and this leads to an episode of high inflation that is hard to revert.

The Fiscal Footprint of Macroprudential Policy, by Ricardo Reis. There is a large economic literature on the many links between fiscal and monetary policy. One of the main channels is that the two of them share an overall government budget constraint. Monetary policies, even if focused on inflation control, leave a fiscal footprint. They tighten or loosen the budget constraint that the fiscal authority must deal with. This chapter investigates this interaction of fiscal policy not with monetary policy but with macroprudential policy. Because there are so many dimensions to macroprudential interventions, the chapter focuses on one dimension that is common to many of them—banks having to hold more government bonds.

The first channel the chapter considers is the increased demand for government liabilities due to tighter policy. This raises the price of those bonds and relaxes the budget constraint of the government. Low policy interest rates and quantitative easing have a similar direct impact, so the chapter compares three policies' fiscal footprint. On the one hand, it concludes that monetary policy tends to have a larger fiscal footprint than macroprudential policy. On the other, it notes that because the channels are similar, we may expect them to be used in tandem. This provides a fiscal argument for concentrating these two policies within a single institution, the central bank.

The second and third channel discussed in the chapter arises in the context of a simple model in which macroprudential policy makes banks less prone to default, thus saving on potential bailout, but it also makes them less willing to extend credit that would raise tax revenues. This leads to four surprising results that the chapter applies to different historical experiences. First, in normal times, when there is neither a fiscal nor a financial crisis in sight, then tougher macroprudential policy makes rolling over the debt easier but lowers credit, which lowers future fiscal revenues. The more focused on the near term is a politician, the more they would like macroprudential to be tighter. This provides support for an independent central bank to conduct macroprudential policy to avoid these temptations. Second, when there is a financial crisis so bailouts are on the horizon, desires for financial stability and looser government budget constraints will coincide. There is no conflict between fiscal and macroprudential policymakers, as both want tougher macroprudential policy. Policy is credible because it is not challenged. Third, the chapter points to a novel "unpleasant macroprudential arithmetic". If the fiscal authority pursues high public deficits, thus threatening to cause a fiscal crisis with sovereign default, then this will risk dragging the banking sector along. Macroprudential policy may then have to be looser in order to help the government finances and prevent the default. In some cases, the central bank is forced to engage in financial repression.

The fourth and final case arises when there is both a financial crisis and a fiscal crisis. The model in the chapter is independently interesting because it generates a doom loop—the worse the fiscal crisis is, the worse the financial crisis will be, and viceversa. This creates a new challenge for macroprudential policy. A too independent policymaker that completely ignores its fiscal footprint may have a policy that is too tight. That would make the fiscal crisis worse and, potentially, in itself endanger financial stability, thus making the policy self-defeating. Ignoring the fiscal footprint is no longer credible because fiscal problems spill over to financial instability. Communicating how to deal with these tradeoffs becomes key. Moreover, having tighter macroprudential policy leads to, after an unexpected fiscal shock, a larger loss for banks. Seemingly safer banks may become riskier, as safe government bonds default. A macroprudential policymaker that ignores the fiscal consequences of their actions will lead to deeper crises.

The financial regulation and macroprudential policies that are set by central banks are often as important as monetary policies. As we re-think the independence and credibility of central banks relative to fiscal authorities, considering the interlink between macroprudential and fiscal policy is important. This chapter provides foundations for thinking about the trade-offs in this task.

Fiscal Inflation and Cosmetic Defaults in a Small Open Economy, by Francesco Bianchi. When public finances become unsustainable, countries are sometimes advised to restructure their public debt to avoid a descent into hyperinflation. This chapter gives a note of caution to this recommendation in a small open economy if it wants to get back economic stability and preserve monetary-policy independence. It argues that, although all sovereign defaults are painful for the defaulting economy, they do not always eliminate the spirals of high inflation, losses in output, and unstable public debt that ultimately caused the default. This happens when defaults are 'cosmetic': the repudiation of public debt is not enough to ensure the restoration of public-debt sustainability and to make it consistent with a monetary policy that stabilizes the exchange rate and inflation. The chapter then takes these ideas to interpret Chile's macroeconomic history since the 1960s.

The mechanism proposed relies on expectations. A default in sovereign debt, in principle, helps to unload some of the fiscal burden and to recover monetary-policy independence. However, a cosmetic default does not create sufficient public-debt unloading, so agents keep considering the possibility of a new spiral down the road. This mere possibility creates inflationary pressure and thus devaluates the exchange rate. Monetary policy may fight against these forces creating a recession. But if these forces are too strong, monetary policy would give up its control of inflation, thus effectively losing its independence.

When interpreting Chile's macroeconomic history since the 1960s through the lens of this model, the chapter argues that it can be divided into four distinct periods. First, in the 1960s, inflation was under control. However, fiscal instability was in incubation. It unleashed in the early 1970s and generated hyperinflation led by large primary deficits. The second period starts around 1974 and lasts until 1981, when monetary-policy dominance is restored with fiscal policy focusing on keeping deficits under control and monetary policy targeting a fixed exchange rate. This period of stability ended abruptly with the international financial crisis of 1981. The subsequent period between 1982 to 1989 brought about a slow and painful recovery process, where reputation of fiscal discipline was slowly gained. The final period started in 1989 to nowadays, when the central bank was formally granted independence, inflation slowly receded, and Chile enjoyed stable growth. First implicitly and later explicitly, a fiscal rule introduced further credibility in fiscal discipline, thus ruling out expectations of explosive paths. As the model predicts, once uncertainty about fiscal responsibility vanishes, monetary policy can control inflation and the exchange rate remain stationary.

Central Banking with Many Voices: The Communication Arms Race, by Annette Vissing-Jorgensen. What are the economics behind informal communication of central banks with the general public? What do data tell us about informal communication? Is the outcome of informal communication inefficient and, if so, is there a way to improve it? These questions have received little formal treatment both on the empirical and theoretical fronts. Annette Vissing-Jorgensen provides some answers in this chapter, filling an important gap in our knowledge with this highly innovative and provocative chapter.

She starts by noticing two key ingredients of modern central banking that create incentives for informal communication. First, the institutional arrangement of central banks usually relies on collective decision-making through a policy committee. Naturally, each member of this committee has her/his own particular view about the state of the economy and what policy should be implemented. For instance, the Board of the Central Bank of Chile is composed of five members who all vote at every monetary-policy meeting while the United States' Federal Open Market Committee is composed of nineteen members out of which twelve vote at any meeting. Second, the current consensus on monetary policy is that central bankers should aim to not surprise markets. Central bankers therefore speak to the press, give speeches, and participate in other outreach activities. The ultimate goal is to make policies credible by being transparent but, at the same time, to reflect the input that they provide. As a result, monetary policymakers effectively shape markets' diagnosis about the state of the economy and their expectations about both future trends in the economy and monetary-policy decisions. Since central bankers are then weary of disappointing those expectations, the result is that communication, both formal and informal, becomes a tool for one individual member of the committee to increase their influence on final monetary-policy decisions.

Central banks are aware of these incentives. They have responded by typically following well-designed strategies of formal communication involving statements, regular reports, and the designation of one or a few spokespersons. Yet, as this chapter carefully accounts for the United States, informal communication is common practice. In particular, this chapter reviews evidence from the asset-pricing literature, documents the Fed's concern about informal communication using released internal documents, and summarizes steps taken by the Fed to reduce the occurrence and effects of informal communication.

For its normative analysis, this chapter proposes a game-theoretical model of informal communication. The model boils down to a form of prisoner's dilemma, where the efficient outcome is to have no informal communication, yet, in equilibrium, there is plenty of it. This generates a cacophony that undermines the effectiveness of central banks on the management of expectations. It also reduces the quality of central-banking decisions. Professor Vissing-Jorgensen proposes ways to mitigate it. High transparency in describing the monetary-policy's best-reaction function is a way to diminish the incidence of informal communication on shaping the public's belief-formation process. In a recommendation that mostly applies to the United States, Professor Vissing-Jorgensen proposes to have a monetary-policy committee with fewer members. More generally, she also notes that more similarity in backgrounds and views across Board members would diminish disagreement among them and thus reduce the incentives of using informal communication. The other side of the coin is that more homogenous committees would lead to less rich monetary-policy decision-making.

The Three E's of Central-Bank Communication with the Public, by Andrew Haldane, Alistair Macaulay and Michael McMahon. This chapter proposes three E's as the principles for effective central-bank communication with the general public: Explanation, Engagement, and Education. To do so, the authors revise extensive literature, convey an empirical analysis based on both a survey of individuals and an experiment, and produce theoretical results by using a model.

The survey they use includes about 2,000 U.K. individuals. It was conducted by the Bank of England from 2001 onwards to construct an index of monetary-policy understanding by the public. The results are disappointing. In spite of the enhanced importance given by the Bank of England to communication and of all the efforts toward this goal made through the years, the general public's understanding of monetary policy is limited and seems to not have improved with time. Looking at disaggregated data yields a slightly better picture. The understanding of monetary policy has increased for those sections in the sample which are more educated, have higher income, or are older. It is among the young, the poor, and the less educated that central-bank communication has found more difficulties. Another interesting result is that trust in the central bank tends to decrease after big downturns, such as the Great Recession in 2007–2009, and it then takes very long to recover. This suggests that trust in the central bank and the effectiveness of central-bank communication is hard to build but easy to lose.

To further shed light on these issues, this chapter also runs an experiment. They ask 285 individuals from the "general public" and a sample of first-year graduate students of Economics at the University of Oxford to read several documents that the Bank of England uses for communication. Some are simplified documents targeting the general public, while others target specialized audiences, like the Inflation Report and briefings of monetary-policy decisions. The simplified documents require knowledge equivalent to eighth graders, and the Inflation Report and the briefing of monetary-policy decisions require knowledge equivalent to college students. They conclude that, despite all the efforts, the communication of the Bank of England does not meet minimum standards of broad reachability.

Finally, this chapter also proposes a rational inattention model to further stress the importance of Explanation, Engagement, and Education as the three pillars of effective central-bank communication. The rational inattention model incorporates the "difficulty to process information" that may prevent individuals to incorporate certain types of information in their decision-making even when such information is readily available. About Explanation, they show that there is a tension in central-bank communication—simpler messages are easier to process and thus more likely to be incorporated in individuals' decision-making but at the cost of having poorer information content. About Engagement, they show that using techniques to capture the public's attention is an effective way to provide incentives to make the public make the effort of processing difficult information. Finally, about Education, they show that it increases the public's capacity to understand complicated messages, including those about monetary policy. Advances on these three fronts improve welfare by allowing monetary policy to achieve better macroeconomic outcomes at lower social costs in terms of activity and employment.

Improving U.S. Monetary Policy Communications, by Stephen Cecchetti and Kermit Schoenholtz. This chapter shares with previous ones its goal of providing recommendations for improvement of central bank communication although relying on different sources of information. They reach some conclusions also considered by the previous two chapters, while others are different or taken from a different perspective. Based on two dozen interviews to academics and policy makers, as well as their own reading of scattered literature on the topic, they identify three main areas for the improvement of central bank communication in the U.S.

Their first recommendation is a call to simplify monetary policy statements, but at the same time to keep and elaborate on dissent views. This way, on the one hand, central banks can reach the broadest possible audience for key monetary policy decisions while, on the other hand, reducing incentives for leaks and informal communication that undermine the effectiveness of monetary policy. Emphasis should be given, according to the authors, to reaching a form of "group accountability," such that the rationale of monetary policy decisions should be explained and justification for dissents. Their second recommendation is to clarify the way that policy will accommodate changing conditions. This allows the general public to understand central banks' decisions as a reaction function rather than inflexible statements. Thus, the general public could internalize more easily the changes in monetary policy decisions. Their final point is to highlight policy uncertainty and risks. This will give the public information about when it is more likely that monetary policy decisions can change, either because the central bank's diagnosis about current conditions is not so clear or because it is likely that the current monetary policy will change in the short run.

Comfort in Floating: Taking Stock of Twenty Years of Freely Floating Exchange Rate in Chile by Elías Albagli, Mauricio Calani, Metodij Hadzi-Vaskov, Mario Marcel, and Luca Antonio Ricci. This chapter looks into the experience of Chile when launching a free-floating regime for the exchange rate, to stress the importance of effective communication, strong credibility, and well-established independence of central banks. When a stark policy shift is implemented, private agents respond accordingly. It is critical for the success of the policy shift itself and the achievements of its intended goals that these reactions are consistent with the policy. This can only happen when the policy shift is credible and well communicated, and the particular case of a floating exchange-rate regime is credible only if the central bank is independent.

The "fear of floating" has been a recurrent factor in the way in which central banks respond to external crises in emerging economies. It introduces a rigidity on the exchange-rate response to the crisis—it is often argued—which makes the overall adjustment of the economy more costly. One obvious way to solve it is the implementation of a fully flexible exchange-rate regime, but such policy can only succeed if it eliminates the social costs that were feared of in the first place. Some feared costs of floating are the destabilizing effects of large swings in exchange rates over firms' balance sheets, surges in inflation, and suddenly reduced access to international credit markets. All these costs can be eliminated if a flexible exchange-rate regime induces the deepening of financial products that allow firms to hedge against large swings in exchange rates. This is the aspect this chapter focuses upon by using the Chilean experience.

A free-floating exchange-rate regime was implemented in Chile in 1999 after the lessons learned from the Mexican crisis in 1994 and the Asian crisis in 1998. This chapter documents a remarkable and progressive reduction in firms' exposure to exchange rates. First, firms reduced the mismatch in their balance sheets on the denomination of their assets and liabilities. Second, firms engaged in international trade started to massively participate in exchange-rate derivative markets, which in turn significantly grew. This allowed firms to avoid the effect of exchange-rate fluctuations on their costs and thus reduce the passthrough of exchange-rate swings to domestic inflation. It also allowed firms to have more access to international financial markets. All these effects—this chapter argues—strengthen the resilience of the real and financial sectors to external shocks. It also improved the performance of the Chilean economy to the Great Recession which happened some years later, when the flexible exchange-rate regime was solidly implemented. In fact, as this chapter documents, Chile was one of the least affected countries by this crisis among emerging economies.

Public Trust and Central Banking

Mario Marcel
Central Bank of Chile

Dear colleagues and friends, distinguished guests: welcome to the XXIII Annual Conference of the Central Bank of Chile (CBC) entitled "Independence, Credibility, and Communication of Central Banking."

Since 1997, the CBC has been convening prominent scholars and policymakers to this Conference to discuss major issues in central banking and their implications for emerging economies. This version is no exception; fresh and thoughtful research will support discussion over the next two days. We thank and welcome all participants, including representatives from 21 central banks around the World.

The Annual Conference this year has some features that make it special. First, it will be held back-to-back with the International Monetary Fund (IMF)-CBC-IMF Economic Review Summer Conference on "Current Policy Challenges Facing Emerging Markets", so we expect many of you to stay in Santiago longer than usual, for a full week of rich discussions. Second, this year we commemorate 30 years of independence of the CBC, so we have devoted our Annual Conference to revisit the achievements and challenges of central bank independence around the globe.

Central bank independence: achievements, challenges and threats

Central bank independence is one of the most remarkable pieces of institutional architecture fostered by economic thinking in the last half century. Theoretical studies in the 1980s stressed central bank independence as a precondition to bringing inflation under lasting control, and support for reform soon spread from academia to

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policymaking. Professor Kenneth Rogoff was a major contributor to this process, so we are privileged to have him as keynote speaker at this Conference.

Central bank independence delivered upon expectations. As the countries with independent central banks grew to nearly 70 in recent years, average world inflation dropped to 4%, from more than 25% 30 years ago. Empirical studies are pretty conclusive on a strong correlation between central bank independence and low and stable inflation after controlling for other variables.

The Central Bank of Chile, as one of the pioneers of this remarkable process in the emerging world, provides a good example of the merits of institutional independence. Independence of the CBC ended 40 years of double-digit inflation and coincided with the return to democratic rule in 1990. Inflation fell from almost 30% to 3% through the 1990s while the economy expanded at an annual average 6% in the decade, doubling the average for the previous 40 years. This provided legitimacy, credibility and respect for the CBC under its independent status, encouraging it to maintain high technical standards and commitment to its statutory goals of controlled inflation and financial stability over the years.

Independence also helped many central banks to deal with the Global Financial Crisis of 2008 and its aftermath. The magnitude of the GFC demanded prompt and decisive action, while its global dimension required coordination across national borders. Independence from national governments and the authority to act swiftly were critical in containing the deepening of the crisis and its spillovers throughout the economy. Some of the largest independent central banks applied their powers to articulate unprecedented measures, like massive asset purchases, whose effects last until today.

Independent central banking has not been an easy ride, though. One thing is to be free from external interference, quite another is to build the policy frameworks, governance structures and standards to guide actions in a consistent and predictable way. Independent central banks have endorsed and benefitted the most from inflation targeting, have led the improvement in communications into forward guidance, have built reporting mechanisms, and have developed transparency and integrity standards beyond statutory requirements.

While policy frameworks, monitoring mechanisms and policy tools could rely on sound theoretical work and accumulated experience for monetary policy over the years, issues are not so well resolved with financial stability. This is not easy to measure, financial instability may come from many sources, and there is still an open debate on who—central banks or government regulators—should command macroprudential policies. This is related to the potential tradeoffs between monetary policy and financial stability that were intensely debated in this venue two years ago.

The former is a good illustration of the difficulty for independent bodies to deal with multiple policy mandates and/or the distributional effects of policy decisions, which involve choices that are normally expected in the political process but not easy to tackle by nonelected officials. This was particularly exposed during the GFC, given the perception of unfairness in the distribution of the burden of the crisis and the actions to contain it.

Even success of independent central banking has come at a price. Controlling inflation has made the latter less of a concern to citizens and politicians. The effectiveness of central banks in securing macro and financial stability in the post-GFC years may have also removed responsibility from other actors and may have encouraged markets to rely too much on central banks as risk managers.

The current wave of political populism is a further source of risks. Threats to central bank independence usually do not come from the public but from political leaders that resent distributed governance as well as checks and balances. In the last few months, we have witnessed a number of attacks on central bankers for coming in the way of ambitious populist agendas.

Independence and credibility

This is a good reminder that independence of central banks cannot be taken for granted. No matter how deeply it is ingrained in the law, independence can always be taken away or significantly undermined, *de facto* or *de jure*. In the real world, central bank independence relies on the willingness of key stakeholders–most notably governments and legislatures—to play by the rules and by the ability of central banks to gain legitimacy and credibility from stakeholders.

Independence does not automatically guarantee credibility either. Being free from political interference of politicians does not make a central bank infallible nor free from undue influence from other actors. Credibility needs to be protected and cultivated amid social, political and technological change.

In a recent piece, the IMF illustrates the importance of central bank credibility (IMF, 2018). It shows that central banks can better accommodate shocks with smaller output loss and social cost the more anchored are inflation expectations to the policy target, with lower pass-through from the exchange rate to consumer prices and lower persistence of inflation.

More generally, public policies should be more effective the more credible the institutions in charge of them, as it helps aligning the behavior of the public to the policy objectives pursued. This is surely more important for independent institutions that cannot rely of a broader set of incentives and controls to shape the behavior of their stakeholders. A key question then is how to build credibility.

This is an issue only partly addressed by Economics. The rational expectations school would suggest adopting a clear-cut policy rule, communicating it openly and clearly, and ensuring strict compliance, to exploit the learning capacities from economic agents. This certainly underlies the growing popularity of inflation targeting and the forward guidance that comes with it. But even this may be challenging in a changing environment, where the business cycle overlaps with structural changes, and more so in areas, like financial stability, where policy targets may be hard to design and explain.

From credibility to trust

So, a broader approach to credibility-building may be needed. To this end, it may be useful to acknowledge that credibility is an attribute of a certain individual or institution: that of being believed or trusted. So surely, credibility does not depend exclusively on your own actions but on how far others trust you.

Trust, in turn, is defined as a person's belief or expectation that another person or institution will act in favor of one's well-being (OECD, 2017). So we could think of credibility as an institutional asset that depends on the factors that influence trust from stakeholders and the public.

Credibility in a central bank refers to public's belief that future actions of monetary policy that are optimal today will be carried out even if they no longer seem optimal in the future. This is related to public trust, but the two concepts are not quite the same. One can imagine the public having trust in the central bank and at the same time the latter adopting a discretionary monetary policy strategy to retain full flexibility regardless of past promises. However, it is hard to imagine the opposite situation of a central bank fully engaged in the management of expectations without trust from the public.[1]

This also applies to communication. We can discuss alternative strategies to make sure that the message issued by a central bank is adequately understood and internalized. However, there is little that a good communication strategy can do if the public does not trust the central bank.[2]

Approaching institutional credibility from stakeholders' trust has a number of conceptual and operational advantages.

First, there is a large body of research assessing its value: trust is at the heart of societies and a major component of social capital. A number of studies have related interpersonal and institutional trust to lower transaction costs, social cohesion and wellbeing.

Second, trust is a livelier concept, which can respond to information and experience acquired by stakeholders, as compared to the more static notion of credibility. Trust is not an abstract concept, but an attitude developed by actual people based on their beliefs, information and actual experiences.

Third, by focusing on stakeholders, trust can help institutions to pay closer attention to their environment, changes in social values and standards, thus reinforcing their end beneficiaries rather than structures or procedures. This may be especially important for technocratic and independent organizations, like central banks, that may tend to isolate themselves despite mandates in the general interest.

Finally, as we will see below, recent work shows that trust can be deconstructed into a series of components that can be linked to institutional actions. This may provide a stronger lead to how trust can be protected, built, or eroded.

1. Christelis *et al.* (2016) have formally explored this for Europe using micro data, finding that higher trust in the European Central Bank (ECB) lowers inflation expectations on average, and significantly reduces uncertainty about future inflation, even after controlling for people's knowledge about the objectives of the ECB. Similarly, Mellina and Schmidt (2018) find that having greater trust increases the probability of expecting unchanged prices and decreases the likelihood of expecting either slightly or sharply rising prices over the medium term.

2. Through behavioral insights, Bholat *et al.* (2018) show that public's trust in the Bank of England can be further improved by enhancing the communication with the public, particularly at times when trust in public institutions has fallen and responsibilities delegated to central banks have increased.

In what remains, I will argue that public trust is the cornerstone for safeguarding central bank independence as a stable outcome of the way modern societies decide to allocate powers across institutions.[3] A central bank that is not trusted is vulnerable to political pressure to deviate from its mandate, regardless of whether it is formally independent or not.

It is therefore crucial for modern central banks to understand better the concept of trust, the mechanisms for fostering and maintaining it, and to think about strategies and tools for the management of public trust.

What is public trust? What can be done about it?

Available data indicates that public trust in government differs substantially across countries, but it tended to deteriorate after the GFC. Within countries, trust may also vary significantly across specific public institutions, being stronger for social services than for political bodies. Cross-section evidence shows a strong, positive relationship between public trust and per capita income, suggesting an association between trust and development, albeit causality is unclear.[4]

To dig deeper into the drivers of public trust and its impact on institutional effectiveness we can draw on recent work developed by the OECD on the subject (OECD, 2017). This work proposes a taxonomy distinguishing five dimensions of trust: reliability, adaptability, integrity, openness, and fairness.

Reliability refers to the extent to which an institution can deliver on the expectations set upon it in an effective and predictable way, reducing uncertainty from the public. Reliability of an institution depends and can be assessed on the basis of the clarity of its mandates and specific goals; the quality of its organization, planning and decision-making process, and its operational efficiency, including its capacity to command the appropriate financial, technical and professional resources.

Adaptability refers to the capacity to recognize changes in the environment, either economic, social, technological or institutional,

3. The broader concept of trust in government institutions is not delinked from the more specific one on central banks. For the case of New Zealand, Hayo and Neumeier (2017) find a statistical connection between overall trust in government institutions and public trust in the Reserve Bank of New Zealand.

4. There is also evidence on the statistically positive relationship between trust and central bank independence, though the link is not linear (Berggren *et al.*, 2014).

and to adapt to them without compromising its commitments to the public. Long-term planning, research, market intelligence and risk management are important mechanisms in this regard. To be adaptable while remaining reliable, an institution should be able not only to identify changes, new trends and risks, but also to explain them to the public, including the adjustments that may be required from them.

Integrity means putting the general interest entrusted to the institution above the particular interests of its authorities, employees or other narrow groups. This means far more than strict regulations and effective control; it may require benchmarks, ethics, checks and balances and openness to scrutiny that can respond to changes in social standards of accepted behavior, which may move faster than legislation.

The latter entails with *accessibility*, which refers to the ability of an institution to understand people's needs, leverage a wide pool of information and achieve higher levels of compliance. To be accessible, an institution should develop active and passive transparency mechanisms, seek feedback from the public and to foster dialogue and consultation with stakeholders.

Lastly, *fairness* acknowledges differences across society and that institutional actions may be far from neutral. As a component of trust, fairness involves being aware of such differences and to find ways to prevent, mitigate or compensate redistributive effects that are particularly undesired. Within an institution, fairness also involves the creation of a working environment that fosters productive exchange of ideas, free of harassment and discrimination.

Fostering trust in a central bank

The OECD taxonomy may be useful in providing a conceptual basis to go beyond generalizations on public trust and to take a more proactive approach to nurture it. In particular, it provides a good framework to develop ways to assess trust and to identify concrete levers that an institution can use to foster trust. However, can this framework be applied to a central bank?

In my view, this is not only possible, but necessary as well. Assessing trust on a central bank by inserting a question in an opinion survey suffers from the same limitations as with government institutions and a few more. Answers to a broad question may be more reflective of prejudice than of attitudes that may shape the response to future policy decisions or incoming information and may come too late in a process of social or market change to make any difference. In addition, experience with opinion surveys in different countries has shown that no more than half of respondents have some basic knowledge of central banks.

Adopting a more systematic and rigorous approach to assessing trust in the central bank may not only help address these shortcomings but also to acknowledge the full diversity of its responsibilities. I have already noted research stressing the relevance of credibility for the effectiveness of monetary policy, but credibility and public trust may be equally important for financial stability, the issuing of currency, or the generation of statistics.

Moreover, one can conceive that trust across these functions could be somewhat connected. Loss of trust from a misconceived financial intervention or from distorted statistics may spillover to the way stakeholders assess the credibility of monetary policy. To foster trust, a central bank must go beyond the conduct of monetary policy to focus on how to develop reliability, adaptability, integrity, openness and fairness in its different areas of work.

In the context of central banking, reliability is not equivalent to a dovish monetary policy giving priority to shortsighted demands to stimulate the economy, but to do the proper balancing of risks to align monetary policy with long-run social welfare. It means acting in a coherent way, showing thorough decision-making, carefully explaining reasons and arguments behind every action, conducing predictable decisions, and running efficiently the central bank as an organization. For this, I consider essential a clear framework for monetary and financial policy, data-driven decision making, unquestionable technical capacity and statistics, and skillful crisis management.

Reliability of a central bank, in turn, can be assessed based on the accuracy of its projections, its ability to identify financial risks, the quality of its statistics and the safety of the domestic currency and payment systems.

For adaptability, a central bank must develop its analytical skills to identify structural changes in the economy and emerging sources of risk, telling them apart from necessary innovation. To this end, it may need to deepen its knowledge of markets and agents, and to be on top of technological developments. Adaptability also depends on the preparedness to react to unforeseen events.

Central bank integrity requires appropriate access to information, control of conflicts of interest, strong middle office arrangements in market operations, and effective auditing across different areas and processes. For accessibility, communication of monetary policy is essential, as well as analysis and communication of financial risk, consultation in the issuing of new regulations, and well-structured accountability. The fairness dimension of trust can be enhanced through prevention of crises and risk management, financial education and inclusion, and securing equal opportunities in staffing and promotion decisions.

Assessing public trust in a central bank across these dimensions does not need to start from scratch. Instead, it provides a framework to organize existing data in a more meaningful way. It can also shed a new light on how to read and use data coming from different streams of the literature. The substantial work on central bank transparency led by some of our participants in this Annual Conference is a good case in point.

In sum, after recognizing credibility as the main asset of a central bank, especially an independent one, we can conclude that drawing on parallel work on trust in institutions may provide a useful framework to assess the current situation and to guide action to address existing gaps and vulnerabilities.

Trust in the Central Bank of Chile

The experience of the Central Bank of Chile can illustrate some of the ideas above.

The IMF study on the importance of credibility for monetary policy underscored anchoring of inflation expectations in Chile as key to the effectiveness of its monetary policy and macro resilience in the face of external shocks. Deviations of long-term forecasts of headline inflation from target have been less than 0.1%–being the lowest for a sample of emerging countries, and even lower than a benchmark group of advanced economies. This is remarkable considering that inflation volatility in Chile has not been particularly low relative to other emerging economies.

Yet we do not see credibility as an immutable attribute, given the dynamism of trust in institutions in the public opinion and market perceptions. We believe that a positive past record helps, but trust can deteriorate in a number of ways, some of them pretty fast, in the face of new standards and developments. Therefore, trust needs to be protected and enhanced in a systematic way with different stakeholders in the different dimensions of activity of the CBC.

This is well reflected in the *2018-2022 Strategic Planning* under course. This was based on an unprecedented consultation of stakeholders and participatory internal process. It defined as a vision for the Bank to be a trustworthy technical institution, known for its high standards in achieving its institutional objectives. On this basis, we have launched a number of initiatives aimed at fostering public trust in terms by improving its reliability, adaptability, integrity, accessibility and fairness.

To improve its reliability, the CBC has taken a thoughtful process of revision of its framework of monetary policy and forward guidance. Great emphasis has also been given to strengthening the technical toolkit to identify and communicate sources of financial risk.

With a focus on adaptability, we have introduced special chapters, analytical boxes and companion studies to our flagship reports. We have also launched the Technological Observatory with the goal of identifying new sources of risk, and the creation of the *Corporate Risk Area* within the CBC.

For integrity, we have broadened the framework and coverage of declaration of interests among executives and staff in sensitive functions, and have strengthened our external auditing committee. Some initiatives to improve the Bank's accessibility include regular presentations of Bank reports throughout the country, the development of market intelligence mechanisms and the upgrading of communications by creating an Institutional Affairs Division. To foster fairness we are also deepening our analysis of the economic and financial behavior of households and raising our contribution to financial literacy and education to the highest world standards.

Last, but not least, the CBC launched an external evaluation of its performance in the two central areas of monetary policy and financial stability by convening a panel of reputed academics and central bankers, some of whom are here today. We have committed to present the report to the Chilean Senate next September and to take the panel´s recommendations as a guidance to further strengthening reliability, adaptability and transparency of our work in the years to come.

Closing remarks and acknowledgements

In sum, I underscore the importance of public trust as foundation of modern monetary policy and for the legitimacy of independent central banks in performing their broader mandates. This is ingrained in the agenda of our Annual Conference this year: new challenges to central bank independence, the management of central bank credibility, and the designing of the best communication strategies for an effective monetary policy.

I would like to thank Ricardo Reis for being the external organizer of this Conference, as well as to Ernesto Pastén and Diego Saravia for being our local counterparts. I also thank all presenters and contributors to our program and the conference volume that will be published thereafter. I also thank to our friends and colleagues from the IMF for being here and for organizing the conference further down the week.

Let me finish by thanking Alejandra Rozas, Camila Figueroa, Paloma Navarro, María José Reyes, Felipe Leal and both the Public Affairs Department and the Research Department for all their invaluable help managing the challenging logistics of organizing these two conferences together.

Thank you, have a pleasant stay in Santiago and a fruitful discussion over the next two days.

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Risks to Central-Bank Independence

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Central banking today faces a number of existential challenges. On the political side, and particularly after the financial crisis, the public has come to expect central banks to take on a dizzying array of responsibilities, some far beyond their power or remit. These include everything from enhanced financial regulation to quasi-fiscal policy to mitigating economic inequality. Some recent populist proposals appear to be based on the presumption that central banks can issue large quantities of bank reserves indefinitely without any long-term inflationary or tax consequences. On the technocratic side, many central banks struggle with the trend decline in global real interest rates that steepened notably in the aftermath of the financial crisis. This decline has, in many cases, left the monetary authorities with little space to cut policy interest rates in the event of steep recession, much less in a financial crisis, and trying to put the best public face possible on much weaker "alternative monetary instruments," such as quantitative easing (QE). At the same time, the fact that many "alternative monetary instruments" are in fact forms of fiscal policy—that could be implemented just as well or even better by finance ministries—has made the challenge of preserving central-bank independence against strong political headwinds even harder.

This paper aims to give an overview of the challenges and to suggest possible ways forward. I would like to highlight especially two issues closely related to my own both distant and recent work. First, I would like to argue that, while it is true that central banks have been to some extent victims of their own success—inflation has fallen dramatically over the last 30 years in virtually every country

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in the world—, they have also been victims of their own dogmatism. This dogmatism, which I have termed elsewhere as "inflation-targeting evangelism," has left too little flexibility for dealing with outside-the-box events or "Knightian uncertainty" in economics jargon. Second, many central banks have been too slow and too reluctant to recognize that changes in the payments and financial environment affords them the possibility of essentially eliminating the effective lower bound on interest rates that hamstrings monetary policy today and may well impinge over long periods in the future.

Let me begin with a brief history of credibility and central-bank policy, starting with my 1985 paper on "The Optimal Degree of Commitment to an Intermediate Monetary Target," which first circulated as an IMF working paper in 1982. This paper introduced the idea of instituting an independent central bank as a solution to the time-consistency problem highlighted by Kydland and Prescott (1977) and Barro and Gordon (1981). It was difficult to publish this paper because, at the time, the idea that there could be an institutional solution to the monetary-policy credibility problem was not the direction of travel in the literature, which instead concentrated on using ever-more sophisticated game theory constructs. Referees commented that, since all political economy is one big supergame, an "independent" central bank is merely a superficial veil that the government could strip away whenever convenient. The idea that the creation of an independent central bank could create useful frictions and barriers to government interference and that this might be enough to constitute meaningful independence was not yet widely accepted, although of course it is now taken for granted.

My 1985 paper is sometimes referred to as "the conservative central-banker paper" because, as one illustrative example, it demonstrates how in some instances society can benefit by appointing an agent to head the central bank who places a greater weight on inflation stabilization than on society as a whole. Despite the fact this distorts the central bank's response to shocks, it also serves to enhance anti-inflation credibility thereby lowering the profile of interest rates.

But, as the title of the paper indicates, the main thrust of the analysis was about all the kinds of rules the central bank could adopt to retain stabilization capacity while enhancing anti-inflation credibility. The paper not only introduces inflation targeting but also considers a range of other options, from nominal GDP targeting to money-supply rules to interest-rate rules.

An absolutely central conclusion is that, in any realistic model, there is a fundamental tradeoff between credibility and flexibility or, put differently, between flexibility and commitment. In any given period, the central bank would like to have free rein to choose stabilization policy as needed but, at the same time, if the public believes the government will abuse this privilege in the future, it will lead to higher interest rates and inflation. As an example of how misguided it is to dogmatically focus on one model of the economy—and therefore implement a rule that is too inflexible—, the paper discusses how it would have been a mistake to enshrine Milton Friedman's fixed-money-supply-growth rule into the U.S. constitution, as he had advocated. Brilliant as he was, Friedman did not forsee the radical changes that would take place in payment systems that would make the demand for the monetary base extremely unstable. In the simple model in my 1985 paper, the credibility versus commitment tradeoff translated into placing only a finite weight on achieving the rule, leaving room for discretion. In equilibrium, this leads to a modest inflationary bias (or, with different parameters, deflationary bias). Since then, much richer and deeper interpretations of this tradeoff have been analyzed. For example, Flood and Isard (1989) and Lohman (1992) offered an alternative and potentially more flexible approach involving an escape clause, which they defined as being triggered by a shock above a specified magnitude, but might potentially be reinterpreted as allowing for Knightian uncertainty[1] By the way, my analysis treated the socially desirable inflation rate as a parameter that might potentially change over time, say, with measurement changes or index changes.

Back in 1985, only a very small number of countries had meaningfully independent central banks. Since then, central-bank independence—in some form—has become the international norm, not only in advanced economies but also in emerging markets and even in many developing economies. And there is strong evidence to suggest this development helped produce the worldwide decline in inflation that followed. Parenthetically, one can argue that a major reason why so many countries were eager to adopt the euro in the last 1980s and 1990s was the belief that it would deliver their countries German-level inflation. Yet, it now seems apparent that if the euro had never been formed, and if countries such as Spain, Italy, Portugal, and Greece had instead instituted independent central banks while

1. For the state of the art in this literature, see Halac and Yared (2019).

retaining their own currencies, they would have likely achieved the much lower inflation without the straightjacket of the euro.

Later on, however, a literature evolved arguing that there was no tradeoff between flexibility and commitment, most notably the influential work of Taylor (1993) and later Svensson (1996). If the central bank chose the right rule (Taylor's has the advantage of simplicity, while Svensson's algorithm is more general but more complex), there did not have to be a meaningful tradeoff. These are both towering contributions; for example, virtually every central-bank research department has explored Taylor rules even if the results were not always made public. But events of the past decade have undermined this view that central banks should always stick to a rule without an escape clause to deal with outside-the-box events such as financial crises. As for the Taylor rule, it has become increasingly clear that Taylor's (1993) target policy interest rate of four percent is too high and, even more importantly, present circumstances dictate that there should be at least double the weight on output deviations than on inflation deviations. Had the central bank been legally bound to follow the original rule, it would have been highly problematic the past fifteen years, albeit perhaps less so than Friedman's fixed money rule. Indeed, any reasonable rule needs to allow for changing parameters, but then of course, that opens the door to the more opportunistic inflation that Kydland and Prescott (1977) and Barro and Gordon (1983) were concerned with. Svensson's forecast targeting is more flexible (albeit requiring vastly more central-bank transparency to make it credible), but on the other hand, it has many issues of its own (Kozicki, 2019).[2] Svensson (2019) now notes that, in some circumstances, an escape clause must be explicitly considered, which brings us back full circle to Lohman (1992), Flood and Isard (1989), and the tradeoff between flexibility and commitment emphasized by Rogoff (1985). In my view, central banks' failure to quickly activate an escape clause during the 2008 financial crisis helped contribute to the depth and duration of the recession.

On top of these technical policy challenges is the threat, and in some cases the stark reality, of creeping political interference in central-bank policy. Central banks have long been under assault from the right for expanding their balance sheets too much during the financial crisis, but now they are under attack from the ascendant left for expanding their balance sheets too little.

2. Available at https://www.chicagofed.org/~/media/others/events/2019/monetary-policy-conference/2-kozicki-comments-strategies-pdf.pdf

This is a remarkable shift. Not too long ago, central-bank independence was celebrated as one of the most effective policy innovations of the past four decades, owing to the dramatic fall in inflation worldwide. Recently, however, an increasing number of politicians believe that it is high time to subordinate central banks to the prerogatives of elected officials. On the right, U.S. President Donald Trump and his advisers routinely bash the U.S. Federal Reserve for keeping interest rates too high. On the left, former British Labour leader Jeremy Corbyn famously called for "people's quantitative easing" to provide central-bank financing for government investment initiatives. The "Modern Monetary Theory" (MMT) is an idea in the same vein.

There are perfectly healthy and legitimate discussions to be had about circumscribing the role of central banks, particularly when it comes to the large-scale balance-sheet operations (such as post-crisis quantitative easing) that trespass into fiscal policy. However, if governments undercut central banks' ability to set interest rates to stabilize inflation and growth, the results could be dangerous and far-reaching. If anti-inflation credibility is lost, governments may find it very difficult—if not impossible—to put the genie back in the bottle.

Complicating matters further, central bankers must figure out how to give normal monetary policymaking teeth at the zero lower bound, given today's ultra-low inflation and real interest rates. The current reliance on quasi-fiscal policies is not only ineffective outside crisis situations where markets breakdown but also dangerous because it lends weight to the argument that finance ministries should have more control over central banks.

Indeed, the primary challenge confronting central banks is not that they are too powerful, but that some see independent montary policy as losing relevance. Inflation has been so low for so long that many have forgotten what it was like before independent central banks were established to rein in double-digit price growth. Instead, it has become increasingly popular to argue that low inflation is a hardwired feature of the twenty-first-century economy. And yet the complacent dismissal of future inflation risks—and thus of the need for central-bank independence—has all the hallmarks of the "this time is different"[3] mentality that has been a recurrent feature of economic history.

3. Available at https://press.princeton.edu/books/paperback/9780691152646/this-time-is-different

1. Four Challenges for Modern Central Banks

Central banks today face four main challenges. First, global inflation has been so low for so long that people have started to forget what it was like in the pre-central-bank-independence era. Second, monetary paralysis at the effective lower bound on interest rates has greatly limited the effectiveness of monetary stabilization policy in normal recessions. (One must acknowledge there is some debate about this.) For example, there is a wide range of estimates over the effectiveness of quantitative easing and, equally importantly, whether finance ministry actions ultimately dominate central-bank actions when it comes to debt maturity of the consolidated government balance sheet. But, over time, it has increasingly come to be recognized that neither QE nor forward guidance is responsible for the trend decline in global real interest rates. (Even within the U.S. Fed, estimates for the effects of QE are fading; see Chung and others, 2019.) Third, although few seriously question the importance of central-bank emergency powers should there ever be another deep systemic financial crisis, the zero bound (the effective lower bound) implies very limited capacity to stimulate a sluggish post-crisis economy. Even the most intense advocates of QE no longer pretend that it can produce the kind of impact that a 500 basis-point cut in interest rates can produce. Fourth, there is a growing view that for advanced economies, ultra-low interest rates make higher government debt a free lunch, with economic growth reliably preventing debt-to-income ratios from growing. The implication is that much higher debt can be accommodated without ever raising taxes, much less resorting to inflation, again undermining the case for having central-bank independence. I will address each of these four issues in turn.

2. Role of Central Banks in Controlling Inflation

Perhaps the greatest cause of the discontent is that independent central banks have been so successful in bringing down inflation that some now view "lowflation" as a hardwired feature of the 21st-century economy, with the services of independent central bankers no longer being required. The complacent dismissal of future risks to inflation is surely a classic example of the recurrent "this time is different" mentality" Carmen Reinhart and I chronicled in our 2009 book on the history of debt, inflation, and financial crises.[4,5] One does not have to travel very far down memory lane to see that not so long ago high inflation roamed the earth. As recently as 1992, there were 45 countries with over 40 percent inflation.[6] In the 1970s, the United Kingdom and Japan experienced inflation in excess of 20 percent, with U.S. inflation also in double digits. What brought this era of epic inflation to an end? Yes, the influx of inexpensive Chinese imports played a role, as did the rise of computers. But if one looks at the timing of when different countries succeeded in bringing down inflation, there is little question that the most important role by far has to be assigned to the rise of central-bank independence.

Starting in the 1980s across much of Europe and spreading around the world in the 1990s, one country after another granted its central bank a significantly greater degree of independence. In 2019, despite anomalies such as Argentina and Venezuela (both countries where central-bank independence was severely compromised), global inflation is now so low—the April 2019 IMF World Economic Outlook forecasts advanced economy inflation at just 1.6 percent—that the question has become whether advanced-country central banks have the capacity to generate it again. This has been true since the 1990s in Japan, but is increasingly true around Europe as well. Even in the United States, where trend growth is higher, long-term inflation expectations derived from indexed bonds show inflation expectations going below two percent, with survey measures also showing sharp declines.

One might thank that long-term expectations of two percent inflation or below are proof that central-bank credibility has strengthened. But this does not consider that, if there is ever a severe fiscal shock—for example, a major physical or cyber conflict, a pandemic, an environmental catastrophe, or a divisive populist government that pushes fiscal limits deep into vulnerable territory—, moderate inflation could be an important safety valve. Even a small chance of inflation being near double-digit for a few years should significantly push up long-horizon expected inflation.

Counterbalancing that, and perhaps helping to explain why long-term expected inflation appears to be so low, is that markets likely

4. See Reinhart and Rogoff (2009).

5. An excellent history and overview are provided in Ha and others (2019). A much earlier study is provided in Rogoff (2003).

6. See Rogoff (2017).

recognize a significant chance that inflation will undershoot its target for very long periods. Federal Reserve economists Michael Kiley and John Roberts (2017), for example, find in their simulation that even the U.S. Federal Reserve is likely to be up against the zero bound 30–40 percent of the time (of course this estimate is sensitive to model assumptions, as Chung and others [2019] argue). Lilley and Rogoff (2019) show that fear of the zero bound is such that during many periods, including the most recent date as of this writing, markets have attached a non-zero probability to even the Federal Reserve adopting mildly negative interest rates.

3. Role of Central Banks in Macroeconomic Stabilization

Aside from maintaining low and stable inflation, a second task of most central banks is to engage in macroeconomic stabilization policy, attempting to smooth out the business cycle. Although there is never-ending controversy in the academic literature, by and large, it is widely accepted that activist monetary policy has played an important role in smoothing out post-World War II business cycles. Part of the way they have achieved this is by standing ready to sharply cut interest rates in a recession, by an average of over five percent in the case of the United States.[7] Obviously, with the European Central Bank (ECB) and the Bank of Japan already at the zero bound, and the U.S. Federal Reserve just 2.5 percent above it, cuts of this magnitude will not be possible if the next deep recession occurs anytime soon.

So, what else can monetary policy do? Much less than most observers think. The contemporary policy debate on central banking has been greatly clouded by crippling confusion over the conceptual distinction between monetary policy and fiscal policy. Central banks, not least the U.S. Federal Reserve, played their part in exacerbating this confusion by overselling and mislabeling "alternative monetary-policy instruments." In the first place, these are not nearly as effective in stimulating output and inflation as is normal interest-rate policy and, beyond that, they are really better thought of as quasi-fiscal instruments where, importantly, central banks are junior partners to Treasuries and finance ministries.

7. See Rogoff (2016) or Yellen (2016).

Early event-based studies seemed to imply that, at the zero lower bound on interest rates, central-bank purchases of long-term government bonds can have significant stimulus effects by pushing down long-term interest rates. Over time it became clear, however, that most of the action in long-term interest rates stemmed from a trend decline that had little to do with QE, and initially optimistic assessments of the effects of pure QE policies have now been sharply tempered.[8] In essence, when the central bank purchases long-term government debt by issuing overnight bank reserves that pay the same as very short-term Treasury-bill interest rates (which both happen to be zero in a liquidity trap), it is not "printing money," rather, it is maturity transformation of the consolidated government debt balance sheet. This generally has some effect, as short-term debt tends to be lower cost. However, shortening the maturity structure of government debt exposes the government to refinancing risk.[9] In any event, compared to normal interest-rate policy, the stimulus effects of maturity transformation on output and inflation appear to be of second order. And importantly for our discussion here, the role of the central bank is secondary and, to a first approximation, unnecessary. Treasuries and finance ministries can perfectly well engage in maturity transformation on their own without any help from the central bank, and they do so all the time.[10] I admit there is still debate over the issue, but I would argue that it stems largely from lingering confusion in financial markets. Indeed, Lilley and Rogoff (2019) use options data to show that in the early years after the financial crisis, markets placed a nontrivial weight on the possibility that QE might end up leading to high inflation.[11] This confusion is not likely to be repeated, especially given the now long experience of Japan and the European Central Bank, which despite massive QE programs over a very long period, have barely been able to tread water when it comes to rising inflation.

8. See Chung and others (2019).

9. Blanchard, in his 2019 American Economic Association Presidential Address, argues that the risk of runs does not much depend on the size of debts, but in the canonical models of Calvo (1988) and others it does, and for the same reasons maturity structure greatly matters as well. See, especially, Farhi and Maggiori (2018).

10. See Greenwood and others (2015).

11. Lilley and Rogoff (2019) show that during the first years of QE (through QE II and QE III), markets attached a nontrivial chance to having inflation in the U.S. exceed 100% over a ten-year period. That is, the early days of QE, markets put some weight on the assessment that QE is akin to printing mass quantities of money, and correspondingly to having very high inflation.

It was not only central banks that created confusion about the potential inflation effects of QE. It is surprising how often one reads economic commentators and even serious policy macroeconomists characterize the quantitative easing policies that central banks engaged in during and after the financial crisis as "money printing," and how difficult it is to explain to them that their ingrained knee-jerk understanding of how monetary policy is just wrong in a liquidity trap when non-interest bearing money becomes a perfect substitute for zero-interest bearing Treasury bills. An incorrect "monetary" characterization of quantitative easing led some to warn that large-scale central-bank asset purchases would inevitably cause inflation. In fact, the right way to look at QE purchases of long-dated government bonds is as a shortening of the maturity structure of consolidated government debt. Central banks may be involved in debt maturity management but, except for very short periods, central banks' actions are generally dominated by Treasuries, which can command much larger volumes, even compared to massive central-bank QE.

Most fundamentally, let us not forget that even the most independent central bank is a wholly-owned subsidiary of its country's Treasury. At the end of the day, the central-bank balance sheet is subsumed in the consolidated government balance sheet. The central bank may earn profits on seigniorage or through its asset trading (or losses), but these are fully passed onto the government after expenses. Thus, any proper definition of government debt should definitely include interest-bearing central-bank debt (or interest-bearing bank reserves). Central-bank holdings of government debt are just in-house bookkeeping entries; what actually matters are private-sector (including foreign government entities) holdings of government debt. In the United States, the Federal Reserve only issues debt (reserves) to the financial system, but in some countries, central-bank debt can be more widely held. The main instrument modern central banks genuinely control is the very short-term policy interest rate, i.e., the federal funds rate in the case of the United States.[12] Those who are still convinced that QE works perhaps

12. By tradition, most central banks also control intervention into foreign exchange markets, since otherwise "impossible trinity" implies that central banks and treasuries could be acting at cross-purposes. Of course, in the United States, the postwar Fed-Treasury accord ceded exchange-rate policy to the Treasury, but since the United States has generally been passive in its foreign exchange policy (other than verbal statements), this has not really mattered. In principle, there is no reason the Treasury cannot be fully in charge of managing foreign exchange reserves as long as it does not try to manipulate them to control the exchange rate. It should be noted that in principle, if the Treasury flooded the market with very short-term debt, it could impinge on central-bank control of the short-term policy rate.

neglect the importance of learning. Over time, markets are learning; in Japan they have learned the lesson very well.

It is, of course, another matter, when the central bank purchases private debt or private assets. In my (2016) book on the past, present, and future of currency,[13] I refer to such a transaction as "fiscal quantitative easing" as opposed to pure quantitative easing, in which the central bank buys Treasury debt. Fiscal quantitative easing may be looked at as a combination of two actions, the first in which the U.S. Treasury issues government debt and buys private debt (or equivalently guarantees private debt), and the second in which the Fed buys up the government debt (pure quantitative easing). The only difference between the two cases is bookkeeping, as in one case the Fed carries the private-sector default risk, while in the other case the central government carries the risk directly instead of indirectly.

The European Central Bank is a special case, because there is no supernational European government with taxing power sufficient to underpin a central bank. When the European Central Bank does "quantitative easing," it is in effect using the credit standing of the fiscally stronger eurozone states to subsidize borrowing from the weaker states. This is not a criticism *per se*, and in fact ECB quantitative easing policy did much to alleviate severe stress at the peak of the eurozone debt crisis. ECB quantitative easing is in many ways akin to using short-maturity Eurobonds to proportionally soak up longer-dated national debts. Put differently, the ECB QE policy of issuing reserves to buy up national debts is equivalent to creating a synthetic (very) short-term Eurobond (recalling again that short-term debt and money pay the same rate at the zero bound).

Of course, the preceding discussion focuses on cases where QE does not actually involve engaging in inflationary finance. When interest rates are above the zero bound—in "normal" times—then central-bank issuance of reserves certainly will stoke inflation *if* the reserves do not bear interest. In positive interest-rate territory, increasing high-powered money to buy up long-term government debt is like printing money and does tend to push up inflation. However, this is not the case if the reserves pay the market rate of interest, which is exactly what is happening today in many countries. For example, the U.S. Federal Reserve has been paying interest on overnight bank reserves at a rate that is slightly above one-week Treasury bills (which are slightly more liquid). So even though interest rates are now above the zero bound,

13. See Rogoff (2016).

quantitative easing (or quantitative tightening) has only a minor indirect effect on inflation since it is only maturity transformation, not money printing.

Obviously, if the central bank is buying up private debt instead of government debt, the effects are larger, since this involves subsidies to select private-sector entities and creates actuarial liabilities for taxpayers. There is little debate that "fiscal QE" was very important during the financial crisis. However, in most advanced economies, the emergency fiscal powers delegated to the central bank for dealing with financial crises were not intended for routine use in picking winners and losers. Again, the European Central Bank is a different animal, given the severe limitations that remain on eurozone-wide governance.

4. Role of Central Banks in Dealing with Financial Crises

This takes us to the third task of central banks, which is dealing with financial crises. There are good reasons why central banks are imbued with emergency powers to buy up certain kinds of private debt in a financial crisis (exactly what kinds of debt depends on the country). Central banks can also backstop some kinds of bank debt directly with guarantees, as the U.S. Federal Reserve did at the height of the 2008 financial crisis. Central banks have several short-term advantages over Treasuries in emergencies. First, in most countries, they are given broad latitude to act quickly and decisively, unencumbered by the need to pass legislation. Second, as financial regulators, they have an extensive relationship with and knowledge of the financial sector, again facilitating fast action. Third, central banks tend to have considerable personnel devoted to technical financial issues.[14]

Even in a financial crisis, the central bank remains an agent of the government. If there are major losses, for example when the central bank purchases massive quantities of private debt that end up in various stages of default, these will ultimately have to be transferred to the government, possibly in special purpose vehicles. This is a routine

14. The third advantage is not necessarily a structural feature of central banks but one that has developed in many countries over recent years. Back in the early 1970s, when the relative pay in the U.S. civil service was much higher than today and Paul Volcker was the undersecretary of the Treasury for international monetary affairs, the U.S. Treasury was the hotbed of ideas and scholarship in the transition to floating exchange rates, not the Federal Reserve.

operation in emerging markets that experience recurrent banking and debt crises. Most outside observers give the major central banks high marks for how they used their quasi-fiscal powers to manage the initial onslaught of the 2008 financial crisis, and to the European Central Bank for strongly invoking its quasi-fiscal powers to alleviate the eurozone debt crisis in 2012. However, it is dangerous when quasi-fiscal policy becomes routine and, as I have already emphasized, this has become a problem for preserving central-bank independence.

After preventing a wholesale collapse of the banking sector in a financial crisis, central banks were expected to promote recovery during the long sluggish growth period that typically follows (Reinhart and Rogoff, 2009). But the zero bound on interest rates (or the effective lower bound) proved extremely constraining.[15] There are indeed other policies that can help restore recovery after a crisis. If debt write-downs are not possible—which many of us have argued would be the first-best response even if it involved higher government debt—, then the next line of defense after monetary policy is fiscal stimulus.

Fiscal stimulus can take the form of debt-financed government spending and tax cuts, but it can also take the form of redistributive policies that favor low-income individuals with a high marginal propensity to consume. Compared to normal monetary policy, however, fiscal policy is a blunt instrument that is always going to be highly contentious and political. Nothing illustrates this more clearly than the case of the United States where, to a first approximation, a Democratic government would inject stimulus through a massive increase in government spending, while a Republican government would inject stimulus through tax cuts. Debt write-downs, while arguably being the single best targeted and most effective strategy in a financial crisis, are even more fraught politically. Such tensions make it difficult to wield fiscal policy with the precision and credibility that well-designed independent central banks can achieve.

Even though there are other tools, the inability of central banks to have a larger role in stimulus policy has been a major problem and could well be an even bigger one in the future. Several ideas have been advanced to restore the effectiveness of monetary-policy stimulus in a deep systemic financial crisis but, by and large, most of them work by attempting to transfer fiscal powers to the central bank that do not sit easily with their limited democratic accountability.

15. Debt write-downs could have included write-downs for subprime mortgages in the case of the United States, and for periphery country debts in the case of the eurozone.

A prime example is "helicopter money," where the central bank on its own accord issues currency (or bank reserves) and transfers the revenue directly to citizens on a per-person basis. It is remarkable how many leading commentators and influencers endorsed this idea in one form or another, even leading financial newspapers.[16] Of course, if central banks had the power to issue helicopter money, there are cases where it would be welcome, particularly in a crisis where the rest of the government might be at loggerheads and unable to act. The problem is that central banks are not endowed with the power to directly distribute or redistribute income to ordinary citizens. This right is reserved by the legislatures and if central banks were to trespass, they would quickly get reabsorbed into Treasuries. In Paul Tucker's[17] framework, decisions over helicopter money are not a suitable power to give to unelected officials, no matter how earnestly opinion writers cry out for doing so.

There is a perfectly valid and legitimate way to engage in the full equivalent of helicopter money, which is for the legislature to engage in debt-financed transfers and then have the central bank buy up the resulting debt.[18] (In fact, it would be more or less equivalent to leave the central bank out of it entirely and finance the transfers with one-week debt, which would give virtually the same effect at the zero bound.) If the legislature cannot agree on the transfers, central banks can complain, but if they try to do something about it, their independence will quickly disappear. Yes, there are some political-economy arguments claiming that, somehow via helicopter money, central banks can cut the Gordian knot when fiscal policy is stuck, but a deeper inspection shows that, unless central banks credibly raise their inflation targets, the effect is zero. And frankly, if central banks were able to credibly raise inflation expectations, then they would be able to drive down real interest rates without cutting the nominal rate and the whole issue of helicopter money would be moot. Bernanke's suggestion that central banks merely decide the quantity of helicopter money to be issued but not how it is allocated does not really solve the problem, since this too is a fundamentally political decision that

16. For thoughtful (but ultimately unsuccessful) attempts to rationalize central-bank issuance of helicopter money, see Turner (2015) and Bernanke (2016).

17. See Tucker (2018).

18. Indeed, one can argue that the Japanese central bank has engaged in helicopter money over the years, in the sense that there have been years where the central government has run large deficits and the central bank has purchased more than 100% of the new issuance.

needs to be made by elected officials. Bringing central banks into this territory is a recipe for their demise.

Another similarly dubious idea, suggested by almost as many commentators, is for a central bank stuck at the zero bound to buy up government debt and then destroy it. The most likely outcome is that this will do absolutely nothing. If one family member tears up debt to another, it has no effect on the family's total assets. When the Fed tears up debt it is owed by the Treasury, there is no effect on the indebtedness of the consolidated government to the private sector.

It is possible that having the central bank destroy its government debt will spark investor concerns about internecine government warfare that could end up with higher inflation. Investors may worry that if the central bank ends up technically bankrupt, the government will make recapitalization conditional on higher inflation, or perhaps it might even use the occasion to bring the Fed offices back into the Treasury building. (In the case of the United States, a "bankruptcy" of the central bank would be entirely contrived, because the Fed's liabilities are in dollars and it has the right to print them.[19]) To suggest that tearing up debt is a serious policy for dealing with the zero bound is just nonsense. It creates expected inflation in an unpredictable and chaotic manner by playing Russian roulette with central-bank independence.

The fact the central bank might not be able to significantly raise inflation in a financial crisis is a problem for many reasons, one of which is that (unexpected) higher inflation provides a simple time-tested mechanism for reducing the real value of private debts. If the Fed had been able to raise inflation to, say, four or five percent for several years after the financial crisis, it would have been very helpful in taking the edge off of private-debt problems that were not easily dealt with otherwise. But at present it lacks the instruments

19. Suppose the economy is at the zero bound, and the central bank tears up its holdings of government debt. Since the central bank is not in tightening mode at the zero bound, for a while it does not miss the government debt on its books because it has no need to sell it to pull liquidity out of the system. Now suppose the day finally comes where the central bank needs to sell government bonds, but it does not have any, and suppose all the gold and foreign exchange are gone too. Is it helpless? Hardly. First, it can stop passively accommodating the transactions demand for paper currency; the Fed printed over $90 billion in 2018 (with roughly 80% being hundred-dollar bills). And if allowed, it can issue special-purpose bank reserves or debt that pay higher interest than the cash or bank reserves it is buying up. If the Federal government blocks all those channels, the central bank must let inflation rise until the central government decides to recapitalize it.

it needs even to fight deflation in a financial crisis, much less to create inflation. We shall return to this point in discussing the case for negative interest rates.

5. Role of Central Banks in Dealing with Government Debt

We now come to the fourth and final point on our list of recent challenges to central banks, which is that they are no longer needed as bulwarks against the temptation to inflation away excessive government debt. In some sense, this is a corollary of the first challenge, that inflation has been so low for so long that people have come to believe that it can never come back. Unlike short-term stabilization policy, however, holding down inflation expectations even as debt rises is a long-term one. There are really two separate ideas in the mix here, the first of which is reasonable but debatable, the second of which is dubious.

The first idea is that thanks to the steady decline in long-term real interest rates on "safe" government debt, governments can now issue much more debt than they used to. This, as we have already discussed, makes perfect sense, albeit with important nuances, for example, the question of the maturity structure of debt. And in the case of the United States, the growing centrality of the dollar in the global financial system has likely reinforced America's "exorbitant privilege" and continued to feed the global demand for U.S. dollar assets, despite the United States' falling share of global output.

A stronger version of the "debt is completely benign" view was endorsed recently by former International Monetary Fund chief economist Olivier Blanchard in an interesting and provocative paper.[20] In essence, Blanchard argues that the economy is an inefficient equilibrium where, for whatever reason (excessive investment is the classic one), the rate of interest is below the growth of the economy. If this is a long-term steady state, then any one-time rise in government debt, potentially even a very large one, will have no effect on the long-term debt-to-income ratio because the growth outstrips the interest rate. Debt in this instance is a free lunch because the economy is investing too much anyway and in fact there is no need even to raise taxes to pay for it, at least in the range of current debt levels. This

20. See Blanchard (2019).

is doubly true if the funds are spent on high-return education or infrastructure investment (although this point tends to be overworked, given that less than four percent of government expenditure in advanced economies is dedicated to infrastructure investment).[21]

In sum, if high debt places no pressure on fiscal policy, then there will be no pressure on central banks to inflate it away either. And thus, there is one less reason why it is important that they be independent.

There are several debatable points. First is the contention that the economy is in an inefficient equilibrium as opposed to, say, having an equilibrium where interest rates are very low relative to returns on equity, so that risk drives the wedge, not low returns on investment. Perhaps the most debatable point is the claim that the risk of entering a fragile equilibrium zone where debt runs are more likely is independent of the level of debt. This is not what standard models suggest—it is surely no accident that investors are more concerned about high-debt countries than low-debt countries in crisis situations—and perhaps it also underestimates the extent to which historically "safe" assets turned out not to be, as shown by Farhi and Maggiori (2018).

This takes us to Modern Monetary Theory which, at least as I understand it, adds the still more extreme twist that the government can pile up debt longer and at lower cost by instructing the central bank to continuously engage in quantitative easing, issuing bank reserves to buy up long-term government debt. The effects of such a mandate depend on whether bank reserves bear market interest (as is now the case) or whether they are non-interest-bearing money. We have already argued that there is essentially no meaningful difference between having the central bank expand reserves to buy back newly minted long-term government debt and simply having the central government issue very short-term debt in the first place. If bank reserves pay interest, then the first-order effect of the MMT prescription is to drastically shorten the maturity structure of government debt. But if the reserves do not pay interest, then as soon as interest rates start rising, banks will rush to withdraw them and inflation will soar.

From the point of view of the consolidated government balance sheet, the central bank only plays a minor booking role in the MMT plan. Short-term debt is typically the cheapest way to finance government debt and there is a case to be made that, after the financial

21. See Abbas and others (2019).

crisis, the cost savings from issuing short-term debt have been even greater than usual.[22] One reason might be that, at the zero bound, investors worry that the potential for capital losses on long-term debt (for example, if interest rates rise significantly) is much greater than the potential for capital gains (since there is not much room to go down). But there is a very good reason why governments don't bet the farm on global real interest rates never rising again, since historically, they have an inconvenient habit of doing so in difficult times. Overreliance on short-term debt is risky—if global real interest rates were to rise, there would be immediate pressures to raise taxes and cut government spending. If the government were unable to respond quickly, then suddenly higher risk premia could exacerbate the problem. But nothing can make global interest rates for safe assets go up significantly, right? Wouldn't any conceivable shock make them go down?

If we have learned anything from the past, it is that economies can be subject to severe adverse shocks and tomorrow's shock may look completely and unpredictably different from the last shock. The model of Farhi and Maggiori (2018) illustrates a very important point. Markets—and policy economists—tend to extrapolate the present events far into the future and to exhibit "present bias." Put differently, the last big shock that hit raised the demand for government debt, the next one might not. It is one thing for a hedge-fund manager to take a big bet on the path of interest rates that they hope will work for a few years, after which they can retire. It is another thing entirely for a government to engage in this game, especially because it is neither easy nor desirable to quickly unwind high debt levels. Fiscal policy for a country needs to be robust, and debt maturity management is an important element of making it robust.[23]

To return to our theme of central-bank independence, the main decisions over maturity transformation are inevitably going to be made by the central government, while the central bank needs to retain control over inflation. If MMT has the central bank simply issuing interest-bearing reserves, then the "added twist" of QE policy is irrelevant. It will neither cause inflation nor give the central government any extra tools to run higher deficits. If, however, the central bank is forced to buy up government debt with non-interest-bearing money, then it is a recipe for inflation.

22. See Krishnamurthy (2012).
23. See Abbas and others (2019).

6. Instituting Effective Negative Interest-Rate Policy as a Means to Restore the Efficacy of Monetary Policy

What can be done to make central banks and monetary policy more relevant in today's low-interest-rate world? I have argued elsewhere that by far the cleanest and most effective idea is to make the institutional changes necessary for *effective* negative interest-rate policy. I highlight the word "effective" because even though a number of central banks have engaged in very mild negative interest-rate policy, none has tackled the most important issue, which is to discourage wholesale cash hoarding when rates turn too far negative. (A deeper analysis shows bank profitability is not going to be an issue if wholesale cash hoarding is dealt with properly).[24]

Due to space limitations, I only sketch the basic arguments here, but they are given in detail in part II of my 2016 book.[25] Also see the insightful recent discussion in Bordo and Levin (2019). The absolute cleanest solution, of course, is to move entirely to digital currency, but for many reasons, including privacy concerns and lingering barriers to financial inclusion, this is not advisable into the foreseeable future. I have argued for decades (Rogoff, 1998) that phasing out large-denomination notes would be a good idea for public finance reasons, and that even if this achieved only a modest benefit in terms of tax evasion and crime, the cost savings would be more than sufficient to compensate for the lost seigniorage that the underground economy currently provides, even for the U.S. dollar, which is by far the most widely used global currency, and certainly for currencies that are almost exclusively held domestically. If combined with administrative measures that shield most depositors from the effects of negative interest rates (since the objective is stabilization, not fiscal enrichment), as well as measures to tax large redeposits into the financial system, such an approach should allow for virtually unconstrained negative rate policy, as Rogoff (2016, 2017) and Lilley and Rogoff (2019) argue.

Eliminating large bills, say, $50 and above (or equivalents for other countries), should be enough to allow negative interest rates of

24. See Rogoff (2016) and Agarwal and Kimball (2019). As Rogoff (2016) argues, it is straightforward to shield the vast majority of small individual depositors from negative rates on bank accounts.

25. See Rogoff (2016) and Lilley and Rogoff (2020).

at least one to two percent, given storage and transport costs. Let's remember that we are excluding smaller depositors.[26] The central bank only needs to worry about large-scale hoarding by financial firms, insurance companies, pension funds, and the like. This is actually quite expensive if one considers insurance and storage costs. There are large fixed costs as well, which might be difficult to amortize if the period of very steep negative rates is short-lived. Adding in administrative measures that heavily regulate large-scale legal tax hoarding, as well as invoking taxes for wholesale redeposits of currency at the central bank should be more than sufficient. This should not be difficult if the central bank and the government cooperate in making the necessary legal and regulatory changes. Moreover, it is actually not necessary to have a system that is "watertight" as long as hoarding does not reach high levels.

But there is another idea first offered by Eisler (1933) that has been conceptually and mathematically analyzed by Davies (2005) and Buiter (2005) and more recently discussed in great practical detail by Agarwal and Kimball (2019). The alternative approach is to create a crawling peg exchange rate between electronic money (bank reserves at the central bank) and paper money. In this approach, the idea would be to move toward an equilibrium where all contracts and taxes were denominated in electronic currency. But transactions could be executed in either paper or electronic currency. During periods where the central bank was setting a negative policy interest rate (which also applies to central-bank reserves), the central bank would no longer accept paper currency at a one-to-one exchange rate with electronic currency. Instead, if the interest rate on electronic currency was -5 percent, then the value of cash in terms of paper currency, when tendered at the central bank, would depreciate at -5 percent as well. This idea is quite interesting albeit not quite as clean as it sounds, because in fact paper currency and electronic currency are not perfect substitutes, which is why central banks already can set slightly negative interest rates without creating a stampede to cash.

As for bank profits, if small retail depositors are excluded and if wholesale clients have no way to hold large quantities of cash

26. In my 2016 book, I suggest a $2,000 limit per taxpayer, but it could be somewhat higher. The purpose of negative interest policy is not to raise revenue but to stimulate inflation and growth, so the foregone income is meaningless. Given modern technology, it would be easy enough to subsidize small retail accounts either directly or through the banking sector.

without great expense and/or being taxed on their facilities, then banks should perfectly well be able to pass-through the negative rates; even mortgage rates have gone negative in some countries. Experience until now where the cash problem has not been taken care of would not necessarily apply. It should be noted that even so, the literature has generally found that bank profits have not suffered from negative interest-rate policy in most European countries except for small banks[27]—which presumably mainly have small depositors that would be excluded under my 2016 proposal. There is a laundry list of other second-order issues, which are dealt with in my book and also in the very thorough primer of Agarwal and Kimball (2019). The existing experience with negative rates suggests these should not be a problem. In my view, negative rate policy would solve the problem of central-bank impotence at the zero bound, which would be of immediate use for Europe and Japan and could help the United States in a recession. If central banks could reestablish their main role as interest-rate-setting institutions, then it might help them push back against efforts to use their balance sheets to make fiscal policy less transparent.

One expects to see unconstrained negative interest-rate policy first tried in a small country; the United States will not be an early adopter for many reasons. But some of the hysterical pushback against negative rates should be viewed as lobbying, not policy analysis, particularly the view that markets will fall apart. As of June 2019, over twelve trillion dollars in debt traded at negative interest rates and markets have not collapsed.

As Milton Friedman observed about the 1951 episode, where the Federal Reserve abandoned its bond price pegging program:

"Before the Federal Reserve gave up the pegging of the bond price, we heard all over the lot that a free market in bonds was going to be chaotic, that the interest rate might go heaven-high or down, that there might be capital losses, that savings institutions might well be wiped out by their capital losses, and that we needed some basic peg price on which the market could form its anticipation. We abandoned the pegged price. None of these things happened…" (Friedman and Roosa, 1967).

To be sure, implementing effective unconstrained negative interest-rate policy will require a host of legal, regulatory, and tax changes,

27. See López and others (2018).

and not all of these can be instituted by the central bank alone.[28] The obstacles in different countries will vary. It is notable, however, that in countries that have implemented mild negative rate policy, none has tackled the main challenge, which is how to prevent paper-currency hoarding and, as a corollary, how to protect bank profitability if rates go deeply negative. Of course, if one believes that it is impossible to have negative deposit rates, then the capacity for instituting negative rate policy is very limited. But in our view, once wholesale paper-currency hoarding is dealt with (the vast majority of retail depositors can straightforwardly be exempted from negative rates[29]), then the passthrough of negative rates to wholesale bank customers should be straightforward, just as the passthrough of negative policy rates has been to mortgages and other wholesale private-debt obligations in many countries in Europe. In general, all of the various approaches to instituting unconstrained negative rate policy should be increasingly easy to navigate as paper currency becomes further marginalized in legal, tax-compliant transactions (outside low-value transactions) and as countries deal with financial inclusion.

One naïve objection to negative interest rates is that they are unfair to savers. First, as already noted, it is straightforward with modern technology to exempt small depositors, so that only a very small percentage of retail depositors would be affected. Second, for savers who have more diversified portfolios, effective negative rate policy would push up the prices of equities, housing, and long-lived assets. Or to be precise, negative rates would counter the sharp drop that usually occurs in a deep recession or financial crisis. Third, long-term interest rates should rise, given that effective negative interest-rate policy pushes up the trajectory of inflation and growth. Fourth, and most importantly for most workers and families, negative interest-rate policy can help restore employment and income growth after a deep recession or crisis.

Some argue that deposit rates can never go negative, in which case, the capacity for instituting negative rate policy is very limited. But if the vast majority of retail depositors are exempted from negative rates (Rogoff, 2016, 2017; Lilley and Rogoff, 2019), then the passthrough of negative rates to wholesale bank customers will be reasonably smoother, as it has been with mortgages and other wholesale private-

28. Rogoff (2016) discusses some of the issues; Agarwal and Kimball (2019) provide an extremely useful handbook on transitioning to unconstrained negative rate policy.

29. See Rogoff (2016, 2017).

debt obligations in many countries in Europe. Of course, in countries where there are legal or regulatory impediments to implementing negative rates, fixing this problem would have to be on the list of administrative measures necessary to adopt effective unconstrained negative rate policy.

There are other ideas for giving the monetary authorities more scope to cut interest rates, for example, raising inflation targets. However, they are far less elegant and likely far less effective, for reasons explained in Rogoff (2016). For example, raising the inflation target from two percent to four percent buys a lot less space than it might seem because contracts would almost surely adjust more frequently (meaning larger interest-rate cuts were needed to achieve the same effect), and there would be costs of higher inflation (for example, a greater dispersion of relative prices) even during normal times. And there are other significant objections such as the cost to central-bank credibility of changing long-established targets, not to mention that, without being able to implement unconstrained negative interest-rate policy, Europe and Japan have not been able to get inflation to two percent, much less four percent. (When Japan raised its inflation target to two percent in 2013, there was very little impact on longer-term interest rates and, to this date, there still has not been.) Finally, even if inflation were raised to four percent, this still might not give nearly enough room for maneuver in a deep recession or financial crisis.

Let me be clear that I am not saying that negative interest-rate policy obviates the need for other forms of stimulus, for example, rises in government spending and tax cuts, during a recession. What it could potentially achieve is restore the balance between monetary policy and fiscal policy, with the monetary-policy response being typically much faster and more reliable than highly politicized fiscal policy. Indeed, if negative interest-rate policy feels too radical, it has to be compared to the dozens of outside-the-box ideas that fill the pages of the major economics journals on options for restoring growth in a crisis. All of these also involve severe risks; deep recessions and financial crises involve severe risks. Unfortunately, time and space constraints for this speech prevent a more complete discussion of the issues here, but there is a growing literature on the topic.[30]

30. See Rogoff (2016) and references therein, Rogoff 2017, Lilley and Rogoff (2019), and Agarwal and Kimball (2019).

In sum, the important point is that the path to virtually unconstrained negative interest rate policy is actualy quite straightforward, and should be achievable with only minor distortions. But each country needs to study what would work best in its particular, legal, financial, and institutional circumstances.

7. Conclusion

To conclude, central banks face challenges today stemming from their past effectiveness in reducing inflation and their present ineffectiveness in finding ways to deal with zero lower bound on interest rates. This has left them vulnerable to populist attacks from the left and the right that threaten to deeply undermine their independence, including some proposals to simply have the central bank be instructed to indefinitely finance massive increases in government debt and others to lower interest rates into a U.S. economy that already seems to be running hot. The idea that high inflation is a problem of the distant past but is unlikely to recur in 21st-century advanced economies is extremely dubious and, all in all, seems to be a classic case of "this time is different" thinking. Instead, the case for having an independent central bank that is hardwired to place significant weight on stabilizing inflation, as proposed in Rogoff (1985), remains strong, as is very clear from countries where central-bank independence has been severely compromised. If central-bank independence is rescinded and monetary policy politicized, it would only be a matter of time until high inflation followed. And if that happens, it may be even harder to put the inflation genie back in the bottle next time than it was in the 1980s and 1990s. Once trust is broken, it is difficult to reestablish. In the 1920s and 1930s, governments tried to reestablish the prewar gold standard that had been abandoned in World War I so that inflation could be used to help finance the war effort. But one of the great challenges was that once investors learned the bond could be broken, it was difficult to make it fully credible again. The same problem will likely face countries that tear down central-bank independence and try to restore it—they will face years of very high interest rates before public trust is restored.

As anyone who has worked at a central bank understands, central-bank independence is rarely granted by constitutional decree, and even where it is, the letter of the law has little meaning if political support is lacking. In reality, central-bank independence is fragile, and something that has to be earned every day. In this difficult period for central banks, these need to look hard for new instruments to restore the effectiveness of normal interest-rate policy. Here I have suggested giving a much more serious look at taking the steps needed to effectively institute unconstrained negative interest-rate policy and argued that this is far preferable to having central banks engage as junior partners in debt maturity management and quasi-fiscal policy. To maintain their relevance and to protect the independence of monetary policy during a period of growing populism, central bankers cannot afford to sit on their laurels. Otherwise, what is perhaps the most important institutional development of our time in macroeconomic policy, the rise of independent central banks, risks being seriously undermined.

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The Transformation and Performance of Emerging Market Economies Across the Great Divide of the Global Financial Crisis

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Before the Global Financial Crisis,[1] a drive towards greater central-bank autonomy and transparency, as part of the achievement of greater central-bank credibility that had begun in the advanced economies (AE), spread to the emerging market economies (EME). This process was greatly enhanced by the adoption of inflation targeting (IT), as analyzed in Bordo and Siklos (2014). Moreover, the adoption of best practices was viewed as a way for emerging market countries especially to "tie their hands" to deliver lower and more stable inflation rates without undue fiscal and/or political influence.

The process of central-bank evolution was interrupted by the Global Financial Crisis, a transatlantic event largely involving advanced economies (Tooze, 2018; McCauley, 2018). The fallout from the Global Financial Crisis in the advanced economies raised the objective of financial stability—which, unlike monetary policy, was

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1. There is no official chronology, but the ones published by the Federal Reserve Bank of St. Louis (https://www.stlouisfed.org/financial-crisis/full-timeline) and the Federal Reserve Bank of New York (https://www.newyorkfed.org/research/global_economy/policyresponses.html) provide useful and comprehensive timelines. Some prefer to call the period from 2007 onwards the "Great Financial Crisis" but we retain the arguably more popular "Global Financial Crisis" expression.

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less well-defined—, and boosted the search for reliable instruments to achieve it. Many of the emerging market economies were affected by the fallout from the crisis, but most were spared the turbulence experienced in the financial markets of advanced economies. Many continued on the trajectory of convergence to best-practice central banking and maintenance of the hard-won benefits in the fight against inflation.[2]

In this paper we compare the performance of a representative set of emerging market economies with a group of advanced economies before and after the Global Financial Crisis. We first consider institutional developments, e.g., changes in central-bank independence, changes in central-bank transparency, changes in central-bank governance indicators. Because central banks do not operate in a vacuum, we develop a new index of institutional resilience that combines institutional information describing central-banking operations as well as other political economy-style indicators. Next, we extend an earlier measure of central-bank credibility based on our previous work—Bordo and Siklos (2014, 2016, 2017). The improved measure combines deviations of inflation from a central-bank's objective, monetary-policy uncertainty, and a global factor that can impact central-bank credibility.

Finally, with these building blocks, we then use econometric methods (panel VARs based on both factor models and observed data) to ascertain the impact of global shocks, financial shocks, credibility shocks, and trade shocks on the emerging versus the advanced countries. The success of any policy regime needs to be underpinned by institutions able to withstand political and other pressures stemming from the impact of a variety of economic shocks that especially hit small open economies. Hence, institutional resilience ought to go hand in hand with resilience against these shocks. Our empirical results document significant improvements among emerging market economies in adopting the best practices followed by central banks in advanced economies. However, the Global Financial Crisis reversed some of the gains made pre-crisis and this highlights the fragility of emerging market economies to the economic shocks that constantly buffet them.

2. See Jasova and others (2018), which provides evidence on exchange-rate passthrough to inflation for advanced and emerging economies since the Global Financial Crisis. They find that, since the Global Financial Crisis, passthrough for emerging market economies has declined and converged on that of the advanced economies. This is perceived as a reflection of improved central-bank credibility.

Section 1 provides a brief historical overview of the evolution of central-bank credibility and its correlates (central-bank independence and central-bank transparency) in both advanced and emerging countries in the post-Bretton-Woods era. Section 2 outlines the data. Section 3 presents our institutional measures. Section 4 contains our econometric estimates. Section 5 concludes with some policy lessons.

1. Historical Background

The Great Inflation of 1965 to 1983 was a defining moment for the central banks of the advanced countries in the post-World War II era.[3] The postwar, post-Bretton-Woods period was one of relative macro stability, reflected in low inflation and inflation variability and high real growth and low real output variability for the advanced countries, as analyzed in Bordo (1993) and Bordo and Siklos (2014). The collapse of Bretton Woods between 1971 and 1973 was followed by accelerating inflation and increased inflation volatility along with declining real activity and rising unemployment (i.e., stagflation).[4] This performance was driven by the termination of the disciplining force of the Bretton-Woods nominal anchor, the Keynesian emphasis on full employment and the belief by central banks that the benefits of full employment outweighed the costs of rising inflation. A key factor in this period across countries was the absence *de facto* and, in some cases, *de jure* of central-bank independence. The story differed across countries. In Great Britain, the Bank of England was a *de facto* part of the Treasury.[5] In the U.S., although the Federal Reserve was *de jure* independent, and had *de facto* regained its independence from the Treasury in the 1951 Accord, under the tutelage of Chairman William McChesney Martin it was "independent within the government" and it increasingly coordinated monetary policy with the Treasury (Meltzer, 2010). Through a process called "even keel", the Fed indirectly monetized the fiscal deficits generated by the Johnson administration to finance the Vietnam War and the Great Society, and later by the Nixon administration (Humpage and Mukherfee, 2015; Bordo, 2020).[6]

3. For a discussion on the history of central banks, see Bordo and Siklos (2018), and Siklos (2002).

4. See Bordo and Orphanides (2013).

5. A similar experience describes the Bank of Japan's relationship with the Finance Ministry until 1997.

6. For Great Britain, see Bordo, Bush and Thomas (2019). For France see Monnet (2019).

The Fed's unwillingness to tighten monetary policy sufficiently to kill inflationary expectations led to a ratcheting up in inflation in the 1970s (Bordo and Orphanides, 2013).[7] This was also a period when central-bank credibility, defined as the deviation of realized inflation from the stated objective, was at a low point (Bordo and Siklos, 2016).

As is well known, the Volcker shock of 1979 in the U.S. and subsequent tight monetary policies and similar strategies in Great Britain, Canada, and other countries led to the Great Moderation period from the mid-1980s to before the Global Financial Crisis and to the restoration of central-bank credibility (Bordo and Siklos, 2015). In that period both central-bank independence and central-bank transparency increased dramatically (Bordo and Siklos, 2014; Dincer and others, 2019).

Along with the evolution described above of the central banks of the advanced countries, the emerging countries followed a similar trajectory, but with generally worse economic performance. These countries had a long history of high and volatile inflation and of frequent currency crises.[8] The political economy in emerging countries, combined with less developed financial institutions and markets, made it difficult to establish an institutional framework for monetary and fiscal stability.[9] Despite this, the Bretton-Woods regime did serve as a nominal anchor for these countries and macro performance was better than after its collapse (Edwards and Santaella, 1993; Bordo and Schwartz, 1998). The Great Inflation period for the emergers was characterized by even worse macro performance than in the advanced countries and the instability was not fully alleviated until the 1990s, when many countries began adopting best practices in central-banking and economic-policy technology.[10] Bordo and Siklos (2014, 2017) present evidence that those countries that adopted inflation targeting converged more rapidly to the inflation levels of the advanced countries than emergers that did not. Moreover, their performance on measures of central-bank independence and central-bank transparency also improved greatly relative to countries that did not adopt inflation targeting.[11]

7. Another important factor was accommodation of the oil-price shocks. See Blinder and Rudd (2013).

8. For example, see Ha and others (2019).

9. For Latin America, see Edwards (2012).

10. Chile was one of the first emerging economies to follow New Zealand's lead in adopting inflation targeting.

11. For example, see Siklos (2017).

The Global Financial Crisis changed the plot considerably. It was primarily an advanced-country transatlantic event (Tooze, 2018; McCauley, 2018), triggered by the collapse of the U.S. housing market. Its causes included: U.S. government policies to encourage home ownership (Rajan, 2011); lax financial regulation and oversight (Calomiris, 2017); financial innovation, especially in the unregulated shadow banking sector (Tooze, 2018), and loose monetary policy (Taylor, 2007). Although the crisis began as an advanced-country event, some emerging countries were also hard hit, especially those in Eastern Europe with financial ties to Western Europe. Other emerging countries were also impacted by the collapse of international trade and the spillovers from the advanced-country credit crunch. But there were a number of countries which had developed the resilience to largely withstand the crisis, including Chile.[12]

Since the crisis, central banks in the advanced countries have been heavily focused on financial stability and in developing the tools of macroeconomic policy and 'leaning-against-the-wind policies' to withstand future global imbalances. This strategic shift was manifest in the U.S. with the Dodd Frank act of 2010 and, in the international financial system, with Basel III in 2011.[13] Many emerging countries have been developing similar policy strategies as in the advanced countries, but their financial architecture and exposure through international trade and capital flows have prevented them from advancing to the level of the advanced countries because their circumstances and vulnerabilities are different.[14]

In this paper we examine evidence on the performance of a panel of emerging central banks from Latin America, Asia, and Europe to ascertain how the crisis affected the trajectories that they had been following before it in comparison to the experience of a panel of advanced countries. Our evidence suggests that several emerging countries, but not all, have developed the institutional resilience to keep them on track.

Our strategy consists in presenting a menu of evidence about institutional developments in monetary policy and beyond, contrasting

12. See Kose and Prasad (2010).

13. https://www.bis.org/bcbs/basel3.htm

14. In 'leaning against the wind,' monetary policy is tightened under some conditions as a way of maintaining financial stability. However, at least in theory, there is an ongoing debate about the wisdom of using policy-rate changes to forestall financial instability. See, for example, Svensson (2017), who warns against the risks of such a policy, while Filardo and Rungcharoenkitkul (2016) make the case for such a strategy.

the record of advanced and emerging countries. In doing so, we propose a new indicator of country-specific resilience for 29 economies that yields insights about the progress each country made before the crisis and the record since. We then augment this longer-run type evidence with some suggestive econometric evidence based on panel vector autoregressions. These provide evidence on the impact of various economic shocks on emerging versus advanced countries that supplement and parallel our findings based on the institutional evidence, as well as a series of narratives for a carefully selected group of economies, which we relegate to an appendix.[15] In appendix I, we present brief case studies for six countries—three advanced (U.S., Canada, Sweden) and three emerging (Chile, Colombia and Mexico). These studies examine in more detail their monetary-policy performance and credibility from the Great Moderation through the Global Financial Crisis.

2. Data

Generally, the data for this study are from publicly available databases, including the national central banks, the OECD Main Economic Indicators, the International Monetary Fund, the Bank for International Settlements, the Federal Reserve Economic Database (or FRED), and the World Bank. We have prepared a separate appendix with detailed data sources. Some forward-looking variables, such as inflation and real GDP growth forecasts, are also publicly available, i.e., from the IMF's World Economic Outlook (WEO). Only Consensus Economics forecasts are not available for distribution. Some institutional data are from databases made available by other researchers. These include data on central-bank independence (Dincer and Eichengreen, 2014), and central-bank transparency (Dincer and others, 2019). Other institutional data used include the World Bank's Governance Indicators,[16] the KOF Swiss Economic Institute Globalisation Indices,[17] exchange-rate and crisis data from Reinhart and Rogoff (2009) and Ilzetzki and others (2019),[18] with other crisis

15. Appendices and additional material (including data) are available at https://www.pierrelsiklos.com/research.html

16. https://info.worldbank.org/governance/wgi/#home

17. https://kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html

18. http://carmenreinhart.com/

data from Bordo and Meissner (2016), and the Chinn-Ito index of financial openness from Chinn and Ito (2006).[19]

As discussed below we also propose an indicator of institutional resilience that partially depends on two other series, namely, Baker and others' (2016) Economic Policy Uncertainty index (EPU),[20] and Caldara and Iacoviello's (2018) Geopolitical Risk index (GPR).[21,22] More details about the proposed indicator follow.

The sampling frequency of the raw data collected for this study ranges from monthly to annual, with most of the key time series usually obtained at the quarterly frequency. Typically, institutional variables are available at the annual frequency, while macroeconomic and financial data are generally available at the monthly and quarterly frequencies. Where required, we convert all data used in the subsequent econometric estimation to the quarterly frequency. Monthly data are converted via arithmetic averaging while, in a few cases—including some forecasts—, semi-annual data are converted to the quarterly frequency via interpolation.[23] Most of the time series are in annualized growth rate form to ease interpretation. Some series, such as interest rates are already in percent.[24] We collected data for the 1980–2018 period though because of missing or incomplete data; the actual sample used in some of the econometric exercises typically begins during the 1990s before any transformations are applied. However, for reasons explained below, panel VAR estimates shown

19. The Chinn-Ito index has since been updated to 2017. The previous vintage of the index is used in the present study from http://web.pdx.edu/~ito/Chinn-Ito_website.htm

20. http://www.policyuncertainty.com/index.html

21. https://www2.bc.edu/matteo-iacoviello/gpr.htm

22. Country-specific Economic Policy Uncertainty indices are available for all countries except AR, CZ, HU, ID, IL, MY, NO, NZ, PE, PH, PL, YH, TR, and ZA. For these cases, the global version of economic policy uncertainty is used. Turning to geopolitical risk, data are available for AR, BR, CN, CO, IL, IN, KR, MY, NO, PH, SE, TH, TR, and ZA. For the remaining economies, the overall GPR indicator is used. See table 1 for the country acronyms used.

23. The basic idea is to fill the gap due to missing observations by fitting a hypothetical function that links observations at both ends of the gap. Many algorithms to do so are available, including the so-called Chow-Lin method (Chow and Lin, 1971) that is used here.

24. Economists continue to debate the form in which macroeconomic and financial times series ought to be analyzed. The fact that this is an ongoing area of research indicates that a consensus has not yet been reached. Part of the difficulty is that some shocks are transmitted through the economy at a faster rate than others (e.g., monetary versus financial). We have generated series by using other methods (e.g., Hamilton and Hodrick-Prescott), but these are not used in the econometric estimates presented in section 4. See, *inter alia*, Hamilton (2018) and Schüler (2018a and 2018b).

are for samples that begin in 2000 (before any differencing or lags are applied). In the case of institutional variables, we also collected data since the 1980s but, as many of the institutional developments discussed in the paper begin during the 1990s, we limit the analysis to data over the past two decades or so.

Our dataset consists of 29 economies, which are shown in table 1. By today's standards (i.e., in 2019), 12 are classified by the International Monetary Fund as advanced economies, while the remaining 17 belong to the emerging market group of economies.[25] By 2019, 23 economies explicitly target inflation, nine of which are advanced economies and 14 are emerging market economies. The starting date for the adoption of inflation targets varies considerably (appendix II), so we also define a group of so-called 'established' inflation-targeting countries in recognition of the longevity of the policy regime in the chosen cases. They are: Australia, Canada, Great Britain, New Zealand, and Sweden. Three of the economies in our dataset are considered systemically important and advanced, that is, the U.S., Japan, and the Eurozone. Conceivably one might add China to the list, the lone emerging market economy in this category, but we elect not to for the present exercise in part because the last 'global' financial crisis originated in the advanced countries.[26]

Before proceeding we would be remiss if readers were not, once again, reminded of criticisms leveled at some of the data used in this study. A common refrain among critics of institutional variables, already noted in the case of measures of central-bank independence, is the degree to which they capture *de facto* as opposed to *de jure* performance of the institutions surveyed. Because the quality of the rule of law varies considerably across countries, while it is desirable to estimate a *de facto* measure, it is often only possible to obtain *de jure* indicators. Many, if not most, of the institutional data used below rely on a mix of *de jure* and *de facto* elements.

25. Two countries (Czech Republic and South Korea) were not considered advanced at the beginning of the sample.

26. See, however, Chen and Siklos (2019) for such an exercise.

Table 1. Economies in the Dataset

Countries and ISO Codes	*Name*
ar	Argentina
au	*Australia*
br	Brazil
ca	*Canada*
cl	Chile
cn	China
co	Colombia
cz	*Czech Republic*
ez	*Eurozone*
gb	*Great Britain*
hu	Hungary
id	Indonesia
il	*Israel*
in	India
jp	*Japan*
kr	*Korea (South)*
mx	Mexico
my	Malaysia
no	*Norway*
nz	*New Zealand*
pe	Peru
ph	Philippines
pl	Poland
ru	Russia
se	*Sweden*
th	Thailand
tr	Turkey
us	*United States of America*
za	South Africa

Source: International Standards Organization (ISO).
Note: Italicized names belong to the advanced economies group while the remainder are emerging market economies. The selections are based on the 2019 World Economic Outlook.

Even if the identification of *de facto* versus *de jure* elements is feasible, there is often disagreement about how to define what constitutes *de facto* performance. This is the case, for example, with exchange-rate regime classification schemes. Hence, over the years, several have been published and new ones proposed.[27] Other complaints raised about indicators of institutional performance include what some consider to be *ad hoc* thresholds when a classification regime is proposed. An example is the decision whether to classify a monetary-policy regime as consistent with inflation targeting. The difficulty is compounded because the commitment of the central bank and political authorities to meeting an inflation objective can vary, as can the adherence to a floating exchange-rate regime, which is considered by some to represent a critical element of an inflation-targeting policy strategy.[28]

Other complaints include the reliance on surveys and different and possibly not comparable sources, not to mention biases in the construction of certain indicators. An example is the World Bank's Governance Indicators. They remain arguably the most widely used proxies for the quality of governance worldwide and have come under criticism although possibly more so for some of the components of the indicators than others (e.g., indicator of corruption). The criticisms are long standing ones,[29] as are the responses to most of them (Kaufmann and others, 2007), but they remain useful since the indicators continue to be updated.[30]

Almost all institutional indicators also share the concern that they are endogenous, that is, they are not independent of current economic performance. While this is undoubtedly true, it is also the case that institutions change more slowly, in some cases far more slowly, than changes in macroeconomic conditions. In a few cases, such as the emergers that joined the European Union, institutional pre-conditions (e.g., central-bank autonomy) preceded the threshold required to join the single currency stated in terms of economic performance (i.e., inflation, exchange rates, interest rates, and debt). In any case, it is an empirical

27. For example, see Frankel and others (2019).

28. See Bordo and Siklos (2017) and references therein.

29. For example, see Kurtz and Shrank (2007).

30. Other indicators in this vein exist, e.g., the Polity IV Project provides a score for governments that range from the most to the least democratic (see https://www.systemicpeace.org/polity/polity4.htm). Another source is the Political Risk Services group (https://www.prsgroup.com/), but they are also subject to some of the same criticisms that have been levelled at the World Bank data.

question whether growth causes changes in governance (or any other institutional change) or *vice versa*. Generally, the evidence is quite clear, as noted above, that best practices in economic-policy making are necessary, if not sufficient, for better aggregate economic performance.

Finally, it should be noted that our strategy is to combine many existing indicators and not rely on a small selection of them. In doing so we follow an approach that has proved successful in other economic applications. For example, it has long been known that forecast combinations often outperform individual forecasts.[31] Similarly, we believe that combining different institutional indicators can provide a more reliable measure of institutional resilience.

3. Institutional Developments: Some Stylized Facts

3.1 Central-Bank Independence, Central-Bank Transparency, Inflation, and Inflation Expectations

In this section, we document a number of measures of institutional performance in our panel of central banks.

Figure 1 plots average changes in the Dincer and Eichengreen's (2014) overall index of central-bank independence for the available sample period, that is, 1998–2017.[32] The advanced economies in our sample are shown to the right of the vertical dashed line while the emerging economies are shown on the left. Only three emergers experience a noticeable increase in central-bank independence that is almost the same number as among the group of advanced economies. However, over the 1998–2017 period, central-bank independence in the vast majority of economies in our sample is unchanged. Central-bank independence alone is unlikely to explain much of the great divide in the title of this paper. Criticisms of *de jure* style indicators of central-bank independence are well known. However, it remains true that most observers regard a form of statutory autonomy of the central bank

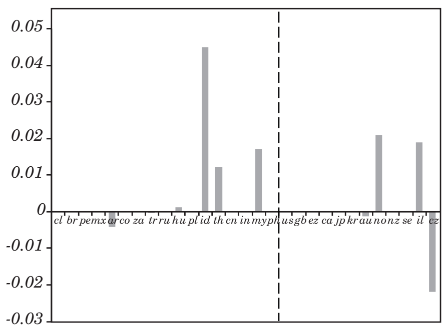
31. For example, see Timmermann (2006).

32. Dincer and Eichengreen's data begin in 1998 and end in 2010. For convenience we extended the data by estimating a fixed effects panel model for the 29 economies by using the overall indicator of each economy's polity quality as a proxy for how central-bank independence might have changed over time. We also considered an index of state fragility together with interactions effects (i.e., with the type of exchange-rate regime, central-bank transparency) to extend the sample from 2011 to 2017. The regression results are available on request. The policy data are from the Polity IV dataset obtained from http://www.systemicpeace.org/inscrdata.html

as a critical ingredient in good governance. Therefore, one should not underestimate the importance of this kind of institutional feature.[33]

Arguably, one of the most important institutional developments over the past two decades has been the rise in overall central-bank transparency. Figure 2A displays average changes in central-bank transparency over the 1998–2015 period.[34] Once again the vertical dashed line separates the advanced from the emerging economies in our dataset. Unlike central-bank independence, we observe progress in central-bank transparency in all economies although unevenly distributed. Indeed, improvements are greater in several emerging countries (e.g., Thailand, Hungary) than in some of the best performers of among the advanced countries (e.g., New Zealand, Czech Republic).[35]

Figure 1. Changes in Central-Bank Independence, 1998–2017



Source: Authors' research.
Note: See table 1 for the ISO codes. The vertical dashed line divides the AE from the EME in the sample. See table 1 for the list. The overall measure of central-bank independence from Dincer and Eichengreen (2014) up to 2010 is used updated to 2017 as explained in the main body of the text. A positive value means an improvement in central-bank independence.

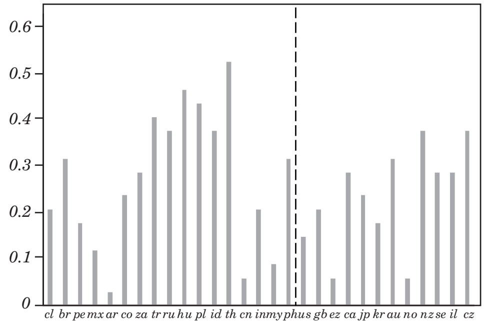
33. Indeed, the current Chair of the FOMC, Jerome Powell, has felt it necessary to remind the public of the importance of central-bank independence. "The Fed is insulated from short-term political pressures—what is often referred to as our 'independence'. Congress chose to insulate the Fed this way because it had seen the damage that often arises when policy bends to short-term political interests. Central banks in major democracies around the world have similar independence." (Powell, 2019).

34. The data from Dincer and others (2019) end in 2015 and we made no attempt to extend their dataset. The index is an update and improvement over the original Dincer and Eichengreen's (2014) index of Central Bank Transparency. The indicator of Central Bank Transparency ranges from a minimum of 0 to a maximum of 15. Central Bank Transparency is an aggregation of scores based on 5 sets of characteristics, namely, political transparency, economic transparency, procedural transparency, policy transparency, and operational transparency. See Dincer and others (2019).

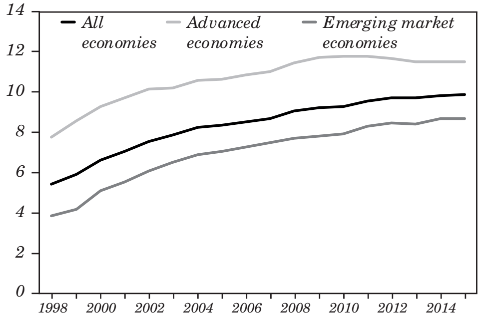
35. Improvements in central-bank transparency in Hungary (and Poland) are no doubt due in large part to the institutional pre-conditions required to join the European Union.

Figure 2. Two Views of Central-Bank Transparency, 1998–2015

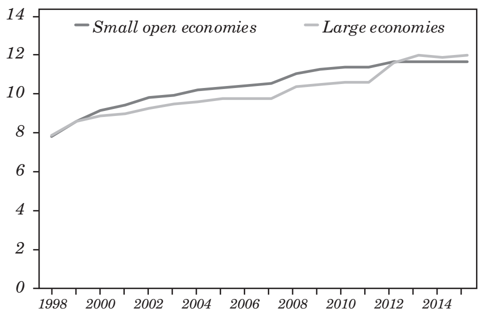
(A) Changes in Central-Bank Transparency



(B) Levels of Central-Bank Transparency over Time



(C) Levels of Central-Bank Transparency



Source: Authors' research.

Note: Constructed from data in Dincer, Eichengreen, and Geraats (2019). Table 1 contains the ISO codes and the list of AE versus EME. Also, see figure 1. CBT ranges from a minimum of 0 to a maximum of 15 as shown by the dashed line in part (B). Positive values signal more CBT or an improvement in CBT.

Figures 2B and 2C provide two other perspectives on central-bank transparency since 1998. Figure 2B highlights the steady rise in central-bank transparency in both advanced and emerging countries but there is little indication that the gap in central-bank transparency between advanced and emerging countries is narrowing substantially. Figure 2C, however, shows that, whereas central-bank transparency in small open advanced economies exceeded levels in large advanced economies, the latter caught up and have slightly overtaken the former group of economies since the Global Financial Crisis. Whether the financial crisis pushed central banks in some advanced countries that were most affected by the crisis to become even more transparent is open to debate; however, it is notable that the small open economies all explicitly target inflation, while only Great Britain is considered an inflation targeter in the group of large economies.

Although we cannot be certain, of course, there is a risk that the steady rise in central-bank transparency, together with the occasional increase in central-bank independence, may come into conflict with an overall deterioration in institutional quality. This would threaten the resilience of central banks in the face of political pressure and, thereby, resilience in the face of shocks. We return to this point below.

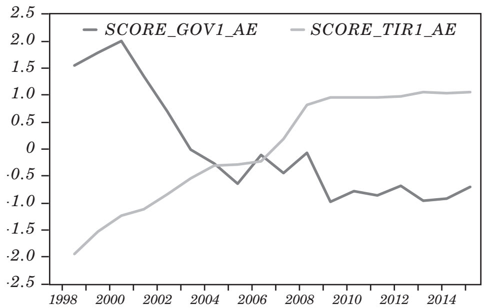
The preceding two indicators suffer from at least two drawbacks. First, as noted already, they tend to rely on *de jure* indicators[36] and they also ignore the wider pressures on monetary policy from overall governance in the countries and economies concerned. Figures 3A and 3B, respectively, display average levels of central-bank transparency in the advanced and the emerging countries against an average of the World Bank's Governance Indicators.[37] To generate the results shown in figures 3A and 3B we estimated, for each group of economies, the first principal component (using the principal factors method) of the overall governance indexes to obtain the scores shown. Hence, we allow the data to determine the relative weight of the constituents of governance quality. However, we do not assign weights to each country's contribution to average governance quality.

36. This is a far more accurate description of the Central Bank Independence index than the Central Bank Transparency indicator, which is largely based on information made public by central banks.

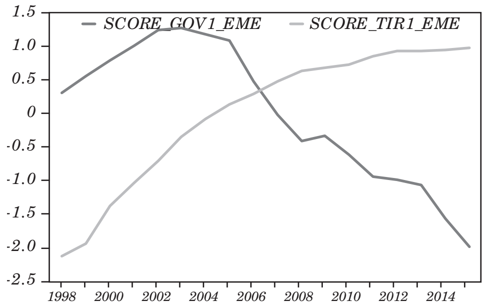
37. The World Bank's Governance Indicators consist of 6 characteristics of governance, namely, voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption. We summed the scores of the 6 characteristics and took the mean as our overall indicator of governance. A rise in the indicator signals improved governance.

Figure 3. Central-Bank Transparency and Governance, 1998–2015

(A) Advanced Economies



(B) Emerging Market Economies



Source: Authors' research.
Note: GOV1 is the sum of the 6 components of governance: voice and accountability, rule of law, regulatory quality, government effectiveness, control of corruption, and political stability. EME are emerging market economies; large economies are US, JP, EZ, GB; small open economies are CA, NO, SE, NZ, KR, IL, AU.

Consider the advanced countries shown in figure 3A. The following economies show a trend deterioration in at least half of the characteristics defined by the World Bank. They are: the Eurozone, the U.S., Hungary, Thailand, South Africa, Australia, Canada, and Brazil. When the governance indicators are combined as described above, seven of the 17 emergers shown in figure 3B experience an overall decline in governance quality. They are: Argentina, Brazil, Hungary, Mexico, Philippines, Thailand, and South Africa.[38] In the case of the advanced countries, the Eurozone, Great Britain, and the U.S. contribute to reducing the AEs' level of governance quality.

Turning to the data aggregated for the advanced versus the emerging countries, we find that, following a drop in the quality of governance from 1998 to 2004, the indicator remains relatively stable, although a small additional drop is observed following the crisis. This stands in contrast with the continued rise in central-bank transparency over time, although there is a leveling off after the crisis. Turning to the emergers, there is a steady drop in the overall quality of governance beginning in 2005 that continues until the end of the sample, while the steady rise in central-bank transparency shows no signs of abating by 2015.[39]

A few other institutional indicators are worthy of mention although we relegate the details to the appendix. First, despite the crisis, financial globalization continues to rise. This is not a phenomenon restricted to the advanced countries but is global in nature. In contrast, the message is far more mixed when it comes to trade globalization, with signs of retreat in several emergers (e.g., Indonesia, Turkey, China and Malaysia) and even in a few advanced countries (e.g., Canada, Norway, and New Zealand).[40] The Chinn-Ito indicator, over the 1998–2016 period, provides a similar interpretation at least as regards capital account openness, with progress in several advanced and emerging countries, although the message is again mixed for the emerging countries with several countries becoming less open to capital flows (e.g., Argentina, Indonesia, Thailand, and Malaysia).[41] Finally, average changes in monthly indicators of the degree of exchange-rate flexibility over the 1998–2019 period obtained from Ilzetzki and others' (2019) exchange-rate regime classification also provide a mixed message: Roughly half

38. This inference is based on a simple regression of the time series of various components of governance on a time trend. Hungary has the distinction of a decline in all categories of governance. The Eurozone indicator is proxied here by the average governance indicators for Germany, France, and Italy.

39. The World Bank's Governance Indicator data are available until 2017 and the downward trend in governance in emerging countries continues. Since the central-bank transparency data end in 2015 the governance indicators for 2016 and 2017 are not shown.

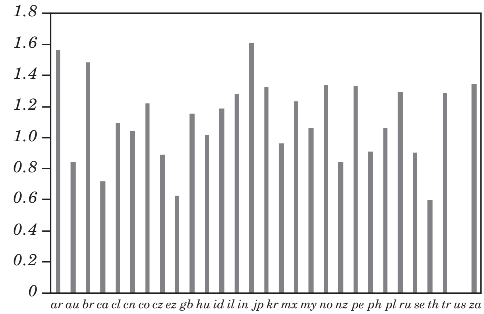
40. The indexes are based on an aggregation, via principal components analysis, of several indicators of trade and financial openness (both de *jure and de facto*; e.g., export and imports to GDP, tariffs, capital account openness). See Gygli and others (2019). Our calculations are based on an average of index values over the 1996–2017 period.

41. The Chinn-Ito index codifies the restrictions reported in the International Monetary Fund's Annual Report on Exchange Arrangements and Restrictions.

of the economies in our sample show no regime changes, five emerging economies' regimes are less flexible (e.g., Thailand, Colombia), and three demonstrate greater flexibility (Chile, Brazil, Turkey). Among the advanced countries, the tendency is in the direction of greater flexibility, but half are unchanged since 1998.

Next, we turn to some evidence on inflation and inflation expectations in advanced versus emerging countries since the late 1990s. Figure 4 plots the 'distance' between inflation in each economy over the 2000–2018 period *vis-à-vis* U.S. inflation. One must take some care in drawing too strong conclusions from these calculations, since it is not immediately evident that U.S. inflation is always the benchmark for best practice in monetary policy.[42] Moreover, the estimates of distance are not conditioned on other variables that might affect cross-country inflation differentials. Finally, if one believes that, in the process of catching up to the advanced economies, emerging country inflation rates should be higher, the distance measure is silent about whether estimates are higher than might be desirable.[43]

Figure 4. Inflation Distance from U.S. Inflation



Source: Authors' calculations.
Note: Distance is $d_{ij} = \sqrt{2^*(1-\rho_{ij})}$ where ρ_{ij} is the simple correlation between U.S. inflation and inflation on the other economies considered. The sample is: 200q1–2018q3.

42. Among the 29 economies in our sample, Japan (0.1%), Sweden (1.2%), and the Eurozone (1.7%) achieved substantially lower inflation rates over the period considered. Canada, China, Great Britain, Israel, Norway, and New Zealand achieved very similar average CPI inflation rates, again over the same period.

43. Relevant to this discussion is the so-called Balassa-Samuelson effect (B-S) which relies on productivity differences to partially explain inflation differentials. Due to the requirements of the Maastricht Treaty, many applications focus on the emergers of Central and Eastern Europe (CEE). Égert (2002) is an example of a study finding that while the B-S is present it is not sufficiently strong to create excessively high inflation differentials between CEE countries and advanced Europe.

It is generally the case that distance remains highest between U.S. inflation and inflation in emergers, although there are a few exceptions among advanced countries including Japan, Norway and Israel. A concern for policymakers is how to think about best practice when it comes to monetary-policy regimes and inflation, when advanced countries suffer from inflation rates persistently below their stated targets while several emerging countries suffer from the opposite challenge. We return to this issue below.

Figure 5 plots the gap between observed CPI inflation and an average of expected inflation rates in selected groups of economies. Expected inflation is the mean of one-year-ahead inflation rates for Consensus forecasts and forecasts from the IMF's World Economic Outlook.[44] A large gap signals the possibility that expectations have become unanchored. Of course, the precise source of the unanchoring remains to be determined. The upper plot compares the evidence for all 29 economies (ALL) against established IT economies (ITEST; defined previously), all advanced economies that explicitly target inflation (ITAE; see table 1), and those that are not considered IT economies (NITAE). The plot below distinguishes between emergers that target inflation (ITEME) and ones that do not (NITEME) as well as the 'global' record (ALL).

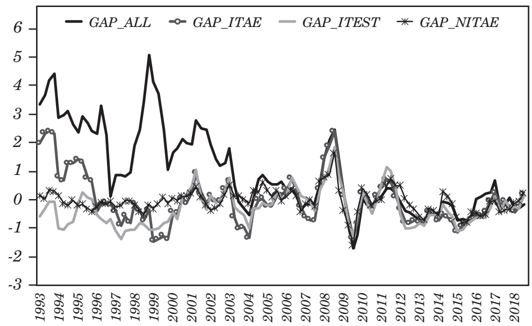
During the early 1990s, even the ITEST economies were in the early days of operating under such a regime and the gap between observed and one-year-ahead inflation is larger than for all remaining inflation-targeting central banks, many of which had not yet formally adopted the regime. Similarly, the gap for the NITAE economies also appears smaller during this period. By the mid-2000s there is little to distinguish the record of all economies, regardless of whether they formally target inflation or not. However, there is also apparently greater volatility in the gap, at least among the NITAE, while volatility in the same measure for the ITEST is largely unchanged.

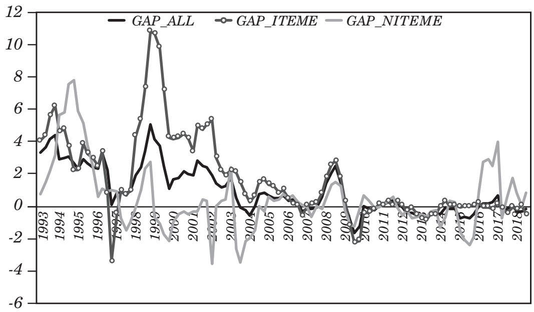
In contrast, differences in the gap are more noticeable for the emerging economies in our dataset. They remain more volatile for the NITEME group of economies relative to ones that target inflation (ITEME). Nevertheless, what is striking is the shrinking of the gap for the ITEME beginning in the mid-2000s, that is, once the economies

44. The former forecasts are monthly, the latter are semi-annual. See above for a discussion of conversion to the quarterly frequency. In addition, both forecasts are fixed-event forecasts, that is, calendar-year forecasts. These were converted to fixed-horizon forecasts (i.e., one year ahead) by using a simple transformation that is commonly used although it is, admittedly, somewhat *ad hoc*. See Siklos (2013) for more details.

in the dataset had formally adopted the regime. Gaps not only hover around zero after approximately 2005, but they are also much lower than in the 1993–2004 period. While this does not prove that inflation targeting is the cause of the improvement since, as we shall see, global factors, to which we now turn, are also likely to have played a role, it is hard to think of other explanations.

Figure 5. Gaps between Inflation and Inflation Expectations, 1993–2018

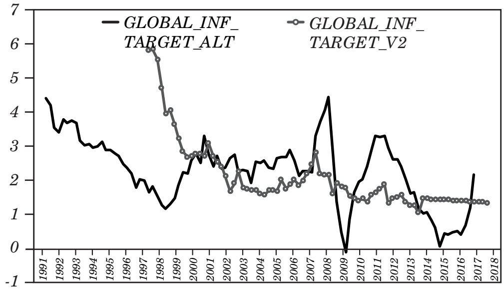




Source: Authors' calculations.
Note: GAP is the difference between inflation (time t) and one-year-ahead expected inflation (at time t). Sources and methods of calculations are described in the main body of the text. ALL refers to the 29 economies in the dataset; IT refers to inflation-targeting economies; NIT to non-inflation-targeting economies; AE and EME are defined in table 1.

Global factors are shown in figure 6 for observed and expected inflation.[45] To obtain an estimate of global inflation, we estimate the first principal component for the advanced countries only (via maximum likelihood), since this is arguably one benchmark that can be used to evaluate inflation performance of the emerging countries. A sharp decline in global-inflation expectations is noticeable in the early 2000s and there is, subsequently, relative stability, although our estimates following the Global Financial Crisis are persistently just below the two-percent goal of central banks in the advanced countries. There is greater volatility in the global-inflation factor based on observed CPI inflation especially since the crisis. Notice that the gap between observed and expected global inflation is positive in the immediate aftermath of the crisis and turns negative after 2014 (i.e., observed inflation is below expected inflation). More generally, expectations change more slowly than observed inflation and, if two percent is deemed an inflation rate that central banks around the world ought to aim for, then global expected inflation persistently underperforms since the crisis, according to this metric.

Figure 6. Estimates of Global Inflation



Source: Authors' estimation.
Note: Estimates of global inflation are used to proxy $\bar{\pi}^G$ in determining central-bank credibility (*CRED*). V2 is obtained as the first principal component from average one-year-ahead expected inflation for AE. TARGET_ALT is obtained as the first principal component for AE for observed CPI inflation. Estimation of the first PC is via maximum likelihood. See also table 1 for the list of AE.

45. We have a shorter sample for expected inflation because Consensus data were not available before the late 1990s for most emerging market economies. WEO data are available for a longer sample. We estimate the separate contribution of Consensus and WEO forecasts in generating a global estimate for expected inflation and not the first principal component of average inflation forecasts. Factor loadings are available on request.

Finally, to further illustrate differences in inflationary developments in advanced versus emerging countries, we present some evidence relying on two case studies, namely Sweden and South Africa. Both are inflation-targeting countries. Shaded areas indicate the inflation-target band. The midpoint of the target, that is, the inflation target is also shown by a dashed line. Observed and average inflation expectations are both plotted.

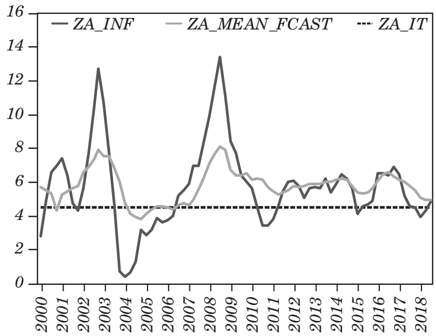
Inflation rates in these countries illustrate one of the features of the inflation record applicable to several emerging and advanced countries that we wish to highlight. In particular, while central banks in emerging countries struggle with inflation rates at the top of the target, the opposite is often true for advanced countries.[46] This phenomenon is particularly noticeable after the Global Financial Crisis, but is also a feature of the years leading up to the end of the Great Moderation around 2006. The impact of the crisis on observed inflation relative to expected inflation is also striking, with the latter seemingly not overly sensitive to changes in observed inflation. However, post crisis, we observe inflation expectations remaining persistently above the target in South Africa, while the opposite is true in Sweden. The Federal Reserve, not considered an inflation-targeting central bank, faces a comparable experience as shown in figure 7B. Inflation is below a notional two-percent medium-term objective for most years since 2008. Only at the end of the sample (i.e., 2016–18) does inflation exceed two percent.[47]

46. The South African Reserve Bank (SARB) has admitted to allowing inflation to drift to the upper limit of the band. See, for example, Reid and others (2018) and references therein. The phenomenon wherein an inflation-targeting central bank targets inflation from below has been studied by Ehrmann (2015).

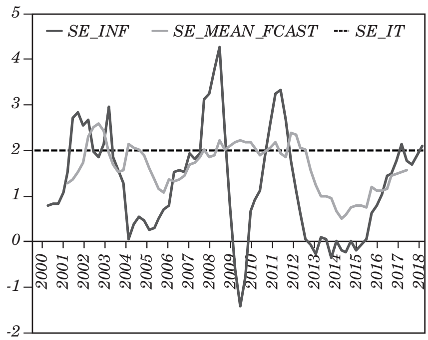
47. The sample ends with 2018Q3. CPI inflation has since dipped below 2%, the Fed's medium-term objective, in 2019 (not shown, but see https://www.bls.gov/charts/consumer-price-index/consumer-price-index-by-category-line-chart.htm).

Figure 7. Case Studies of Inflation and Expected Inflation: South Africa and Sweden

(A) South Africa



(B) Sweden



Source: Authors' calculations.
Note: Inflation (inf) is the annualized quarterly CPI inflation rate. See the text for details. MEAN_FCAST is the average one-year-ahead expected inflation constructed from Consensus Economics and World Economic Outlook forecasts. See the text for other details.

3.2 Resilience

The tension between rising central-bank independence and transparency and weak political institutions may well threaten the ability of an economy to remain resilient to a series of economic shocks. There exists a rich literature linking economic performance (e.g., economic growth) to the quality of governance and the latter is often thought to be a function of the strength of democratic institutions.[48]

We exploit the fact that a rich and growing number of datasets have become available over the years to explore how developments in central banking combine with other institutional developments to provide resilience to economic shocks. Stated differently, we collect variables that provide indications of the overall quality of its institutions. No matter how autonomous or transparent a central bank is, it is not an island. The monetary authority cannot deliver best practices without the support of other strong institutions. The higher the overall quality of domestic institutions, the greater the resilience to economic shocks of the domestic and external varieties. Of course, even if theory suggests a positive relationship between institutional quality and resilience, there is still no consensus on the composition of the former concept. Our aim, however, is merely to suggest that it is likely reasonably measured by a combination of the institutional characteristics discussed in earlier sections.[49]

Our approach is straightforward. We aggregate ten institutional indicators, and first normalize each one to generate values that range between 0 and 1.[50] We then aggregate the scores by summing the normalized scores to obtain our resilience indicator.[51] Out of the ten institutional characteristics, seven are defined such that an increase in their value raises resilience; the remaining three serve to reduce resilience. The elements that improve resilience when the relevant indicator increases are: central-bank independence, central-bank transparency, flexibility of the exchange-rate regime (greater exchange-rate flexibility improves resilience), governance quality as measured by the entire collection of World Bank indicators previously examined,

48. See, *inter alia*, Acemoglu and others (2019), Eichengreen and Leblang (2008), Rivera-Batiz (2002), and references therein

49. We leave it to subsequent research to determine whether there are any statistical links between the proposed indicator of resilience and economic performance (e.g., inflation or growth), although we suspect, based on other evidence to be provided below, that greater institutional resilience is likely to contribute to ensuring that a monetary-policy regime adheres to best practices. We previously discussed criticisms of widely used measures of institutional performance.

50. Each indicator for each country or economy is normalized as follows: $(X_t - \min(X_t))/(\max(X_t - \min(X_t))$ where X is the value of an indicator, min is its minimum value in the sample, and max is the maximum value in the sample.

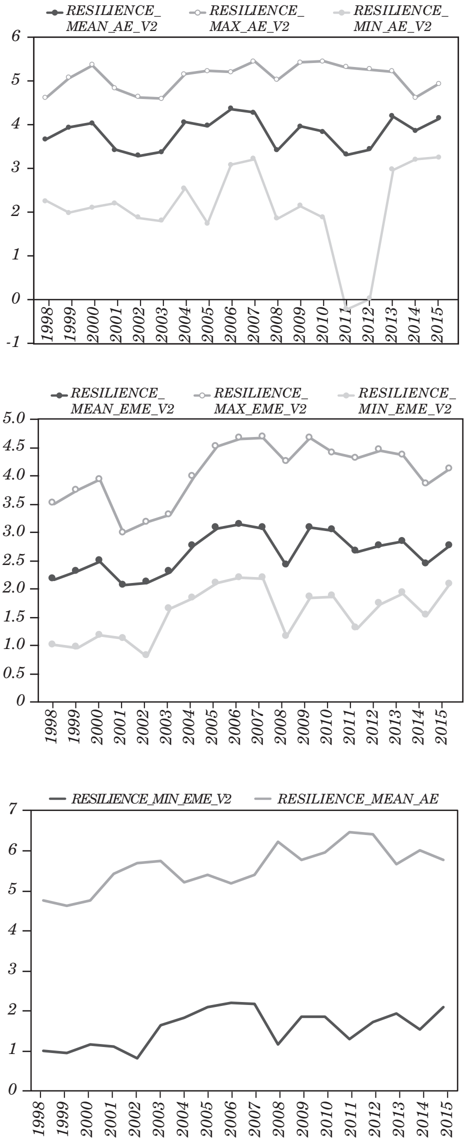
51. Hence, each component of the indicator has equal weight. In practice this is unlikely to be the case. However, absent a theory or empirical guidance about how to aggregate the individual institutional characteristics, we leave it for future research to consider the impact of different weighting schemes.

capital account openness, financial and trade globalization. Three factors contribute to reduce resilience when their indicators increase, namely: greater economic policy uncertainty, higher geopolitical risks, and the incidence of financial crises.[52] As a result, the resilience index ranges from a minimum of - 3 to a maximum of + 7.

Figure 8 provides three different views of our resilience indicator. The top portion of the figure shows the range of estimates for advanced countries; the middle portion, for the emerging countries in our dataset; and the bottom portion offers a direct comparison of resilience between the two. Perhaps unsurprisingly, there is considerable variation in resilience between the two country groups although mean levels of resilience in advanced countries always exceed the ones obtained for emergers. Nevertheless, while resilience declined temporarily in the advanced countries in the aftermath of the Global Financial Crisis, the opposite took place in the emerging countries. Unfortunately, the temporary rise in resilience after 2008 in emerging countries did not last, although the gap between the best and worst performers has narrowed since the crisis relative to the period between 1998 and 2008. In the case of the advanced countries, the impact of the crisis is most clearly seen in the rising gap between the best (i.e., "MAX") and worst performers (i.e., "MIN") that lasts until 2013, when the gap narrows substantially. It is somewhat comforting that resilience in emerging countries is higher at the end of the sample relative to the period before the crisis. However, as shown in the bottom of figure 8, there is no evidence of a narrowing of the mean values of the resilience indicator after 2008. If anything, there is a slight widening of differences in resilience between the advanced and emerging countries and, while we cannot assign any statistical significance to the results, one would hope that institutional resilience in emergers can catch up to levels reached in the advanced countries, as is the case with some key indicators of central-bank institutional quality (e.g., central-bank independence, central-bank transparency, adoption of inflation targeting).

52. The incidence of financial crises is the sum of the average annual number of banking, currency, domestic and external sovereign-debt crises based on Reinhart and Rogoff's (2009) and Bordo and Meissner's (2016) chronologies of financial crises. The maximum value this indicator can take is, therefore, 4. The original data end in 2013. The following financial crises were added to extend the sample to 2018, although other data limitations mean that the resilience indicator is fully calculated only until 2015: Russia (currency, 2014); Eurozone (domestic sovereign debt, 2011–15); Argentina (currency and external sovereign debt, 2017–18); a table in the appendix provides additional details.

Figure 8. Three Views of Institutional Resilience



Source: Authors' calculations.
Note: Resilience is defined in the main body of the text and consists of the aggregation of 10 institutional characteristics. The mean, maximum (most resilient), and minimum (least resilient) are shown for AE and EME. See table 1 for the ISO codes and classifications.

We also examined the resilience indicators for each country in the sample (not shown; see the appendix). The scores for advanced countries are consistently higher than in emerging countries. However, scores appear more volatile in emergers with more frequent reversals in resilience. For example, resilience in Argentina generally trends down since the late 1990s. Similarly, other than some improvements in the early and late 2000s, resilience in Russia remains no higher at the end of the sample than at the beginning. Approximately the same interpretation applies to the resilience scores for Turkey. Nevertheless, there are also a few bright spots among the emerging countries, including Colombia, Indonesia, and Mexico, where improvements in resilience in the early 2000s have persisted.[53]

In sum, the resilience of institutions, including central banks in emerging economies, has not caught up with their counterparts in the advanced countries. This suggests that these countries remain more vulnerable to shocks.[54]

3.3 Credibility

Next, we return to a central feature used to identify the success of monetary policy, namely credibility. As noted earlier, there is no unique definition of credibility. However, all versions have, at their core, the notions that best practice implies that central banks ought to be able to control inflation in the medium term (e.g., over a two- to five-year horizon), that policy surprises should be used as a tool of last resort or only when necessary, and, in order to anchor expectations, that the gap between observed and expected inflation ought to be as close to zero as practical. Since, as former and current prominent central bankers have frequently observed, we do not yet have a complete understanding of how expectations are formed, perhaps the best that can be expected is

53. However, since the sample ends in 2015, recent changes that might have taken place globally (e.g., in governance, central-bank independence, economic policy uncertainty) will not be reflected in the data.

54. In her panel presentation at the same Conference, Kristin Forbes uses our data but omits the last three elements, that is, economic policy uncertainty, geopolitical risk, and the incidence of financial crises. The reason is that the remaining seven components are more exclusively focused on domestic institutional quality, while the last three contain a global or external element. The mild upward trend shown at the bottom of figure 8 is more pronounced in Forbes' version, but the increasing gap between advanced and emerging resilience post-crisis remains. Interestingly, however, emerging country resilience dips temporarily in 2008, while there is hardly any change in advanced-country resilience.

for the aforementioned gap to be small.[55] Moreover, one might add, in view of growing evidence that macroeconomic uncertainty in general also has negative economic consequences,[56] that it is plausible that this can translate into less monetary-policy credibility. Finally, there is also a body of evidence that global factors also play a role in explaining inflation dynamics.[57]

We build and improve on our earlier estimates of monetary-policy credibility (Bordo and Siklos, 2015, 2017) by combining three elements of credibility, two of which are new. We, therefore, write:

$$
\begin{aligned}
&(\bar{\pi}^{f}_{t+1} - \pi^{*}_{t}),\ \text{if } \pi^{*}_{t} - \theta \leq \bar{\pi}^{e}_{t+1} \leq \pi^{*}_{t} + \theta && \text{(a)} \\
&(\bar{\pi}^{f}_{t+1} - \pi^{*}_{t})^{2},\ \text{if } \pi^{*}_{t} - \theta > \bar{\pi}^{e}_{t+1} > \pi^{*}_{t} + \theta && \text{(b)} \\
&\theta^{AE} = 1; \theta^{EME} = 2 && \text{(c)} \\
&MPU = (\pi^{f1}_{t+1} - \pi^{f2}_{t+1})^{2} + (\dot{y}^{f1}_{t+1} - \dot{y}^{f2}_{t+1})^{2} && \text{(d)} \\
&GLOBAL = \pi_{t-1} - \bar{\pi}^{G}_{t-1} && \text{(e)}
\end{aligned}
\tag{1}
$$

The first two lines in equation (1), that is, (a) and (b), define the credibility 'penalty' central banks suffer when they miss their targets. The penalty is defined as the difference between a forward-looking measure of inflation, such as the one-year-ahead average inflation forecast ($\bar{\pi}^{f}_{t+1}$) relative to an inflation objective (i.e., a target or π^{*}_{t}). The connection between the gap just defined and credibility is a function of how large the difference is between an inflation forecast and its target. This is shown by the right-hand-side inequalities in the first two lines of equation (1). The forward-looking inflation measure is a proxy for mean inflation expectations ($\bar{\pi}^{e}_{t+1}$) which defines the inequalities in the first two lines of equation (1). Once inflation expectations exceed the tolerance band—shown by the inequality in the first two lines of equation (1)—, the penalty becomes a quadratic in line with most definitions of central-bank loss functions. We treat positive and negative misses symmetrically, so that credibility is defined in terms of the absolute value of the level of misses when these are inside the tolerance range.

55. One could add a lack of persistence in deviations between observed and expected inflation, but there is already a voluminous literature that rejects this view. Indeed, AR(1) regressions of the gap referred to in figure 5 suggest considerable persistence. Notably, the period since the crisis only affects persistence in the Eurozone and New Zealand. Both experience a significant drop in persistence since 2008Q4 (results not shown).

56. For example, see Bloom (2009), and Jurado and others (2015).

57. For example, see Forbes (2019).

Since IT is typically defined somewhat more loosely in many EME via a more liberal tolerance band around an inflation target, our measure of credibility also takes this into account. Specifically, the tolerance level around the target is set at one percent for advanced and two percent for emerging countries. This explains the values taken by θ as shown in the third line of equation (1), that is (c), $\theta = 1$ for advanced and $\theta = 2$ for emerging economies. Finally, we consider three different proxies for the gap between expected inflation or its forecast and the target (i.e.,$(\bar{\pi}^{f}_{t+1} - \pi^{*}_{t})$). One proxy is the average one-year-ahead inflation expectations; a second proxy consists in using last year's observed inflation; finally, for a third proxy, we also use a two-year moving average of inflation.[58]

Next, we turn to estimates of the inflation target (π^{*}_{t}). In our earlier work we proxied each economy's inflation target by using a moving average of past inflation (e.g., five years). In the present study we allow for the possibility that, since the announced target is not meant to be met every period, a distinction can be made between *de jure* and *de facto* inflation targets. The latter is, to some extent, unobserved.[59] We proxy the *de facto* inflation target as the mean from three different filters applied to observed inflation. They are: a 5-year moving average of inflation, the inflation obtained by a band pass filter for frequencies ranging from two to eight quarters, and estimates from a one-sided Hodrick-Prescott filter.[60] These are applied to the full available span of the data.

The next two elements of our estimates of credibility, defined in the last two lines of equation (1), that is (d) and (e), represent the impact of monetary policy uncertainty (MPU) and the global factor (GLOBAL). Given the wide range of economies considered, we were only able to rely on two sets of comparable estimates of expected inflation, that is, Consensus Economics and WEO forecasts. Hence, $\pi^{f1}_{t+1}, \pi^{f2}_{t+1}, \dot{y}^{f1}_{t+1}, \dot{y}^{f2}_{t+1}$ are, respectively, the two one-year-ahead inflation forecasts and real GDP growth forecasts. To proxy monetary policy

58. So far, the definition follows our earlier work, although previously we were more conservative in some of our estimates for EME where the tolerance range was set at 1% for some estimates, and we try three different proxies for the gap between inflation and the target instead of just two.

59. Stated differently, the *de facto* target is expected to be a series that fluctuates around the announced inflation objective. For IT economies, replacing the moving average estimates with the mid-point of the announced inflation target, once the regime is adopted, did not impact the conclusions. In general, an inflation target, even if one is announced, is expected to be met over the medium term.

60. We use a smoothing parameter of 1600 for the HP filter.

uncertainty, we sum the squared differences between the two forecasts of inflation and real GDP growth. This effectively amounts to capturing a form of disagreement between forecasters. It is plausible to assume that greater monetary policy uncertainty translates into larger differences in the outlook for the economy. There are, of course, other proxies for forecast disagreement[61] and forecast uncertainty. However, absent a greater variety of available comparable forecasts across 29 economies, we cannot generate a useful estimate of, say, the kurtosis or some other indicator of forecast uncertainty. Our information set is sufficiently limited that we are unable to generate reliable estimates of the distribution of inflation forecasts or forecast disagreement.

The global factor in credibility—GLOBAL, last line in equation (1)—is captured by deviations of observed inflation in a country, lagged one period, from an estimate of average global inflation also lagged one period ($\pi_{t-1} - \overline{\pi}_{t-1}^{G}$). We chose to use the levels of the respective series because higher inflation relative to some global estimate likely translates into currency depreciation, among other economic consequences.[62] However, it is also questionable whether deviations from global inflation are seen as penalizing central-bank credibility in the same manner as misses in domestic inflation *vis-à-vis* an inflation target. Part of the reason is that global inflation is not as readily observed as domestic headline inflation. Moreover, it is difficult to know how much weight a central bank might attach to the global component, especially since, as noted earlier, passthrough effects vary considerably across the economies in our sample.

We proxy the inflation target, π_t^*, by using the two estimates shown in figure 6 and described earlier. Other proxies, such as a moving average of observed or expected inflation, or the mid-point of the inflation-target bands in countries that target inflation, do not appreciably impact the results (results not shown). Note that, in estimating the deviation from global inflation, $\overline{\pi}_{t-1}^{G}$ is lagged one period to allow for a delay in collecting the data.[63]

61. For example, see Siklos (2013, 2019) and references therein.

62. The addition of this element is partially inspired by Clarida (2018), who argues that, to the extent global inflation has declined (see figure 6), this might yield substantial benefits and may reflect a form of international monetary-policy coordination. Nevertheless, alongside any benefits there are challenges that depend on the differences between domestic observed and targeted inflation, and the same differential for the foreign benchmark inflation rate.

63. Using the contemporaneous measures of inflation and global inflation has little impact on the results.

Once the individual components of credibility are estimated they are aggregated to obtain the credibility proxy (*CRED*). We calculate both raw estimates as well as normalized estimates. Therefore, our proxy for credibility is defined as:

$$CRED_{it} = (\overline{\pi}^{f}_{i,t+1} - \pi^{*}_{it}),\ \text{if } \pi^{*}_{it} - \theta \leq \overline{\pi}^{e}_{i,t+1} \leq \pi^{*}_{it} + \theta \qquad \text{(2a)}$$
$$+ MPU_{it} + GLOBAL_{it}$$

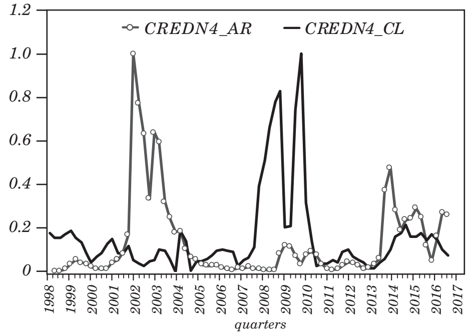
$$CRED_{it} = (\overline{\pi}^{f}_{i,t+1} - \pi^{*}_{it})^{2},\ \text{if } \pi^{*}_{it} - \theta > \overline{\pi}^{e}_{i,t+1} > \pi^{*}_{it} + \theta \qquad \text{(2b)}$$
$$+ MPU_{it} + GLOBAL_{it}$$

where *CRED* is the estimate of monetary-policy credibility for economy i at time t, and all other terms were previously defined. The actual value of the credibility indicator, as previously explained, is dictated according to whether gaps between inflation expectations and the target are within the tolerance zone or not, thereby giving rise to equations (2a) and (2b). Positive values for each component are seen as contributing to reduce credibility, because as the gap between observed and expected inflation widens, there is more monetary policy uncertainty, and domestic inflation is higher than a measure of global inflation. Estimates of *CRED* are unweighted since it is not obvious, in theory, how much relative importance ought to be attached to any one of the three components.

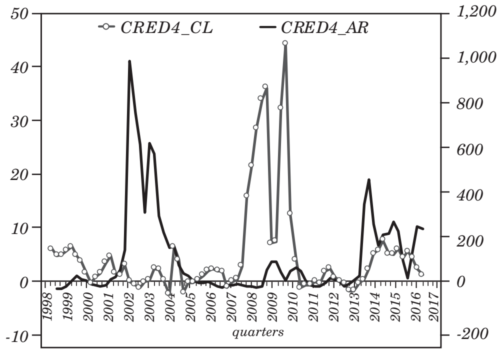
We also estimate and focus on a normalized estimate of *CRED*, since this transforms the raw estimates into ones that range from 0 (perfect credibility) to 1 (no credibility), based on the historical credibility of the monetary policy of an individual economy. It is useful to compare the two different estimates. As an illustration, consider figure 9 which plots *CRED* in both raw and normalized forms for Argentina and Chile. Normalized estimates are shown in the top of figure 9, while raw estimates are plotted at the bottom. Estimates for Chile are on the left-hand-side scale, while *CRED* for Argentina are scaled on the right. Both convey essentially the same message. However, raw *CRED* estimates indicate that credibility losses in Argentina, when they occur, are as much as 20 times larger than in Chile, as seen by comparing the two scales in the plot at the bottom of figure 9.

Figure 9. Illustrating Estimates of Central-Bank Credibility: Chile versus Argentina

(A) Normalized Scores



(B) Raw Scores



Source: Authors' calculations.

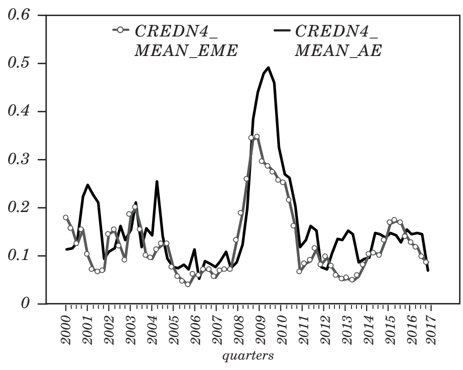
Note: *CRED*N4 is the credibility estimate in equation (2) estimated on a normalized scale, part (A), and in raw form, as n equation (2), part (B). N indicates normalized estimates. *CRED*4 is the version of credibility that uses inflation lagged one period relative to the first principal component of observed inflation in AE. AR is Argentina; CL is Chile. The set of AE and EME are listed in table 1. The global inflation target is TARGET_ALT (see figure 6), while π_{t-1} proxies π^f_{t+1} in equation (1).

Credibility falls sharply during the Global Financial Crisis but is volatile. Credibility recovers quickly but begins to decline once again toward the end of the sample. Indeed, Argentina suffers large losses as the currency board collapses in early 2002 and large losses reappear once again after 2014, when sovereign-debt problems and rising inflation return. However, the credibility loss is less noticeable in Argentina during the Global Financial Crisis than in Chile. Hence, normalizing the scales does not change the fact that the credibility of the Central Bank of Chile is more often than not higher than for the Central Bank of the Argentine Republic.

As explained earlier, our preferred estimates of credibility—equation (2)—are normalized to range between [0,1]. Several estimates for different country groupings are shown in figures 10A through 10F. Figure 10A provides the most general picture, since it pits mean credibility for the advanced versus the emerging countries. For the available sample, the Global Financial Crisis stands out, not surprisingly, as signaling a large but temporary loss of credibility. Note, however, that the loss of credibility is comparatively greater for advanced countries. Similarly, emerging central banks regain credibility faster than their advanced counterparts once the crisis peaks. Credibility in both groups of economies does not recover until 2011. The tables are turned around the time of the Asian financial crisis of 1997–1998, with emerging central banks losing credibility for longer than in advanced economies. Nevertheless, the latter were not immune to what are likely the spillovers from the Asian financial crisis on the advanced countries.[64] Central banks in emerging countries also suffered credibility losses in the early to mid-1990s, while credibility in the advanced group improved, perhaps due to the increasing number of countries that adopted the inflation-targeting monetary-policy strategy.

Figure 10. Credibility Estimates

(A) EME versus AE

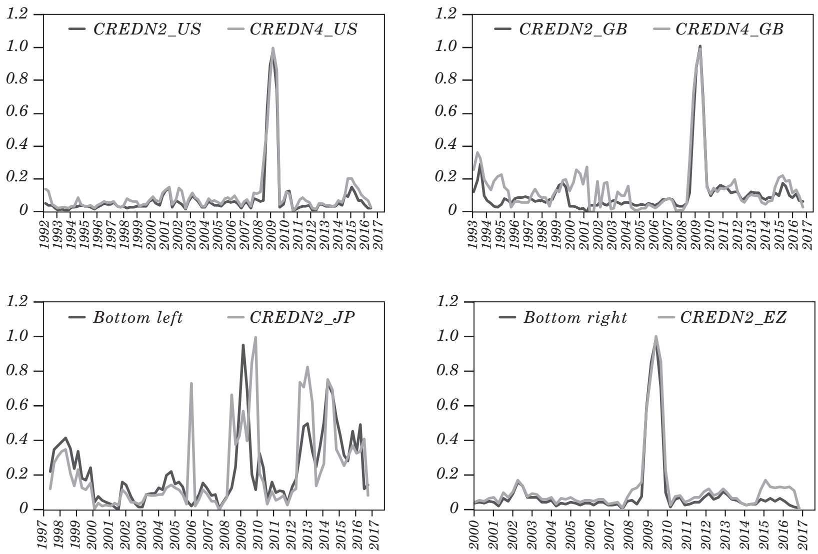


Source: Authors' calculations.
Note: Equation (2) normalized so that *CREDN*4 ranges between [0,1]. *CRED*4 is the version of credibility that uses inflation lagged one period relative to the first principal component of observed inflation in AE. Mean estimates for AE and EME are shown. Also, see table 1.

64. Note that Japan and South Korea are among the advanced-economy group of economies.

Figure 10. Credibility Estimates (continued)

(B) Large AE



Source: Authors' calculations.

The remaining figures (figure 10B through 10F) show credibility estimates for other economies or regions of the globe. Figure 10B, for example, shows two different estimates of credibility for four 'large' economies that depend on whether lagged observed inflation (*CREDN*4) or the one-year-ahead mean inflation forecast is used (*CREDN*2). While the two sets of estimates are comparable, there are the occasional differences. At least three of the four were at the center of the crisis, while Japan has long been mired in a low-growth, low-inflation or deflation environment. Clearly, the crisis stands out for the U.S., Great Britain and the Eurozone, as well as Japan. However, Japan experiences more bouts of credibility losses than any of the other three economies shown. Indeed, based on our indicators, it appears that the latest attempts by the Bank of Japan to raise inflation[65] have led to substantial increases in credibility losses. Figure 10C focuses on the so-called BRICS[66],

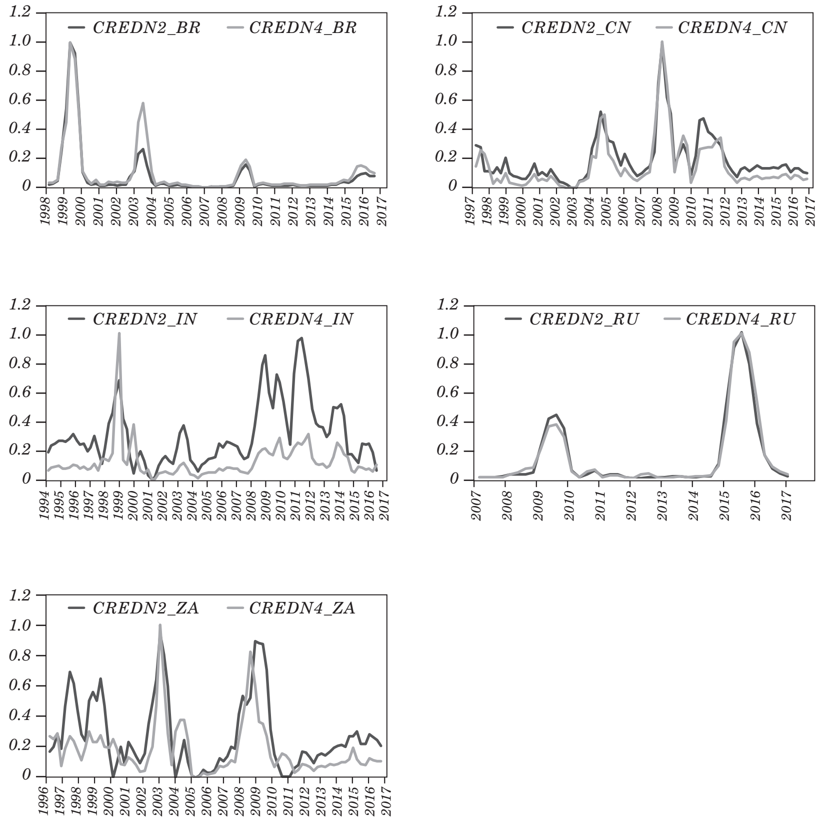
65. Since 2012 the Bank of Japan has raised the inflation target, introduced additional quantitative and qualitative easing measures. See, for example, Iwasaki and Sudo (2017).

66. Brazil, Russia, India, China, South Africa.

essentially the largest emerging market economies in our dataset. There are two aspects to note for these economies. First, unlike their advanced counterparts, there tend to be more frequent credibility losses. Brazil, India, China, and South Africa stand out. Second, differences between the two credibility proxies are more apparent for some of these emergers, most notably India, where credibility losses tend to be larger when the forward-looking inflation data are used.

Figure 10. Credibility Estimates (continued)

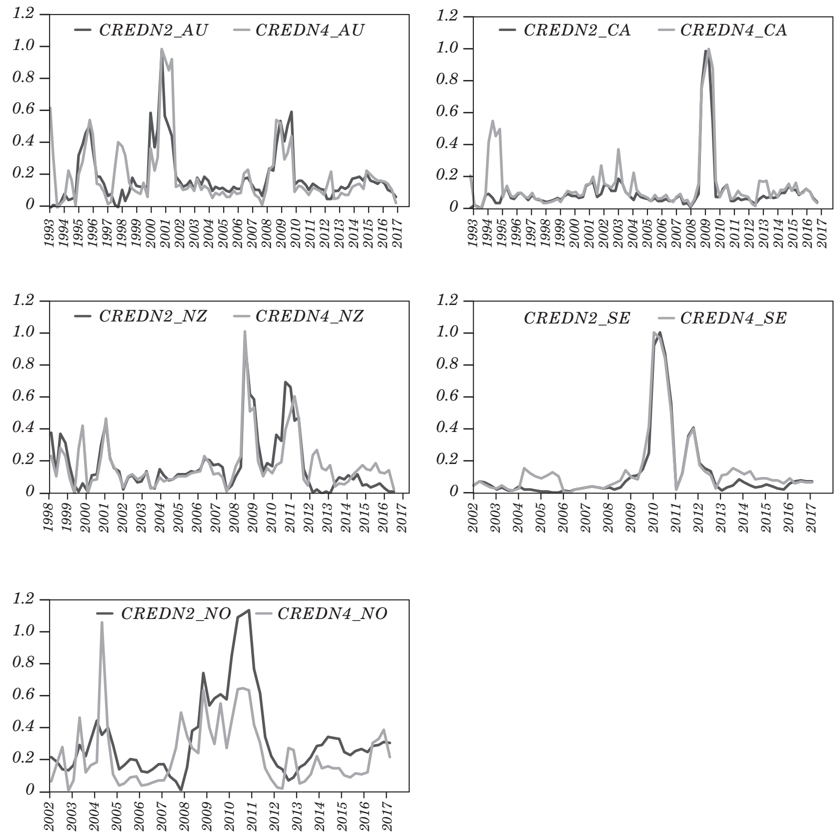
(C) BRICS (Brazil, Russia, India, China, South Africa)



Source: Authors' calculations.

Figure 10. Credibility Estimates (continued)

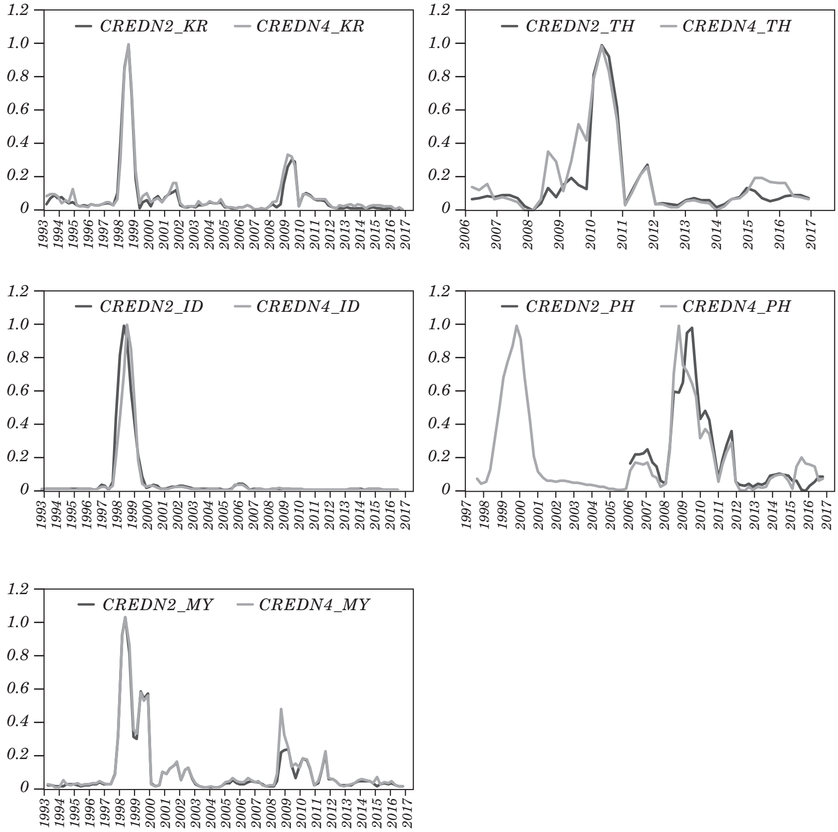
(D) IT in Selected AE



Source: Authors' calculations.

Figure 10. Credibility Estimates (continued)

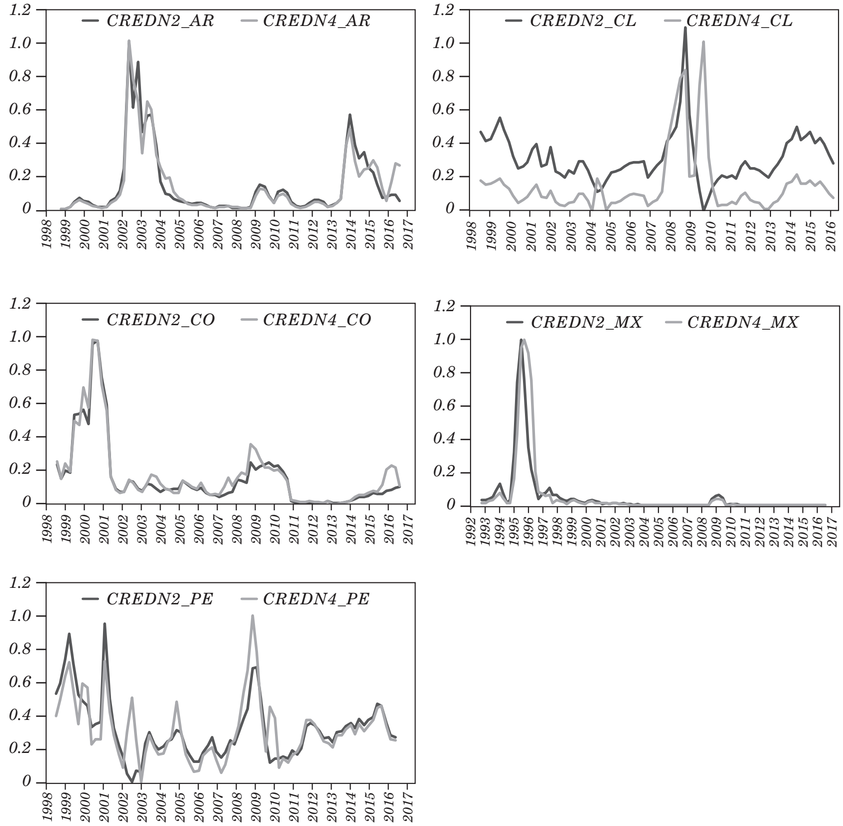
(E) Asia



Source: Authors' calculations.

Figure 10. Credibility Estimates (continued)

(F) LATAM Countries



Source: Authors' calculations.

Note: See part A of this figure. *CREDN*2 is the normalized version that uses the mean one-year-ahead inflation forecast. See the main body of the text for more details.

Next, in figure 10D we examine credibility in advanced countries that adopted inflation targeting earliest, namely, Australia (AU), Canada (CA), New Zealand (NZ), Sweden (SE), and Norway (NO). While the crisis led to a reduction of credibility everywhere, the size of the loss is historically smaller in AU and NO than in SE, NZ, and CA. Indeed, NZ and SE were hit twice, once in 2008–9 and again in 2011. In NZ's case the earthquake in Canterbury and the increase in the Goods and Services tax in 2010 likely provide the explanation.

Figure 10E plots our credibility measures for Asian economies, while figure 10F shows the results for the Latin American (LATAM) countries in the dataset. In the former group of economies, the Asian financial crisis stands out in at least three of the five countries shown, namely, i.e., Indonesia (ID), Korea (KR), and Malaysia (MY). Even in the Philippines (PH) 1998 stands out and is not far from levels reached in 2008–9. Data for Thailand (TH) reveal that the financial crisis of 1997–1998 leads to a loss of credibility as large as in 2009–2010 (not shown). A similar story is repeated for many of the LATAM economies with more than one episode of large losses of credibility. Chile stands out because, while credibility levels do not match the ones in the advanced countries with inflation targeting, only the Global Financial Crisis really stands out in the data shown since the late 1990s.

To conclude, emerging central banks, with the exception of the BRICS economies, did not suffer the same credibility losses during the crisis as did central banks in advanced countries. Moreover, a credibility gap remains as the emerging central banks, on average, are less credible than their advanced counterparts. Once lost, credibility can be regained reasonably quickly. However, the recovery period appears to be a function of the size of the crisis central banks must confront.

4. The Impact of Selected Shocks

4.1 Econometric Model

Institutions impact economic performance slowly and their effects are not always straightforward to identify. Hence, serious differences of opinion exist concerning the effect of central-bank independence and governance, to name but two examples. Even if there is agreement on best practices in institutional arrangements, economic shocks can thwart best laid plans. Therefore, we augment our institutional resilience results by examining how advanced and emerging economies fared through the lens of a more conventional econometric approach that considers the impact of unexpected changes in key macroeconomic variables. To be sure, just as there are different views about the impact of institutional factors, similarly there are differences of opinion about how to identify certain types of economic shocks, not to mention the model that is most appropriate under the circumstances. In what follows then we adopt an eclectic approach that permits readers to make their own judgment about our findings while conducting extensive sensitivity tests.

We focus on three shocks, as these highlight the potential sources of the great divide in the title of the paper. They are: financial, trade, and credibility shocks. We choose a technique where cross-border effects are center stage, since this seems like the most fruitful way to understand differences between advanced and emerging countries in how they respond to a variety of economic shocks. As noted in earlier sections, many of the reforms in monetary policy adopted by emerging countries originated in the advanced economies. Moreover, by virtue of their size, shocks emanating from advanced countries are likely to be an important device to understand how resilient emergers are to such shocks.

Consider first the case of an individual economy j. We assume that economic shocks can be sub-divided into five factors. Although factors, as such, are not observed (we return to this issue below), they have the advantage that this approach can deal with the "curse of dimensionality" when one is seeking to model dynamic relationships. This approach permits us to greatly enrich the number and types of variables included in our estimated model.

Estimated factors are as follows: a real economic factor, a financial factor, a trade factor, a monetary factor, and a global factor. The global factor is either a shock from the U.S. or a combined shock from three systemically important advanced economies, namely, the U.S., the Eurozone, and Japan. Each factor is labeled i. Each economy is identified by j. If X denotes the vector of variables used to estimate each one of these factors i, we can write

$$X_{ijt} = \alpha_{ijt} F_{ijt} + \varepsilon_{it} \tag{3}$$

where X are vectors of observable time series from which factors F are estimated, α are the factor loadings, and $i = R, F, T, M, G$ denote respectively the real, financial, trade, monetary, and global factors.

We extract the first principal component which then serves as the proxy for each factor for R, T, G, but not M.[67] For the monetary factor we use the policy rate, since this remains the principal instrument of monetary policy throughout in most of the economies in our dataset. Of course, this is not the case for the major economies since the beginning of the Global Financial Crisis (i.e., U.S., GB, and EZ) as well as Japan. For these four economies, we replace the observed policy rate with a shadow rate once the policy rate reaches the zero lower bound.[68] Separately, we also add our estimates of central-bank credibility (*CRED*), thereby adding one more element to i. After all, resilience to economic shocks is also likely to be directly impacted by the credibility of the monetary authority as discussed above.

Since it is unlikely over the sample period considered that the factors loadings are constant, we allow these to vary with time in a manner described below. All series in X are assumed to be stationary.[69] After extensive testing we use the annualized (*log*) first difference for many series, the first difference, or the levels for others in the results to be reported in the following section. Other filters were considered (see above), including a one-sided HP filter, a band-pass filter, and Hamilton's (2018) filter, but some experimentation led us to conclude that our main results would remain unchanged.[70]

In estimating (3) we collect series that are typically thought to be representative of each one of the factors listed. Table 2 presents a listing of series that are available for all economies in the study. We proceed in this manner in part because it is a more intuitive way

67. Owing to the short sample, we elected not to include more than one principal component, although the first component explains the majority of the variation in the series included (results not shown). A disadvantage of this approach is that we are unable to identify whether the estimated shocks are primarily driven, say, by supply or demand factors. This is left for future research.

68. We use Krippner's dataset (https://www.rbnz.govt.nz/research-and-publications/research-programme/additional-research/measures-of-the-stance-of-united-states-monetary-policy/comparison-of-international-monetary-policy-measures), since these are constructed in a similar manner for all four economies. Other methodologies to estimate have, of course, also been proposed. See, for example, Howorth and others (2019) and references therein. It is worth noting that the zero-lower-bound period begins before the Global Financial Crisis in Japan's case.

69. We conduct a series of panel unit root test. The series, as described below, were found to be stationary (results not shown).

70. See Chen and Siklos (2019) and references therein for a more extensive discussion of the specification and impact of various filters for a dataset that consists of four systemically important economies, including China.

to generate factor loadings as well as ones that are consistent with economic theory.[71]

Table 2. Factor Estimation

Cred	*Real*	*Trade*	*Financial*	*Monetary*	*Global*
CRED is the credibility indicator	Real GDP	Real exchange rate	Equity prices	Policy rate	U.S.
	Inflation	Current account/ GDP	Private non-bank financial assets to GDP1		or
	Real GDP growth forecast	Forex reserves	Housing prices		S3 = U.S., EZ, JP
	Inflation forecast		Yield curve (i.e., short less long rate)		
			Interest rate differential (domestic less U.S. short-term interest rate)		

Source: Authors' calculations.
Note: The text also provides some details about the form in which the series enter the various factor models. Real GDP, the current account/GDP, interest rate differential, the yield curve, and the policy rate are in levels; (1) enter in first difference form. The remaining series are in annualized growth rate form, i.e., 100 times (log($X(t)$)-log($X(t-4)$)).

71. A criticism of our approach is that factor models often rely on a larger number of variables than are being used. Nevertheless, as discussed above (also see the appendix), once a dataset moves beyond the advanced economies, the number of available and comparable time series over a reasonable span of time becomes difficult to compile. Moreover, the total number of series used in our study does not differ much from, for example, Stock and Watson (2018), or Hatzius and others (2010). More importantly perhaps, many studies of this kind, regardless of the number of variables that enter the factor model, end up finding that only a small handful of variables dominate all others in terms of their explanatory power in the factor model.

Many in the literature have proxied a global component by assuming that shocks emanating from the U.S. fulfills this role.[72] We follow this approach. However, others have also created large cross-country datasets to derive a common factor that is interpreted as the global factor.[73] Therefore, we also identify the global component for R, T, F, and M, again via factor model estimation. This time we specify a panel consisting of the data from the U.S., the Eurozone, and Japan as our second proxy for the source of global shocks. Since the main findings of our study are unchanged, we do not discuss this case further.

The modified factor model specification with the addition of the global factor can then be written as follows:

$$X_{ijt} = Y_{ijt} F^{G}_{it} + \lambda_{ikt} F^{D}_{ikt} + V_{ijkt} \tag{4}$$

where i is as previously defined, $k = US$, γ, λ are, respectively, the factor loadings for the global (i.e., F^G; the U.S.), and domestic factors (F^D; real, financial, trade, and monetary), and ν is the residual term. As before, the factor loadings are time-varying in a manner described later. Equation (4), therefore, makes clear that there is a global component for each of the factors named earlier.

To exploit the cross-sectional dimension, we then estimate the dynamic relationship between the factors in a panel setting. This gives rise to the following (quasi) time-varying panel factor or factor-augmented vector autoregression model (PFVAR) written as[74]

$$P_{jt} = \Omega_{jt}(L)P_{jt-1} + \psi_{jt}(L)F_{jt} + \xi_{jt} \tag{5}$$

where $P_{jt} = \left[R_{jt}, T_{jt}, F_{jt}, M_{jt}\right]'$ and F^G is exogenous. The latter, as we shall see, can include a set of observable variables or factors. As mentioned previously, the factors are time-varying which, in effect, implies that F^G_{jt} is also a time-varying element. Recall that the elements of P consist of the (domestic) real (R), trade (T), financial (F), and monetary (M) factors.

One issue that arises from estimation of any VAR is the ordering of the variables. Ordering the real factor first is unlikely to be

72. For example, see Feldkircher and Huber (2016).
73. For example, see Kose and others (2012).
74. "Quasi" time-varying because the factors scores are time-varying, not because the coefficients in the PVAR are time-varying. See below.

controversial, as almost all empirical work of this variety suggests that real economic factors are the 'most' endogenous in a recursive or Cholesky decomposition. However, the rest of the ordering is less clear-cut with the possible exception of the monetary (M) factor, which is traditionally seen as the 'least' endogenous because it is affected by all the other shocks, while these same shocks only impact M, with a lag. This is also standard in almost all estimated macroeconometric models. Accordingly, we estimate versions of the panel VARs where the real factor is placed first, followed by the financial and trade factors, with credibility and monetary factors last. In a separate exercise, we place credibility first and switch the order of the trade and financial factors.

Alternatively, one might also consider identifying more precisely the structural shocks either by imposing long-run or short-run restrictions, or even sign restrictions. Such extensions are feasible[75] but create additional challenges with the net benefits unclear. In the present context the most important drawback is that the economic development of the various countries in our dataset is quite diverse. This makes it difficult to impose common structural restrictions across the four economies considered (U.S., Great Britain, Eurozone, Japan). The same challenge arises when sign restrictions are considered. There is a real risk that such identification schemes can distort the results.

Finally, we discuss how the time-varying factor scores are obtained. First, we estimate factor models for the full available sample. Next, we estimate the same factor models for samples that range from five to six years in length in a rolling manner. The sample is rolled ahead two years at a time. This produces a series of overlapping samples.[76] The estimated factor scores are averaged when samples overlap to produce a unique factor estimate that is time varying.

Specifications such as equation (5) are based on unobservable factors. To gauge the sensitivity of our results, we also consider a version of (5) relying on observable time series. Define $P_{jt}^{d'} = \left[y_j, f_j, \varepsilon_j, pr_j\right]'$ where y is real GDP growth, ε is the rate of change in the real exchange rate, f is

75. For example, see Canova and Ciccarelli (2013) and references therein.

76. The samples are 5 years long for the real and trade factors, and 6 years long for the financial factor. The slightly longer span for the financial factors is inspired by the finding that the phase length of the financial cycle is longer than for business cycle (e.g., see Borio, 2012). Ideally, we would have liked to estimate the financial factor for an even longer sample (e.g., 7 to 10 years) but data limitations prevented us from doing so.

credit growth, and *pr* represents monetary policy. Again, we also consider a version augmented with credibility where $P_{jt}^{d'} = \left[y_j, f_j, \varepsilon_j, CRED_j, pr_j\right]'$.[77] Hence, the specification based on observable time series is written

$$P_{jt}^{d'} = \Omega\left(L\right)P_{jt-1}^{d} + \psi_j\left(L\right)P_{jt}^{US} + \xi_{jt} \tag{6}$$

where all terms were defined previously. Note that P^d, P^{US} are time invariant and d indicates the domestic portion, while US represents U.S. spillovers into the other economies j. We continue to assume that the global factor consists of U.S. shocks alone.

We now turn to the data and estimation results.

4.2 Shocks to Advanced and Emerging Economies

The panel VARs are estimated via GMM instrumented by using one or two lags of the endogenous variables.[78] The VARs rely on one lag. Panel-specific fixed effects are removed via a Helmert transformation to reduce dimensionality.[79] All panel VAR results shown here are estimated for a balanced sample that can vary depending on how the factor scores are estimated and the economies considered. When all economies are considered, the sample is 2001Q4–2018Q3 before lags. For the advanced countries, where 11 cross-sections are included, this yields 649 observations or 68 observations per cross-section. For the emerging countries, there are 16 cross-sections yielding 1088 observations.[80] Confidence intervals are also estimated via Monte Carlo and 68 percent significance levels are used (i.e., equivalent to ± 1 s.e.), which is fairly typical in the relevant literature, although none of the highlighted results are greatly affected when, say, an 80-percent confidence interval is used. In all the panel VARs, the ordering is as follows: real or real GDP growth, financial conditions or the change in the ratio of private non-bank financial assets to GDP, the trade factor

77. For completeness, another version where *CRED* is placed first and the ordering of y and ε is reversed is also estimated. Technically, *CRED* is not observed but it seems important nevertheless to examine the role and impact of credibility when the shocks are to observable variables.

78. See Holtz-Eakin and others (1988); also see Abrigo and Love (2015).

79. It is a transformation used in instrumental variable estimation even if the label itself is not always used. See, for example, Arellano and Bover (1995).

80. The Philippines are omitted because we could not obtain a long enough sample for enough of the series in the factor model version of the panel VAR.

or real effective exchange-rate growth, central-bank credibility,[81] and the monetary factor which is represented by the policy rate in both versions of the model. U.S. shocks are deemed exogenous. Where the results are affected by the ordering of some of the variables, this is noted below.

Results are shown in figures 11 and 12. The first set of figures (i.e., figure 11A to 11D) relies on observable time series; the second set of figures (i.e., figure 12A to 12D) contains the estimates based on factor models. Figures 11A and 12A plot the impulse responses (IR) to shocks in the endogenous variables, while figures 11B and 12B show the dynamic multipliers of exogenous shocks from the U.S. (i.e., global shocks) on the remaining advanced and emerging countries. As argued above, our discussion focuses on the differential impact of central-bank credibility, monetary policy, trade, and financial conditions in advanced versus emerging countries.

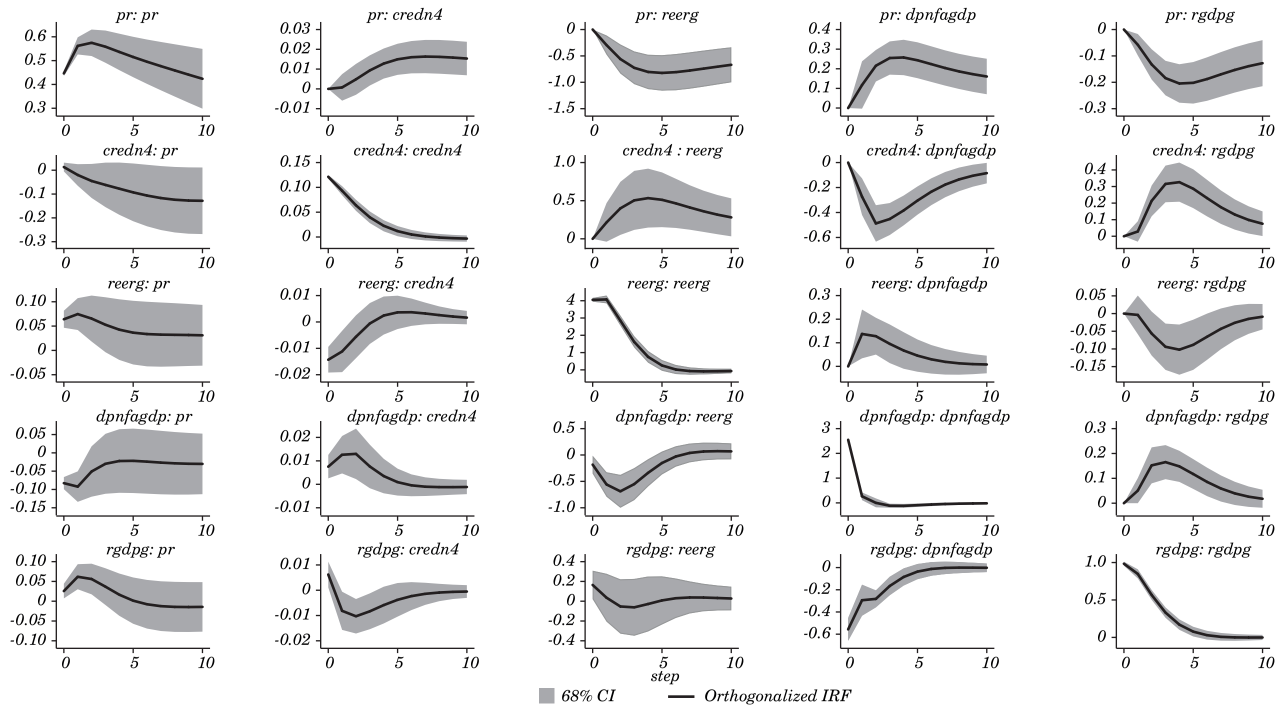
We first examine the results for the advanced countries. These are shown in figures 11A through 11D. A positive credit shock fuels a rise in real GDP growth. Similarly, real exchange-rate appreciations[82] improve central-bank credibility and raise policy rates. A positive policy rate shock reduces central-bank credibility and the real exchange rate. Policy rate shocks also have a negative impact on real GDP growth. Finally, a reduction in central-bank credibility[83] reduces credit growth but has a positive impact on real GDP growth. Since our credibility indicator aggregates three components, a rise in inflation forecast errors, monetary policy uncertainty, or global inflation divergences (which can also impact competitiveness) can combine to erode credibility and may well prompt advanced-country central banks to raise the policy rate. All of these can explain the kinds of impulse responses reported in figure 11A.

81. *CREDN*4 is the label describing the normalized estimates of central-bank credibility described earlier.

82. The real exchange is defined here such that a rise signals an improvement in competitiveness.

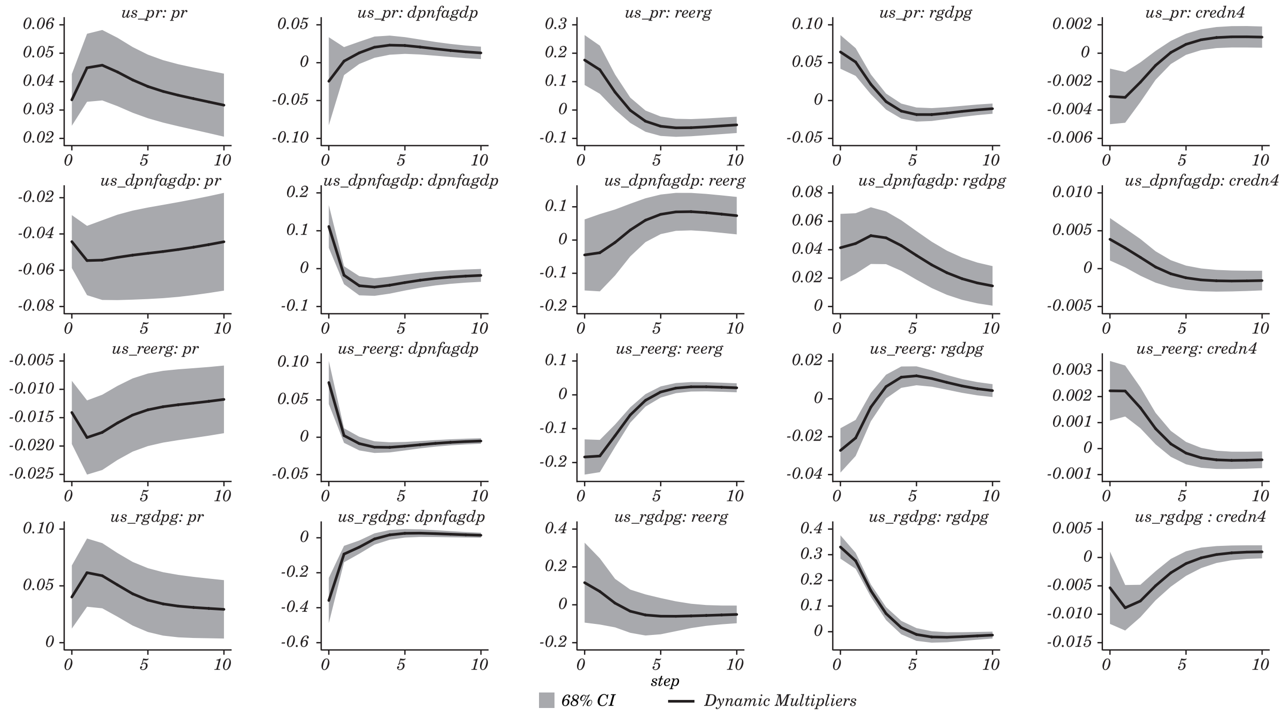
83. Recall that *CRED* is defined in a such a way so that a rise implies a fall in central-bank credibility.

Figure 11A. Impulse Responses: AE Based on Observables



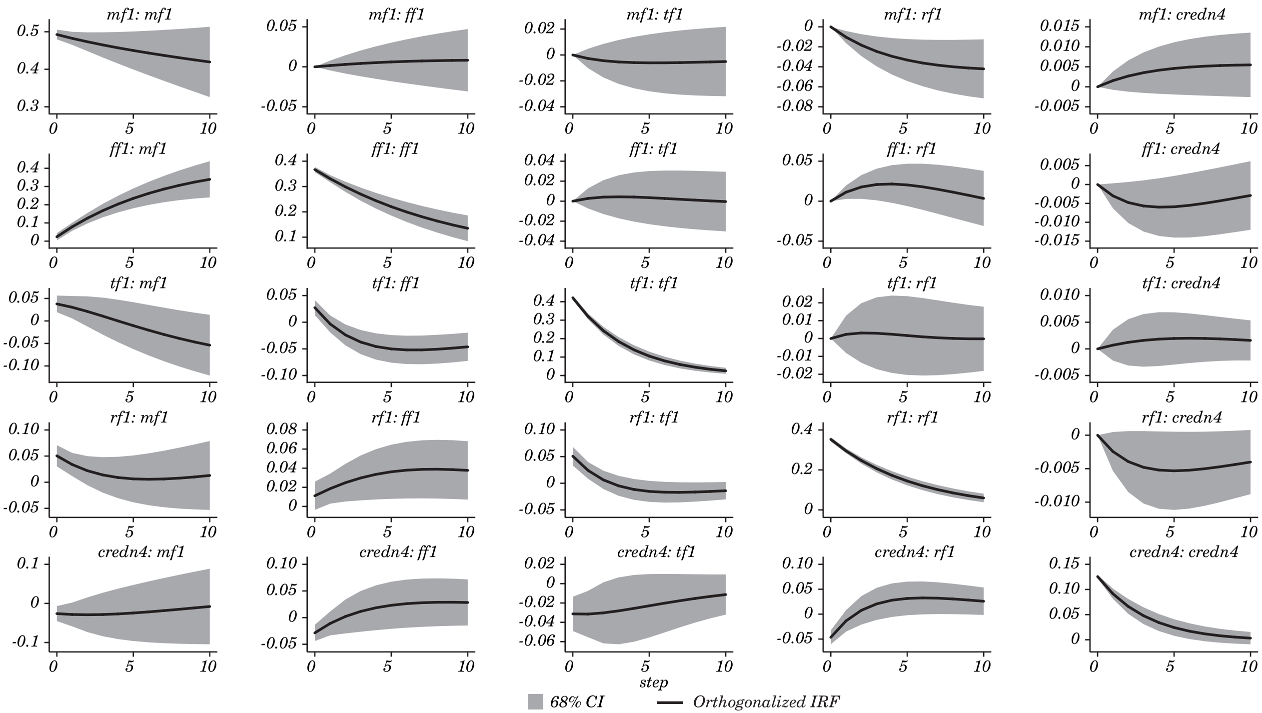
Source: Authors' calculations.
Note: See equations (4) to (6). Variables are defined in table 2. The ordering of the Panel VAR is from the last row (first) to the first row (last). 1 lag used in the estimation. See the main body of the text for more details. See figure 9 for the definition of *CREDN4*.

Figure 11B. Dynamic Multipliers: AE Based on Observable Series



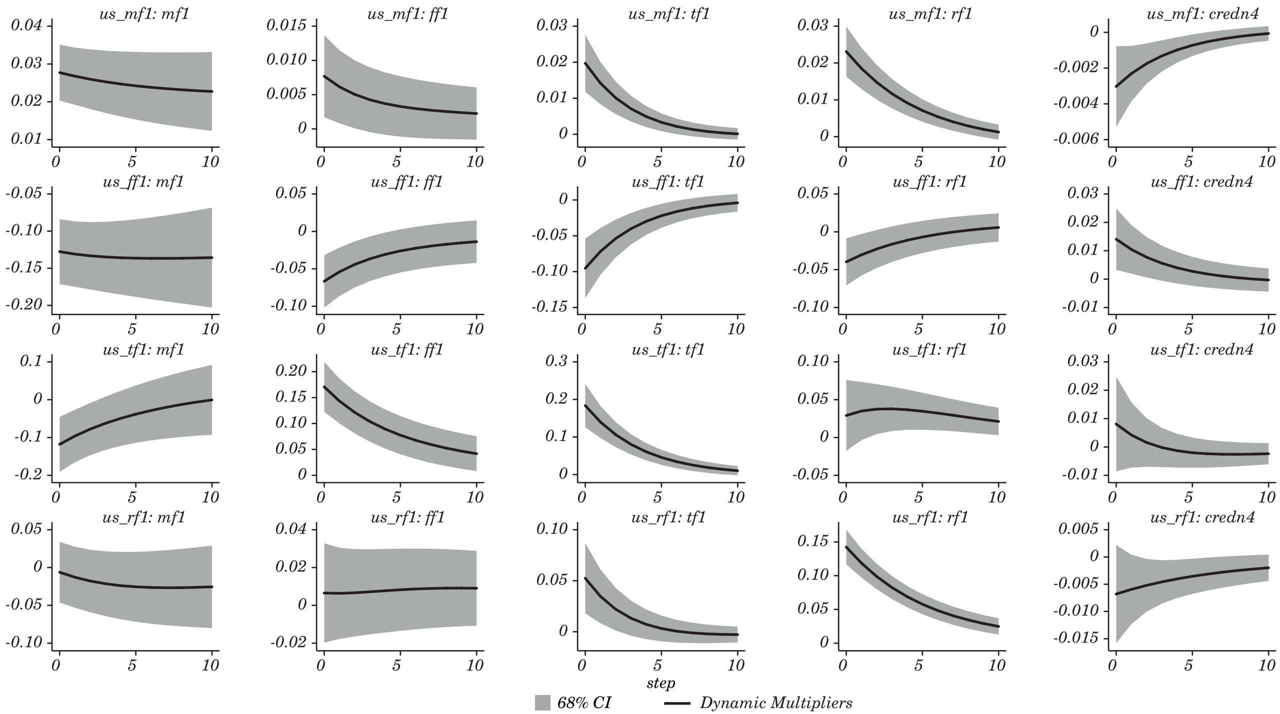
Source: Authors' calculations.
Note: Same panel VAR as in figure 11A. U.S. shocks are treated as exogenous.

Figure 11C. Impulse Responses: AE Based on Factor Model Estimates



Source: Authors' calculations.
Note: RF is the real factor, TF is the trade factor, FF is the financial factor. Factors are obtained from the first principal component of the series shown in table 2. 1 lag used in estimation. See the main body of the text for more details and the note to figure 11A.

Figure 11D. Dynamic Multipliers: AE Based on Factor Model Estimates



Source: Authors' calculations.

Dynamic multipliers in figure 11B reveal that U.S. shocks, in the form of a higher policy rate (fed funds) have spillover effects by raising credit growth and improving central-bank credibility and real GDP growth in the advanced countries. This occurs at first, but it is eventually reversed beginning five quarters in the future. A rise in U.S. competitiveness is seen as reducing real GDP growth in other advanced countries, the policy rate temporarily, and central-bank credibility. The latter result might be explained by the reduction in competitiveness when U.S. competitiveness improves. This can be interpreted as having negative consequences on some, or all, of the elements that make up our indicator of credibility. Indeed, higher U.S. real GDP growth improves central-bank credibility in the advanced countries in part because domestic competitiveness also improves. Finally, it is worth noting that central-bank credibility stands out as a variable that explains up to 16 percent of variation in real GDP growth, 18 percent of real exchange-rate fluctuations, as well as about 15 percent of variation in policy rates.[84] However, credibility shocks explain virtually none of the changes in credit growth (one percent of the variation), while real exchange-rate movements are not very sensitive to policy rate shocks (eight percent of the variation).

Turning to the same model now estimated by using factor scores for the real, trade, and financial variables, impulse responses are shown in figure 11C. Although the interpretation of many of the IR is compatible with the version that relies on observables, there are a few differences. First, a tighter monetary-policy factor (i.e., higher mf1) has no impact on central-bank credibility. However, a reduction in credibility (i.e., a higher *CREDN*4) leads to reduced real economic activity (i.e., rf1 declines). This contradicts the result shown in figure 11A. However, it is worth adding that the real factor contains forward-looking elements, whereas the observed proxy for real economic performance does not. Hence, it is possible that a credibility shock (i.e., a reduced credibility) creates expectations of negative economic outcomes that translate into lower real economic activity. Finally, a trade shock (i.e., a rise in tf1

84. We also examined the variance decompositions and performed Granger causality tests (results not shown). Not surprisingly, all models suggest that own shocks matter most. This is a common finding in the literature and captures the strong persistence property found in macroeconomic and financial time series. Granger causality tests confirm the chosen ordering in the sense that, whereas the policy rate Granger-causes the other variables in the system, it is only Granger-caused by central-bank credibility. Nevertheless, when the ordering is changed as discussed earlier, only the size—not the sign—of the impulse responses from the real exchange rate and credit growth to central-bank credibility are affected. All other impulse responses are unchanged.

which translates into greater competitiveness) leads to temporarily tighter monetary-policy and financial conditions.

The dynamic multipliers shown in figure 11D suggest that global shocks (i.e., shocks from the U.S.) impact all the variables in the model. However, two are worth highlighting. First, tighter U.S. monetary policy tightens monetary conditions in the remaining advanced economies and improves their central banks' credibility. Second, a positive U.S. real shock (i.e., a rise in us_rf1) improves competitiveness and real economic conditions in the other advanced countries.[85] This is the case of a rising tide lifting all boats.

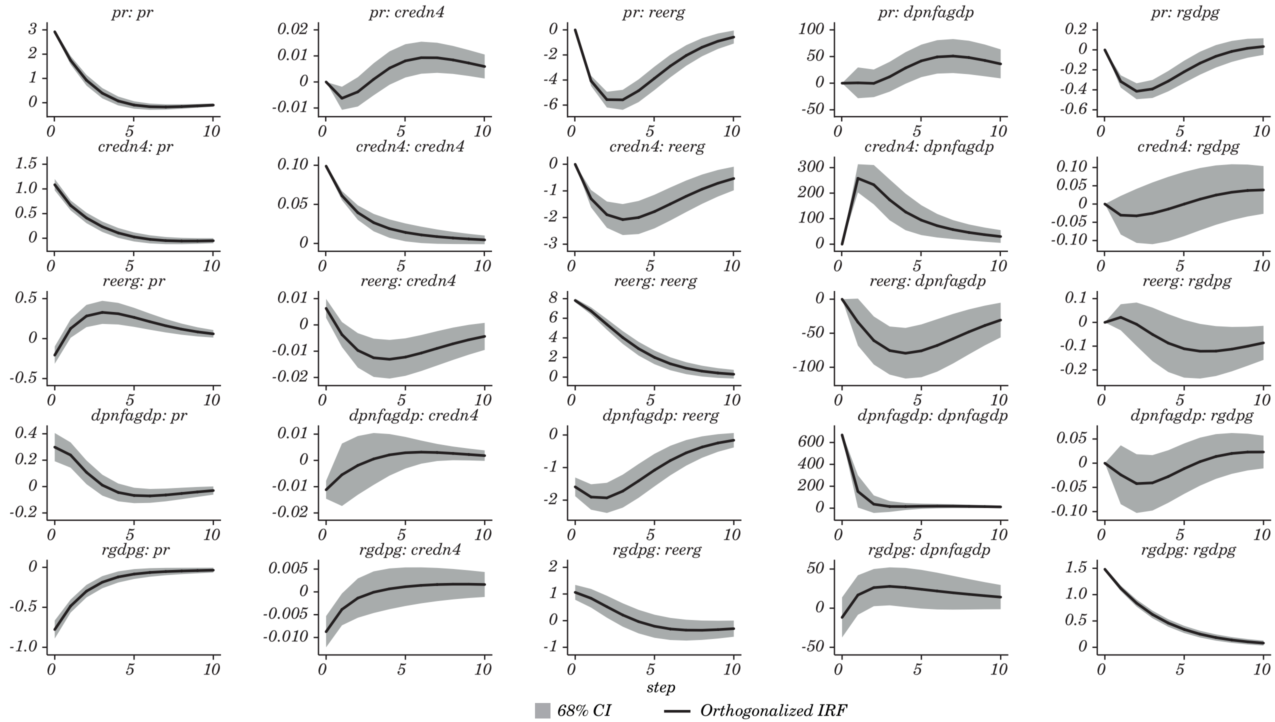
We now turn to the results for the emerging countries shown in figures 12A through 12D when the variables are observable. Early policy rate increases improve central-bank credibility, but this is more than offset in later quarters. The same shock reduces real GDP growth. The former result is consistent with the ones shown in figure 11A for the advanced economies. Unlike the experience in the advanced countries, credit growth has no impact on real GDP growth. Otherwise, the results are broadly similar with the ones reported for them.[86]

Variance decompositions (not shown) reveal that credibility shocks explain around 25 percent of variation in credit growth and 11 percent of the policy rate in the emerging countries after ten quarters. The same shock explains only two percent of real GDP growth and six percent of real exchange-rate changes. Policy rate changes explain a large portion of the real exchange-rate variable (38 percent). Other than the impact of credibility shocks on the policy rate, which are comparable for both sets of countries, central-bank credibility in emerging countries explains far less real GDP growth developments and real exchange-rate changes than in their counterparts in the advanced economies. By contrast policy rate shocks have a much bigger influence in real exchange-rate developments in emerging than in advanced countries.

85. When the ordering of some of the variables is changed, the link between credibility, trade, and financial conditions becomes insignificant. Other impulse responses are unaffected. The only noteworthy results from the variance decompositions (not shown) when factors are used is the finding that almost 20% of the variation in monetary conditions is explained by changes in financial conditions. Hence, the nexus between financial markets and monetary policy is significant and cannot be ignored in advanced countries. As we shall see below, the same result is not obtained for the emergers.

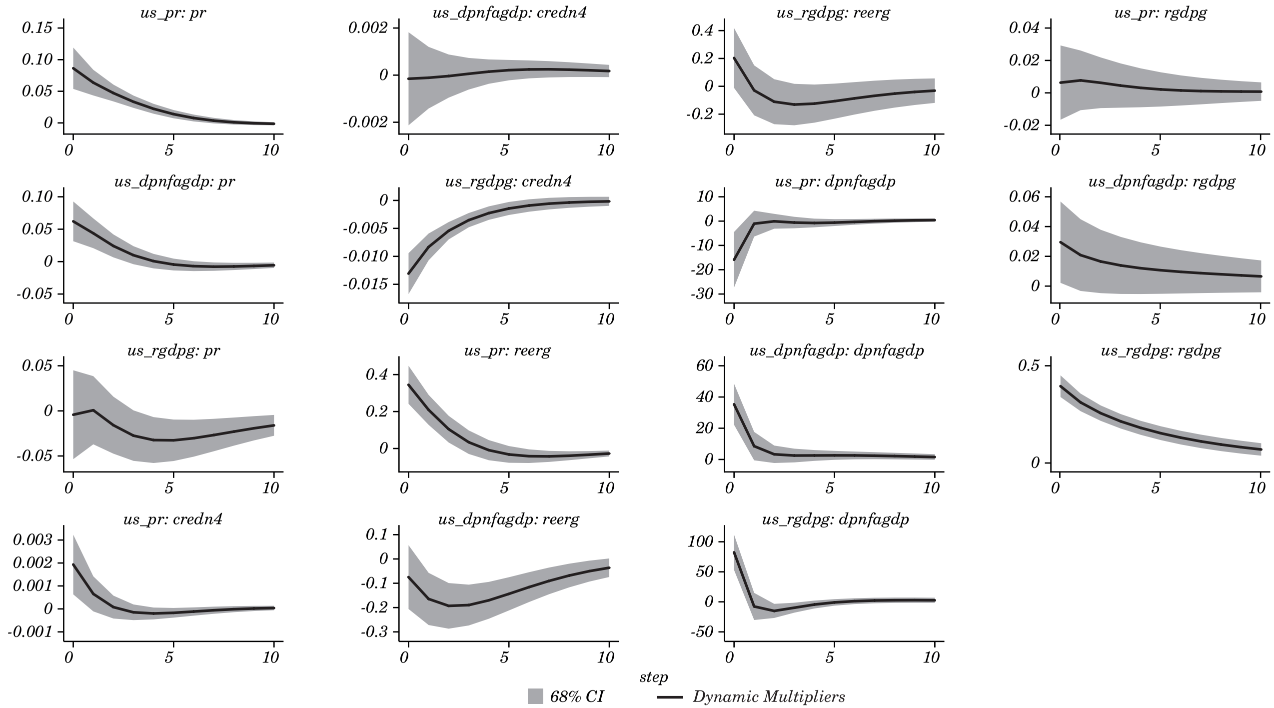
86. Changing the ordering of the variables renders insignificant the links between credit growth and credibility, and real GDP growth and central-bank credibility. Otherwise the other conclusions are unchanged.

Figure 12A. Impulse Responses: EME Based on Observables



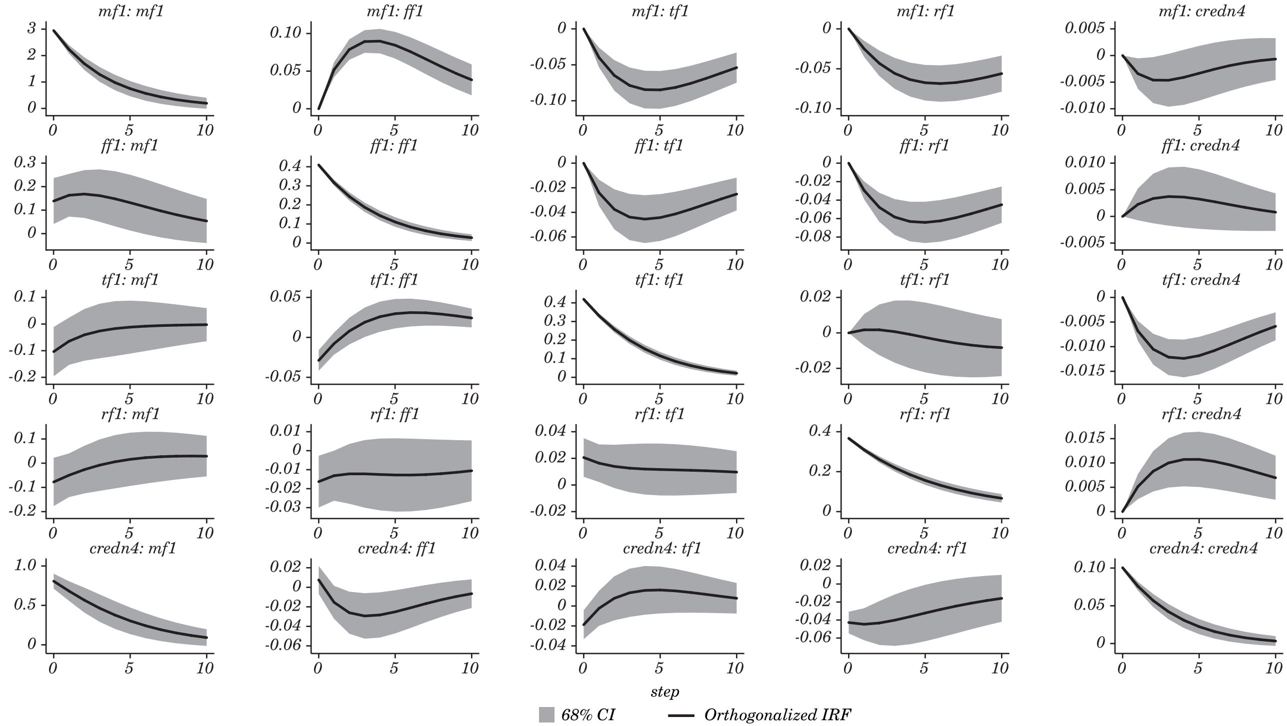
Source: Authors' calculations.
Note: See the notes to figure 11.

Figure 12B. Dynamic Multipliers: EME based on Observables



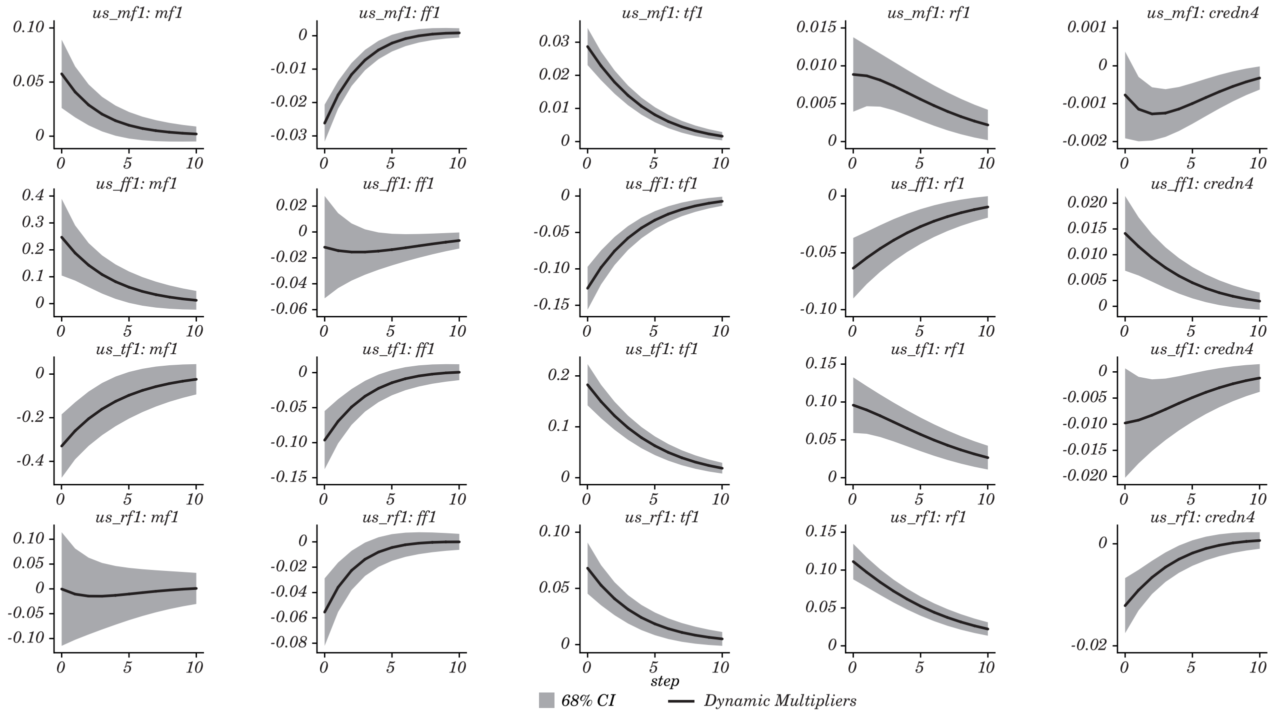
Source: Authors' calculations.

Figure 12C. Impulse Responses: EME Based on Factor Model Estimates



Source: Authors' calculations.

Figure 12D. Dynamic Multipliers: EME Based on Factor Model Estimates



Source: Authors' calculations.

Turning to spillovers from U.S. shocks shown in figure 12B, we find that, although a tightening of U.S. monetary policy also leads to higher policy rates in emerging countries and higher credit growth, central-bank credibility in these economies also deteriorates slightly but only for one quarter. There is no impact on emerging real GDP growth of a U.S. tightening of monetary policy. However, unlike for the advanced countries, rising U.S. real GDP growth improves trade competitiveness and leads to a small decline, after five quarters, in policy rates in emerging countries and not an increase as in the advanced countries.

Finally, figures 12C and 12D plot the IR for the factor-based model applied to the emerging countries. Tighter financial conditions lower real economic outcomes and have no effect on central-bank credibility. An improved trade factor, which is akin to an improvement in trade competitiveness, improves central-bank credibility. Finally, a loss of central-bank credibility produces a tightening of monetary policy, looser financial conditions, and poorer real economic outcomes.[87] Only the impulse responses between credit growth (figure 12A) and credibility or real GDP growth differ from the factor model results shown in figure 12C. Other than the finding that a competitiveness shock does not lead to tighter monetary conditions in the emerging countries, both the impulse responses and dynamic multipliers behave similarly in both sets of countries.

Variance decompositions (not shown) suggest that around nine percent of credibility shocks explain monetary conditions, which is considerably higher than in the case of advanced. However, monetary shocks explain less of the variation in financial, real, and trade factors in the emerging countries than in the advanced countries (around six to ten percent).[88] Moreover, greater U.S. competitiveness also leads to looser financial conditions in emerging countries, as well as improved central-bank credibility and improvements in the trade factor.

Given the large number of results, it may be useful to contrast the impact of a single shock—a tightening of domestic monetary policy—, for each country including the U.S. (which itself serves as the global

87. Changing the ordering of some of the variables (see above) in the model has no impact on the impulse responses.

88. Granger causality testing (not shown) also finds that, unlike in the advanced countries, monetary-policy shocks in emerging countries are more responsive to the other variables in the model. Finally, dynamic multipliers (figure 12D) suggest that U.S. monetary-policy shocks deliver a central-bank credibility dividend for emergers but at the expense of looser financial conditions.

shock), between advanced and emerging countries. A summary of the results is provided in table 3. The domestic response to a tightening shock is the same on both and irrespective of whether observable or factor modeling used. In principle, this ought to make it easier for policymakers to agree on the response to conventional monetary-policy actions. Turning to the spillover effects from the U.S., our stand-in for a global shock, these amplify the domestic response in advanced countries based on observable data with one exception. The U.S. tightening shock offsets what would otherwise be a deterioration in trade competitiveness. The same result holds for the emergers. Equally important, spillovers from a U.S. tightening shock are benign for credit growth, real GDP growth, and central-bank credibility. Turning to factor model-based estimates, global shocks are, in the main, beneficial for both sets of countries.

The only sour note for the emerging countries is that the negative real impact of a tightening of monetary policy is amplified when global shocks are added. The beneficial impact on trade competitiveness from the global shock is interesting in view of recent discussions about whether exchange-rate appreciations can be blunted because so much of trade is invoiced in U.S. dollars. Finally, even if the sign of the responses is often similar when the two groups are compared, this need not imply that the total impact of a monetary-policy shock will be the same in both groups of economies.

How then do the econometric findings relate to the institutional developments previously discussed? First, the fact that the response to many shocks are common to both suggests that the parallel changes in some critical elements of institutional change (e.g., central-bank transparency, monetary-policy regime strategy) are broadly reflected in how the two types of economies respond to selected economic shocks. In contrast, the finding that emerging countries are far more sensitive to monetary-policy shocks (i.e., based on variance decompositions) while credit growth is also more responsive to central-bank credibility shocks in advanced than in emerging countries, may also provide part of the explanation for the divergence in resilience between the two groups of economies in recent years. Clearly, this conclusion is preliminary and will require more data before it is conclusive.

Table 3. Comparing the Response to a Tightening Shock: AE versus EME

Advanced Economies		*Emerging Market Economies*	
Observables Panel Var			
Impulse Responses	*Dynamic Multipliers*	*Impulse Responses*	*Dynamic Multipliers*
Tightening	Amplified	Tightening	Amplified
Credit Growth rises	Amplified	Credit Growth rises	No change
Trade competitiveness worsens	Improves	Trade competitiveness worsens	Improves
Real GDP growth declines	Amplified	Real GDP growth declines	No change
Factor Model Based Panel Var			
Impulse Responses	*Dynamic Multipliers*	*Impulse Responses*	*Dynamic Multipliers*
Tightening	Amplified	Tightening	Amplified
Financial conditions: no change	Looser	Looser	Amplified
Trade competitiveness: no change	Improves	Improves	Amplified
Real economic factor declines	Improves	Real economic factor declines	Amplified
CB credibility: no change	Improves	CB credibility: no change	Improves

Source: Authors' calculations.
Note: The interpretations refer to the accumulated impact of shocks after 10 quarters. When a term is underlined, it means that the dynamic multipliers (i.e., a tightening monetary-policy shock from the U.S.) offset the domestic shock. When a term is in italics, the impact (domestic- or U.S.-based) differs between AE and EME. Interpretations are based on the results reported in figures 11 and 12.

5. Conclusions and Policy Lessons

In this paper we present some empirical evidence, based on a panel of 29 countries (with the euro area treated as a country, the Eurozone), on the performance of central banks in both advanced and emerging countries. Our focus is on the post-Bretton-Woods era. We document the progress made by the advanced countries since the end of the Great Inflation in the early 1980s. Most of these countries achieved credibility for low inflation by adopting the major institutional changes of central-bank independence, central-bank transparency, and inflation targeting. The apogee of this evolution was the Great Moderation from circa 1985 to 2006.

The emerging countries started with a less favorable track record. For them, the 1980s into the 1990s was characterized by macroeconomic and financial instability exhibited in frequent currency, banking, and twin crises (Bordo and others, 2001). Many of these countries had fiscally dominant regimes and problems establishing constitutional representative democracies, rule of law, and sound governance of fiscal, monetary, and financial institutions. They also had limited financial development and financial repression.

Beginning in the 1980s, a number of emergers (e.g., Chile and Korea) began to learn from their crisis experience and began following the lead of the advanced countries in developing sound fiscal, monetary, and financial institutions. By the 1990s several emergers began to tame their inflation problems and their inflation rates converged to those of the advanced countries. Those adopting inflation targeting were at the vanguard of this process (Bordo and Siklos, 2014).

The Global Financial Crisis of 2007–2008 was a major global shock, which had serious consequences for the advanced countries. Their central banks began to attach greater importance to financial stability while still following flexible inflation-targeting policies. Many of the emerging countries fared well but some with exchange rates pegged to the advanced countries were hard hit (e.g., Hungary). Also, many were hit by the collapse of global trade and commodity markets in 2009–2011, and by the spillover effects of the credit crunches in the advanced countries, especially those with original sin (i.e., foreign currency denominated debt).[89]

89. See Bordo and others (2010).

Given this background we document what has happened since the Global Financial Crisis to central-banking institutions and inflation performance in the emerging countries relative to the advanced countries. We show that some of the patterns observed before the crisis continued, but some were significantly different. Our study shows that, although some emergers did maintain the levels of central-bank independence and central-bank transparency that they had before the crisis, they experienced a decline in our measure of institutional resilience to shocks, as well as a reduction in the quality of their governance. They also exhibited a reduction in our measures of central-bank credibility. Indeed, it appears that central-bank credibility in the emerging countries is more fragile than in the advanced countries. Although the emergers, as a group, avoided the worst of the direct effects of the credit shocks of the crisis, a number are still struggling.

This we believe reflects not only the impact of the global shock, but also deep structural flaws that made them vulnerable, such as less developed financial institutions and markets, and exposure to original sin. For example, it is noteworthy that credibility shocks reverberate through the emerging economies to a greater degree than in the advanced countries. Stated differently, credibility shocks appear to have more temporary effects in advanced than in emerging countries. Moreover, U.S. shocks, when viewed as representative of global shocks that hit all economies, range from being benign to beneficial for emerging countries and more so than for the remaining advanced countries in our dataset.

Two main policy lessons follow from our study:

First, that the emerging countries should "carry on," to paraphrase a British World War II slogan, and continue improving their financial institutions, financial markets, and governance, so that they can grow up to the advanced countries as some earlier emergers (e.g., Israel and Korea) have done. This is likely the best strategy to improve institutional resilience.

Second, the problem of the post-crisis era is not just of the emerging countries' making. Advanced central banks following best practice have been unable to hit their inflation targets from below (Ehrmann, 2015). This impinges on their credibility just as the emerging countries not being able to hit their inflation targets from above. In particular, one difficulty faced by the emergers but not the advanced countries, at least over the past decade, is that explicit inflation targets and the permissible range of inflation rates have changed on several occasions, thereby giving the impression of a moving target. In contrast, among advanced countries, there is a consensus that one to three percent is the range of CPI inflation rates they ought to be targeting (Siklos, 2017).

The reasons for this are complex and not fully understood. Some argue that the slow recoveries observed in the advanced countries after the crisis were because of the Global Financial Crisis—that all serious recessions with financial crises have slow recoveries(Reinhart and Rogoff, 2009).[90] Some argue it is because of the zero lower bound and the use of quantitative easing and forward guidance by the Federal Reserve and other major Central Banks, and of the fact that the Federal Reserve and the other central banks did not follow an expansionary monetary policy but a credit (carry-trade) policy because of the payment of interest on excess reserves.[91] Others focus on the supply side and see the deep fundamentals of globalization and total factor productivity as keeping wages and prices down. Still others argue that central banks should raise their inflation targets to give them more cutting room for the next recession (Blanchard and others, 2010; Ball, 2014). However, the fact that central banks have up to now been unable to reach their two-percent targets casts doubts on this case. The implication of these issues is that it is difficult to urge the central banks of emerging countries to follow the advanced-countries best practice if our understanding of the concept is in a state of flux.

The ongoing debate in the Federal Reserve and the European Central Bank over the monetary strategy that should be followed illustrates this conundrum. The issues under consideration include: continuing to follow a form of inflation targeting, shifting to an average inflation-targeting strategy or price-level targeting; nominal GDP targeting; keeping the central bank's balance sheet large along with forward guidance or returning back to a "bills only" doctrine; and central-bank digital currency and negative policy rates (Bordo and Levin, 2019). Until these issues are resolved, it will be difficult for the central banks of the emerging countries to develop their catching up to their counterparts in the advanced countries.

90. Not all serious recessions accompanied by financial crises have slow recoveries. Research for the U.S. suggests that, following Friedman's plucking model, recessions with financial crises recover faster (See Bordo and Haubrich, 2017).

91. See Lombardi and others (2018) and references therein.

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Inflation Targeting under Political Pressure

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Historically, many emerging economies, particularly in Latin America, battled against persistently high and volatile inflation.[1] Today, emerging economies continue to experience higher inflation than developed ones, and their central banks deviate more frequently from inflation targets.[2] These patterns partly reflect the added political pressure and a lower degree of independence faced by central banks in emerging markets. For example, Aisen and Veiga (2006, 2008) find that inflation is higher and more volatile in countries with a lower quality of political institutions and a higher degree of political instability. By using a narrative approach, Binder (2018) finds that, on average, ten percent of central banks face political pressure and that this pressure is associated with higher inflation and inflation persistence.

Motivated by this evidence, this paper studies optimal monetary policy when the central bank lacks commitment to policies and is subject to time-varying political pressure. We characterize the welfare-maximizing policy that can be self-enforced conditional on the degree of central-bank independence and the level of political instability.

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1. Capistrán and Ramos-Francia (2009) provide evidence of these patterns in Latin America.

2. For a discussion, see Fraga and others (2003).

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Our analysis elucidates how these political factors affect both average inflation and inflation dynamics.

We cast our model in a Barro and Gordon (1983 a,b) framework, in which the central bank's policy determines output and inflation at every date. Following Mishkin and Westelius (2008), we model political pressure as the weight the central bank places on output expansion versus inflation stabilization. A higher weight reflects the increased importance of stimulating output in order to boost the popularity of an incumbent political party or to accommodate a fiscal expansion, for example. We take these political shocks to follow an independent and identically distributed (i.i.d.) process. In each period the central bank observes the realized shock prior to its choice of policy. This observation is private, as political pressure cannot be perfectly assessed by an external entity.[3]

Due to its lack of commitment, the central bank is inflation-biased when choosing policy. Specifically, the central bank does not internalize the impact of its actions on past inflation expectations, and it thus overweighs the benefit of stimulating output. This bias is increasing in the political shock, which accentuates the focus on output expansion over inflation stabilization. Moreover, since the central bank has full policy discretion, its policy choice must be self-enforcing and can only be disciplined by the policy choices of future central banks, via their effect on the current central bank's continuation value. Such future policies can respond to past policies; however, they cannot depend directly on past political shocks which are privately observed. Hence, monetary policy in our setting can be represented as a rule that assigns the central bank a policy choice and a continuation value for each shock at every date, where this assignment must satisfy the central bank's private-information and self-enforcement constraints. Such a rule is optimal if it maximizes social welfare.

To describe the forces underlying our model, suppose first that monetary policy could be perfectly enforced by an external entity. Then political shocks—whether publicly observable or not—play no role, and inflation is optimally set at a constant low level. Suppose next that external enforcement is not possible, but political shocks are public. Then any deviation by the current central bank (where it does not choose its assigned inflation level) is observable, and it can thus

3. In order to focus on the impact of political shocks, we abstract from economic shocks. Under some conditions, observable economic shocks can be introduced without affecting our analysis. Details available upon request.

be punished (off path) with the worst continuation value sustained by future central banks' equilibrium behavior. If this punishment is harsh enough, enforcement constraints are nonbinding. Otherwise, an optimal rule assigns the lowest level of inflation that is enforceable conditional on the realized shock. Relative to the case of perfect enforcement, inflation under this rule is higher and more volatile, as it responds to political shocks that tighten the enforcement constraint, albeit only temporarily.

An optimal monetary rule in our setting must deal not only with the problem of enforcement but also with the realistic constraint of private information. Because only the current central bank observes the realized political shock, the rule just described that conditions directly on the shock is not incentive-compatible: the central bank can deviate privately from its assigned policy and choose a higher inflation level, thus making itself strictly better off without being penalized with a lower continuation value. Incentive compatibility requires that, for each political shock, the central bank prefer its assigned inflation level and continuation value to those prescribed for any other shock.

Our main result shows that the optimal monetary rule is characterized by a hawkish low-inflation regime and a dovish high-inflation regime. The threat of transitioning to the dovish regime sustains the hawkish regime, and the promise of returning to the hawkish regime sustains the dovish regime. Moreover, unlike under observable political shocks, a temporary transition from the hawkish regime to the dovish regime may now occur on path, following high-enough shocks.

Monetary policy in each regime admits a simple implementation. We show that the hawkish regime takes the form of a *maximally enforced inflation cap*. If the central bank respects the cap, future inflation expectations remain low and the equilibrium restarts in the hawkish regime in the next period. If, instead, the central bank violates the cap, inflation expectations rise and the equilibrium transitions to the dovish regime. The central bank may not be constrained by the inflation cap when experiencing low political pressure, but it will be constrained under high pressure and, in some cases, it will break the cap.

Additionally, we show that the dovish regime takes the opposite form of a *maximally enforced inflation floor*. If the central bank respects the floor (by choosing high-enough inflation), future inflation expectations decline, and the equilibrium returns to the hawkish regime in the next period. If, instead, the central bank violates the floor, inflation expectations remain high, and the equilibrium restarts in the dovish regime. The central bank may not be constrained by the inflation floor when experiencing high political pressure, but it will be constrained under low pressure and, in some cases, it will break the floor. The dovish regime can be interpreted as a temporary abandonment of rules, with the inflation cap of the hawkish regime being reinstated only when inflation becomes high enough.

A key feature of our environment is that, *ex ante*, the central bank shares the same preferences as society for low average inflation. The central bank realizes that private-sector expectations are rational, and that future realized inflation will be incorporated into inflation expectations, thus limiting the benefit of inflation surprises. It is only after private-sector expectations are set and the political shock is realized that the central bank sees an added benefit of inflation. Thus, a maximally enforced inflation cap maximizes social welfare by counteracting the political pressure to inflate: the central bank is rewarded for choosing low inflation with a hawkish continuation regime, and it is punished for choosing high inflation with a dovish continuation regime. Analogously, a maximally enforced inflation floor—which serves as a punishment—minimizes social welfare by inducing the central bank to bend to the political pressure. Punishment is always temporary since a central bank's succumbing to political pressure is rewarded with a transition back to the hawkish regime.

We complete our characterization of inflation dynamics by examining the conditions under which the inflation cap is occasionally broken in the hawkish regime. We find that an optimal rule prescribes on-path violations following high-enough shocks only if these shocks are sufficiently unlikely. Intuitively, in this case, the benefit of lowering average inflation by specifying a tight inflation cap exceeds the cost of occasional punishment following extreme (and rare) political shocks.

Our analysis sheds light on the empirical differences in average inflation and inflation volatility in emerging versus developed economies. In our framework, inflation is high and volatile, and temporary political shocks not only impact current inflation but may also persist into the future by changing future inflation expectations. Our results suggest that these patterns, which resemble those in the data, may correspond to the best policy that can be self-enforced when the central bank is subject to time-varying political pressure.

Related literature. Our paper fits into the literature on central-bank credibility and reputation pioneered by Rogoff (1985) and, in particular, it relates to prior work that examines the role of private information in such a context.[4] We follow Athey and others (2005) by taking a mechanism-design approach to characterize optimal policy subject to private-information constraints.[5] We depart from the literature by combining private information with lack of enforcement, where we show that the latter may lead to transitions between a hawkish and a dovish inflation regime.[6]

Our paper also relates more broadly to the mechanism-design literature that studies delegation.[7] Most importantly, our analysis builds on Halac and Yared (2019), which examines optimal fiscal rules under private information and limited enforcement. A main difference is that our current focus is monetary policy, which requires us to incorporate the role of expectations, absent in the context of fiscal policy. Despite this difference, we find that the mathematical arguments developed in Halac and Yared (2019) apply, and thus our results follow from applying the general results in that paper to the present monetary-policy application.

Finally, our paper sheds light on the continuing debate about the causes of the rise and fall of inflation in the U.S. and Latin America in the postwar period; (e.g., Sargent, 2001; Sargent, and others, 2009). We find that these persistent regime transitions may reflect the central bank's least socially costly means of responding to temporary political pressure to expand the output gap.[8]

4. For example, see Barro and Gordon (1983 a,b), Backus and Driffill (1985), Canzoneri (1985), Cukierman and Meltzer (1986), Walsh (1995), and Kocherlakota (2016), among others.

5. In contrast to Athey and others (2005), we study political shocks that are payoff-irrelevant for society. Our analysis can be extended to consider shocks to the social cost of inflation, as in their work, without impacting our main results. Details available upon request.

6. These equilibrium dynamics bear a relationship to the seminal work of Abreu and others (1990), who establish the optimality of bang-bang continuation values in a class of repeated games. Their analysis however is constrained to settings with finite actions and a continuous public signal, and thus it does not apply to our environment in which the action is continuous. See Halac and Yared (2019) for a discussion.

7. The study of delegation in principal-agent settings dates back to Holmström (1977). For recent work, see Amador and Bagwell (2013) and the references cited therein. Yared (2019) discusses fiscal-policy applications of delegation theory.

8. Regime transitions in our setting can also be interpreted as arising from temporary shocks to the central bank's belief about the slope of the Phillips curve, as in Primiceri (2006), for example. Such shocks would enter the central bank's welfare function in a mathematically identical fashion as our political shocks.

1. Model

Consider an infinite-horizon setting with periods $t = \{0, 1, \ldots\}$. At the beginning of each period, an i.i.d. political shock $\theta_t > 0$ is drawn from a bounded set $\Theta \equiv [\underline{\theta}, \overline{\theta}]$, with a continuously differentiable probability density function $f(\theta_t) > 0$ and associated cumulative density function $F(\theta_t)$. The realization of θ_t is privately observed by the central bank in period t, so we refer to θ_t as the central bank's *type*. We make the following assumption:

Assumption 1. *There exists* $\widehat{\theta} \in \Theta$ *such that* $\theta f'(\theta)/f(\theta) > -2$ *if* $\theta < \widehat{\theta}$ *and* $\theta f'(\theta)/f(\theta) < -2$ *if* $\theta > \widehat{\theta}$.

Note that this assumption allows for $\theta f'(\theta)/f(\theta)$ to exceed or be below -2 over the whole set Θ; in this case, $\widehat{\theta}$ is defined as either the upper bound or the lower bound of the set Θ. Assumption 1 holds for a broad range of distribution functions, including uniform, exponential, log-normal, gamma, and beta for a subset of its parameters. This assumption is analogous to the distributional assumption used in Halac and Yared (2019).

Following the realization of θ_t, the central bank chooses inflation π_t. Let $\pi_t^e \equiv \mathbb{E}_t[\pi_t]$ be the rational expectation of inflation formed by households at the beginning of the period.[9] The output gap x_t is then determined according to the Phillips curve:

$$x_t = \kappa\,(\pi_t - \pi_t^e),$$

where $\kappa > 0$ denotes the slope of the Phillips curve.

Social welfare at date t is

$$V_t = \mathbb{E}_t\left[\sum_{s=0}^{\infty} \beta^s \left(-\frac{(\pi_{t+s})^2}{2} + \frac{\gamma}{\kappa} x_{t+s}\right)\right], \tag{1}$$

where $\beta \in (0,1)$ is the social discount factor and $\gamma/\kappa > 0$ represents the social weight on output expansion relative to the cost of inflation (normalized by κ to ease the exposition). Note that by the Phillips curve, $\mathbb{E}_t(x_t) = \kappa\,\mathbb{E}_t(\pi_t - \pi_t^e) = 0$.

9. The operator $\mathbb{E}_t$ denotes the expectation at the beginning of period t without knowledge of the realized shock θ_t.

Substituting into (1), social welfare at t can thus be rewritten recursively as

$$V_t = \mathbb{E}_t\left[-\frac{(\pi_t)^2}{2} + \beta V_{t+1}\right].$$

The central bank's welfare when choosing policy at date t, after expectations π_t^e have been formed and the shock θ_t has realized, is

$$-\frac{(\pi_t)^2}{2} + \frac{\gamma}{\kappa}\theta_t x_t + \beta V_{t+1}.$$

Substituting with the Phillips curve, this can be rewritten as

$$-\frac{(\pi_t)^2}{2} + \gamma\theta_t\pi_t - \gamma\theta_t\pi_t^e + \beta V_{t+1}. \tag{2}$$

Following Mishkin and Westelius (2008), we model the political shock θ_t as impacting the weight that the central bank places on output expansion versus inflation stabilization. A higher weight reflects the increased importance of stimulating current output in order to boost an incumbent political party's popularity or to accommodate a fiscal expansion, for example.[10]

We require the inflation rate at each date to satisfy $\pi_t \in [\underline{\pi}, \overline{\pi}]$, for finite $\underline{\pi}$, $\overline{\pi}$, so that welfare is bounded. We take the range $[\underline{\pi}, \overline{\pi}]$ to be wide enough that this constraint is otherwise nonbinding.

There are three main features of our environment. First, since $\gamma > 0$, the central bank is time-inconsistent. The central bank at date t shares the same preferences as society from date $t + 1$ onward. The reason is that this central bank does not place any weight on future political shocks and, moreover, it realizes that future realized inflation will be incorporated into the private sector's rational inflation expectations, thus limiting the benefit of inflation surprises. Thus, from the perspective of date t, setting $\pi_{t+s} = 0$ for all $s \geq 1$ maximizes both society's and the central bank's welfare. However, the central bank at date $t+s$ is biased relative to society: given a fixed continuation value, its welfare is maximized by setting a strictly positive inflation rate $\pi_{t+s} = \gamma\theta_{t+s} > 0$. The reason is that, at the time of choosing policy, the

10. Our results also apply if the political shock enters additively in the cost of inflation. Under this modification, our results can be extended to a dynamic New Keynesian framework. Details available upon request.

central bank does not internalize the effect of current inflation on past inflation expectations, and it thus underweighs the cost of inflation in its decision making. This form of time inconsistency is common to many models of monetary policy.[11] In our setting, the degree to which the central bank underweighs the cost of inflation depends on political pressure; specifically, the central bank's bias is increasing in the political shock θ_t. We denote by $\pi^f(\theta_t)$ the statically optimal, or *flexible*, level of inflation for the central bank at date t conditional on θ_t:

$$\pi^f(\theta_t) = \gamma\theta_t. \tag{3}$$

The second feature of our environment is that the political shock θ_t is privately observed by the central bank at date t. This captures the fact that political pressure cannot be perfectly observed or quantified by an external entity, be it an entity in the current period or central banks in future periods.

The third feature of our environment is that the central bank has full discretion when choosing policy. This is a main distinction from previous work, such as Athey and others (2005), which assumes that available policies can be restricted arbitrarily and at no cost. Instead, we posit that the central bank can freely choose policy at each date , and the continuation game following its policy choice serves as reward and punishment for its actions.

2. Equilibrium Definition

We define a self-enforcing rule as a perfect public equilibrium of the interaction between successive central banks. Let $h^{t-1} = \{\pi_0,\ldots,\pi_{t-1}\}$ denote the public history of inflation through time t–1 and $\mathcal{H}^{t-1}$ the set of all possible such histories. A public strategy for the central bank in period t is $\sigma_t(h^{t-1}, \theta_t)$, specifying, for each history $h^{t-1} \in \mathcal{H}^{t-1}$ and current central bank type $\theta_t \in \Theta$, a feasible level of inflation, $\pi_t(h^{t-1}, \theta_t) \in [\underline{\pi}, \overline{\pi}]$. Expected inflation at h^{t-1}, $\pi_t^e(h^{t-1})$ must be consistent with the central bank's strategy. A perfect public equilibrium is a profile of public strategies $\sigma = (\sigma_t(h^{t-1}, \theta_t))_{t=0}^{\infty}$ such that, for each $t \in \{0,1,\ldots\}$, $\sigma_t(h^{t-1}, \theta_t)$ maximizes the t-period central bank's welfare (2) given expectations $\pi_t^e(h^{t-1})$ and the continuation strategies $(\sigma_{t+s}(h^{t+s-1}, \theta_{t+s}))_{s=1}^{\infty}$ of all central banks. We henceforth refer to perfect public equilibria as simply equilibria.

11. See, for example, Barro and Gordon (1983 a,b).

Let $V_t(h^{t-1})$ denote the continuation value to the central bank starting from a history h^{t-1}. At any (on- or off-path) history h^{t-1}, the continuation value given the equilibrium strategies can be represented recursively as follows:

$$V_t\left(h^{t-1}\right) = \mathbb{E}_t\left[-\frac{(\pi_t(h^{t-1},\theta_t))^2}{2} + \beta V_{t+1}\left(h^{t-1}, \pi_t\left(h^{t-1}, \theta_t\right)\right)\right]. \tag{4}$$

A profile of strategies $(\sigma_t(h^{t-1}, \theta_t))_{t=0}^{\infty}$ constitutes an equilibrium if and only if, for all $t \in \{0, 1\ldots\}$ and all (on- and off-path) histories h^{t-1}, the following private-information and self-enforcement constraints are satisfied:

$$\begin{aligned} &-\frac{(\pi_t(h^{t-1},\theta_t))^2}{2} + \gamma\theta_t\pi_t\left(h^{t-1},\theta_t\right) + \beta V_{t+1}\left(h^{t-1}, \pi_t\left(h^{t-1},\theta_t\right)\right) \\ &\geq -\frac{(\pi_t(h^{t-1},\theta_t'))^2}{2} + \gamma\theta_t\pi_t\left(h^{t-1},\theta_t'\right) + \beta V_{t+1}\left(h^{t-1}, \pi_t\left(h^{t-1},\theta_t'\right)\right) \\ &\text{for all } \theta_t, \theta_t' \in \Theta \end{aligned} \tag{5}$$

and

$$\begin{aligned} &-\frac{(\pi_t(h^{t-1},\theta_t))^2}{2} + \gamma\theta_t\pi_t\left(h^{t-1},\theta_t\right) + \beta V_{t+1}\left(h^{t-1}, \pi_t\left(h^{t-1},\theta_t\right)\right) \\ &\geq -\frac{(\pi_t')^2}{2} + \gamma\theta_t\pi_t' + \beta V_{t+1}\left(h^{t-1}, \pi_t'\right) \text{ for all } \theta_t \in \Theta \\ &\text{and all } \pi_t' \neq \pi_t\left(h^{t-1}, \theta_t'\right) \text{ for all } \theta_t' \in \Theta. \end{aligned} \tag{6}$$

The private-information constraint (5) captures the fact that the central bank at any date t can misrepresent its type. This constraint guarantees that a central bank of type θ_t prefers to pursue its assigned inflation rate rather than that of any other type $\theta_t' \neq \theta_t$. The enforcement constraint (6) captures the fact that the central bank at any date t can freely choose any feasible inflation rate $\pi_t' \in [\underline{\pi}, \overline{\pi}]$, including rates not assigned to any other central bank-type. This constraint guarantees that a central bank of type θ_t prefers to pursue its assigned inflation rate rather than any other rate π_t' satisfying $\pi'_t \neq \pi_t\ (h^{t-1}, \theta_t')$ for all

$\theta'_t \in \Theta$. Note that in representing both of these constraints, we have ignored inflation expectations $\pi^e_t(h^{t-1})$, as this expectation has no impact on the central bank's strategy at (h^{t-1}, θ_t).

Since inflation is bounded and shocks are i.i.d., there exists an upper bound $\overline{V}$ that corresponds to the highest continuation value that can be sustained by equilibrium strategies, with $V_{t+1}(h^{t-1}, \pi'_t) \le \overline{V}$ for all h^{t-1} and π'_t. By analogous logic, there also exists a lower bound $\underline{V}$ with $V_{t+1}(h^{t-1}, \pi'_t) \ge \underline{V}$. Moreover, note that satisfying the enforcement constraint (6) requires that this constraint hold under maximal punishment, namely when $V_{t+1}(h^{t-1}, \pi'_t) = \underline{V}$. In fact, since the inequality must then hold for all $\pi'_t \in [\underline{\pi}, \overline{\pi}]$, it must necessarily hold when $\pi'_t = \pi^f(\theta_t)$. Therefore, a necessary condition for the enforcement constraint to be satisfied is

$$
\begin{aligned}
&-\frac{(\pi_t(h^{t-1},\theta_t))^2}{2} + \gamma\theta_t\pi_t\left(h^{t-1},\theta_t\right) + \beta V_{t+1}\left(h^{t-1},\pi_t\left(h^{t-1},\theta_t\right)\right) \\
&\ge -\frac{(\pi^f(\theta_t))^2}{2} + \gamma\theta_t\pi^f\left(\theta_t\right) + \beta\underline{V} \quad \text{for all } \theta_t \in \Theta,
\end{aligned}
\tag{7}
$$

where note that the right-hand side is the central bank's minmax payoff.

Constraints (5) and (7) are clearly necessary for a sequence of inflation rates to be supported by equilibrium strategies. Furthermore, these constraints are also sufficient: if a sequence of inflation rates satisfies (5) and (7), then it can be supported by a strategy profile that specifies the worst feasible continuation value following any observable deviation. Since such a deviation is off path, it is without loss to assume that it is maximally punished.

3. Optimal Self-Enforcing Rule

We examine the equilibrium that maximizes social welfare starting from date 0. In what follows, we first consider a recursive representation of the welfare-maximizing equilibrium. We then show that this equilibrium can be characterized by a hawkish low-inflation regime associated with the highest welfare level $\overline{V}$ and a dovish high-inflation regime associated with the lowest welfare level $\underline{V}$. We maintain the assumption that $\overline{V} > \underline{V}$; this inequality is guaranteed to hold provided that $\beta \in (0,1)$ is sufficiently high.

3.1 Recursive Representation

Let $\{\pi(\theta),\ V(\theta)\}_{\theta\in\Theta}$ specify the equilibrium inflation rate and continuation value for each type θ at a given date. By our equilibrium definition, this allocation must satisfy the following private-information and self-enforcement constraints, analogous to (5) and (7), respectively:

$$-\frac{(\pi(\theta))^2}{2}+\gamma\theta\pi(\theta)+\beta V(\theta)\geq-\frac{(\pi(\theta'))^2}{2}+\gamma\theta\pi(\theta')+\beta V(\theta') \tag{8}$$

for all $\theta,\theta'\in\Theta$,

$$-\frac{(\pi(\theta))^2}{2}+\gamma\theta\pi\left(\theta\right)+\beta V\left(\theta\right)\geq-\frac{(\pi^f(\theta))^2}{2}+\gamma\theta\pi^f\left(\theta\right)+\beta\underline{V}\text{ for all }\theta\in\Theta. \tag{9}$$

Additionally, $\{\pi(\theta),\ V(\theta)\}_{\theta\in\Theta}$ must satisfy the following feasibility constraints:

$$\underline{\pi}\leq\pi\left(\theta\right)\leq\overline{\pi}\text{ and }\underline{V}\leq V\left(\theta\right)\leq\overline{V}\text{ for all }\theta\in\Theta. \tag{10}$$

A rule is incentive-compatible if it satisfies (8)–(9), and it is incentive-compatible and feasible if it satisfies (8)–(10).

Given this representation, the highest welfare level $\overline{V}$ corresponds to the solution to the following program:

$$\overline{V}=\max_{\{\pi(\theta),V(\theta)\}_{\theta\in\Theta}}\mathbb{E}\left[-\frac{(\pi(\theta))^2}{2}+\beta V\left(\theta\right)\right] \tag{11}$$

subject to (8), (9), and (10).

Analogously, the lowest welfare level $\underline{V}$ is the solution to:

$$\underline{V}=\min_{\{\pi(\theta),V(\theta)\}_{\theta\in\Theta}}\mathbb{E}\left[-\frac{(\pi(\theta))^2}{2}+\beta V\left(\theta\right)\right] \tag{12}$$

subject to (8), (9), and (10).

An optimal self-enforcing rule solves program (11). We assume that the solution admits a sequence of inflation rates that are piecewise continuously differentiable in type. Additionally, if the program admits multiple solutions that differ only on a countable set of types, we select the solution that maximizes social welfare for those types.

3.2 Benchmarks

To understand the role of self-enforcement and private information, it is useful to first consider optimal monetary policy in the absence of these frictions. Suppose that the enforcement constraint (9) in program (11) could be ignored. Then social welfare is maximized by setting $\{\pi(\theta), V(\theta)\} = \{0, \overline{V}\}$ for all $\theta \in \Theta$. That is, in this case, inflation can be set at zero in all periods, and the economy does not respond to political shocks. As such, the private-information constraint (8) plays no role if the enforcement constraint is never binding.

Suppose next that the enforcement constraint (9) does bind (under some or all $\theta \in \Theta$), but political shocks are observable and, thus, the private-information constraint (8) in program (11) can be ignored. Then by using arguments similar to those in Thomas and Worrall (1988), it can be shown that the solution to this program admits $\{\pi(\theta), V(\theta)\} = \{\max\{0, \pi^o(\theta)\}, \overline{V}\}$ for all $\theta \in \Theta$, where $\pi^o(\theta) < \pi^f(\theta)$ satisfies

$$-\frac{(\pi^o(\theta))^2}{2} + \gamma\theta\pi^o\left(\theta\right) + \beta\overline{V} = -\frac{(\pi^f(\theta))^2}{2} + \gamma\theta\pi^f\left(\theta\right) + \beta\underline{V}.$$

An optimal rule in this case assigns the lowest enforceable level of inflation conditional on the observed political shock. Relative to the case of perfect enforcement, inflation is higher and more volatile since it directly responds to political shocks that tighten the enforcement constraint. Note however that, since the continuation value equals $\overline{V}$ at all dates, the equilibrium restarts in every period, and temporary political shocks only have a temporary impact on inflation.

Our setting incorporates both classes of constraints, due to self-enforcement and private information. A shock-contingent rule as that used in the absence of private information is thus not incentive-compatible: the central bank can deviate privately from its assigned policy and choose a higher inflation rate, thus making itself strictly better off without being penalized with a lower continuation value. Incentive compatibility in our setting requires that, given a realized political shock, the central bank prefer its assigned policy and continuation value to those prescribed for any other shock. We will show that, as a result, temporary political shocks can have persistent effects on inflation under an optimal monetary rule.

3.3 Hawkish Regime

To characterize the solution to program (11), we define the following rule:

Definition 1. $\{\pi(\theta), V(\theta)\}_{\theta\in\Theta}$ *is a maximally enforced inflation cap if there exist* $\theta^*\in[0,\overline{\theta})$ *and finite* $\theta^{**} > \max\{\theta^*, \underline{\theta}\}$ *such that*

$$\{\pi(\theta), V(\theta)\} = \begin{cases} \{\pi^f(\theta), \overline{V}\} \text{ if } \theta < \theta^* \\ \{\pi^f(\theta^*), \overline{V}\} \text{ if } \theta \in [\theta^*, \theta^{**}] \\ \{\pi^f(\theta), \underline{V}\} \text{ if } \theta > \theta^{**} \end{cases} \tag{13}$$

where

$$-\frac{(\pi^f(\theta^*))^2}{2} + \gamma\theta^{**}\pi^f(\theta^*) + \beta\overline{V} = -\frac{(\pi^f(\theta^{**}))^2}{2} + \gamma\theta^{**}\pi^f(\theta^{**}) + \beta\underline{V}. \tag{14}$$

Under this rule, types $\theta\in[\underline{\theta}, \theta^*)$ and $\theta\in(\theta^{**}, \overline{\theta}]$ choose their flexible inflation level $\pi^f(\theta)$, and types $\theta\in[\theta^*, \theta^{**}]$ choose type θ^*'s flexible inflation level $\pi^f(\theta^*)$. Types $\theta \leq \theta^{**}$ are maximally rewarded with continuation value $\overline{V}$, whereas types $\theta>\theta^{**}$ are maximally punished with continuation value $\underline{V}$. By (14), the enforcement constraint holds with equality for type θ^{**}. This rule can be implemented by using an inflation cap $\pi^f(\theta^*)$: if the central bank respects the cap, it receives maximal reward $\overline{V}$; if the central bank breaches the cap, it receives maximal punishment $\underline{V}$.

The following proposition shows that the highest continuation value $\overline{V}$ is sustained by a maximally enforced inflation cap:

Proposition 1 (hawkish regime). *If* $\{\pi(\theta), V(\theta)\}_{\theta\in\Theta}$ *is a solution to* (11) *with* $\pi(\theta)\in(\underline{\pi}, \overline{\pi})$ *for all* $\theta\in\Theta$*, then it satisfies* (13)–(14) *for some* $\theta^*\in[0, \overline{\theta})$ *and finite* $\theta^{**}> \max\{\theta^*, \underline{\theta}\}$. *Hence, any interior solution is a maximally enforced inflation cap.*

The optimal monetary rule, therefore, consists of an inflation cap that leads to the worst punishment whenever violated. So long as the inflation cap is respected, the economy remains in a hawkish regime that implements this cap in every period.

The proof of Proposition 1 and our other results in the next sections follow from applying the arguments developed in Halac and Yared (2019). We thus omit formal details from this article and refer the reader to the work therein.[12]

As noted in Subsection 3.2, in a setting with perfect enforcement, the optimal rule would set zero inflation at every date. Such a policy corresponds to a maximally enforced inflation cap of 0, associated with type $\theta^* = 0$. Naturally, if this cap can be enforced given $\{\underline{V}, \overline{V}\}$, then it is also optimal under self-enforcement:

Corollary 1. *Suppose*

$$\beta \overline{V} \geq -\frac{(\pi^f(\overline{\theta}))^2}{2} + \gamma\overline{\theta}\pi^f\left(\overline{\theta}\right) + \beta\underline{V}. \tag{15}$$

If $\{\pi(\theta), V(\theta)\}_{\theta\in\Theta}$ *is a solution to* (11) *with* $\pi(\theta)\in(\underline{\pi}, \overline{\pi})$ *for all* $\theta\in\Theta$, *then it is the perfect-enforcement inflation cap, with* $\theta^* = 0$ *and* $\theta^{**} \geq \overline{\theta}$.

When condition (15) holds, the highest type $\overline{\theta}$, and therefore all types $\theta\in\Theta$, prefer to respect the perfect-enforcement inflation cap of 0 and receive maximal reward $\overline{V}$, rather than inflate above this cap and receive maximal punishment $\underline{V}$. The optimal rule under self-enforcement therefore coincides with that under perfect enforcement and features no on-path punishment. Note that condition (15) trivially holds in a scenario where the central bank is fully independent from political pressure, namely where the political shocks satisfy $\overline{\theta} = \underline{\theta} = 0$.

Our interest is in characterizing the optimal self-enforcing rule when condition (15) does not hold, so the perfect-enforcement inflation cap is not enforceable given $\{\underline{V}, \overline{V}\}$. Proposition 1 implies that this rule takes one of two possible forms. One form is a relaxed inflation cap specifying $\theta^{**} \geq \overline{\theta}$, so that the enforcement constraint is satisfied under all shocks and there are no transitions to punishment on path. In this case, welfare equals $\overline{V}$ and the economy remains in the hawkish regime at all dates. The second possible form is an inflation cap specifying $\theta^{**} < \overline{\theta}$, so that the enforcement constraint is violated under high-enough shocks $\theta > \theta^{**}$ and punishment occurs on path. In this case,

12. Relative to Halac and Yared (2019), here the bias of the agent (namely, the central bank) takes a different mathematical form, and there is no state variable across periods. Despite these differences, the proof of Proposition 1 follows from analogous arguments, by applying Assumption 1 along with the first-order approach to simplify the central bank's private-information constraints. Details available upon request.

the economy remains in the hawkish regime associated with welfare $\overline{V}$ as long as the realized value of θ is below θ^{**}; once a shock $\theta > \theta^{**}$ is realized, the economy transitions to the worst punishment associated with welfare $\underline{V}$. In the next subsections, we characterize the equilibrium that sustains $\underline{V}$ and provide a necessary and sufficient condition for on-path punishment to be prescribed by the optimal self-enforcing rule.

3.4 Dovish Regime

In principle, different continuation equilibria could serve as punishment for a central bank violating the inflation cap in the hawkish regime. In fact, Proposition 1 holds independently of the exact structure of punishment. However, the optimal self-enforcing rule requires that the worst punishment be used, as such a punishment maximally relaxes the constraints in program (11) and thus maximizes welfare. We therefore next study the solution to program (12). To characterize this solution, it is useful to define the following rule:

Definition 2. $\{\pi(\theta), V(\theta)\}_{\theta\in\Theta}$ *is a maximally enforced inflation floor if there exist finite* $\theta_n^* > \underline{\theta}$ *and* $\theta_n^{**} \in [\underline{\theta}, \min\{\theta_n^*, \overline{\theta}\}]$ *such that*

$$\{\pi(\theta), V(\theta)\} = \begin{cases} \{\pi^f(\theta), \underline{V}\} \, if\, \theta < \theta_n^{**} \\ \{\pi^f(\theta_n^*), \overline{V}\} \, if\, \theta \in [\theta_n^{**}, \theta_n^*] \\ \{\pi^f(\theta), \overline{V}\} \, if\, \theta > \theta_n^* \end{cases} \tag{16}$$

where

$$-\frac{(\pi^f(\theta_n^*))^2}{2} + \gamma\theta_n^{**}\pi^f(\theta_n^*) + \beta\overline{V} = -\frac{(\pi^f(\theta_n^{**}))^2}{2} + \gamma\theta_n^{**}\pi^f(\theta_n^{**}) + \beta\underline{V}. \tag{17}$$

Under this rule, types $\theta \in [\underline{\theta}, \theta_n^{**})$ and $\theta \in (\theta_n^*, \overline{\theta}]$ choose their flexible inflation level $\pi^f(\theta)$, and types $\theta \in [\theta_n^{**}, \theta_n^*]$ choose type θ_n^*'s flexible inflation level $\pi^f(\theta_n^*)$. Types $\theta \geq \theta_n^{**}$ are maximally rewarded with continuation value $\overline{V}$ whereas types $\theta < \theta_n^{**}$ are maximally punished with continuation value $\underline{V}$. By (17), the enforcement constraint holds with equality for type θ_n^{**}. This rule can be implemented by using an inflation floor $\pi^f(\theta_n^*)$: if the central bank respects the floor, it receives maximal reward $\overline{V}$; if the central bank breaches the floor, it receives maximal punishment $\underline{V}$.

The following proposition shows that the lowest continuation value $\underline{V}$ is sustained by a maximally enforced inflation floor:

Proposition 2 (dovish regime). *If* $\{\pi(\theta), V(\theta)\}_{\theta\in\Theta}$ *is a solution to* (12) *with* $\pi(\theta)\in(\underline{\pi}, \overline{\pi})$ *for all* $\theta\in\Theta$*, then it satisfies* (16)–(17) *for some finite* $\theta_n^* > \underline{\theta}$ *and* $\theta_n^{**}\in[\underline{\theta}, \min\{\theta_n^*, \overline{\theta}\}]$. *Hence, any interior solution is a maximally enforced inflation floor.*

In the absence of enforcement constraints, the worst punishment would entail forcing all central-bank types in all future periods to choose the highest or lowest feasible inflation rates, so as to minimize the value of welfare. However, such a harsh punishment would not be self-enforcing. Proposition 2 shows that the worst punishment that is self-enforcing takes the form of a maximally enforced inflation floor. This floor minimizes welfare by incentivizing overinflation. Intuitively, given a central bank type θ, there are two ways in which (*ex-ante*) welfare can be reduced: either by inducing too little inflation or by inducing too much inflation. Since the central bank is biased towards overinflating in the present, the latter relaxes enforcement constraints, and it is thus a more efficient means of reducing welfare. As a result, in the worst-punishment allocation, all central-bank types choose inflation that is positive and thus socially costly. In fact, inflation is weakly above the flexible level preferred by the central bank. Analogous to Proposition 1, this overinflation is incentivized by maximally rewarding the central bank for respecting the inflation floor and maximally punishing the central bank for violating it.

3.5 Transitions

The results in Proposition 1 and Proposition 2 have important implications for the dynamics of inflation. Starting in a hawkish regime at date t, the central bank is subject to a maximally enforced inflation cap $\pi^f(\theta^*)$. If $\theta_t \leq \theta^{**}$, the central bank respects the cap, future inflation expectations remain low, and the equilibrium restarts in the hawkish regime at $t + 1$. If, instead, $\theta_t > \theta^{**}$, the central bank violates the cap, future inflation expectations rise, and the equilibrium transitions to the dovish regime at $t + 1$.

Starting in a dovish regime at date t, the central bank is no longer subject to an inflation cap, but it recognizes that this cap will be reinstated with a transition to the hawkish regime if inflation is above a floor $\pi^f(\theta_n^*)$. If $\theta_t \geq \theta_n^{**}$, the central bank respects the floor, future inflation expectations decline, and the equilibrium transitions to the hawkish regime at $t + 1$. If instead $\theta_t < \theta_n^{**}$, the central bank violates the floor, future inflation expectations remain high, and the equilibrium restarts in the dovish regime at $t+1$. Therefore, the dovish regime corresponds to a temporary abandonment of the inflation cap, which is eventually reinstated when inflation becomes high enough.

A maximally enforced inflation cap in the hawkish regime maximizes social welfare by counteracting the political pressure to inflate. A maximally enforced inflation floor in the dovish regime minimizes social welfare by inducing the central bank to bend to the political pressure. The threat of transitioning to the dovish regime sustains the hawkish regime, and the promise of returning to the hawkish regime sustains the dovish regime. Punishment is always temporary since a central bank's succumbing to political pressure is rewarded with a transition back to the hawkish regime.

A natural question is whether transitions to the dovish regime occur on path (i.e., $\theta^{**} < \overline{\theta}$), or the economy always remains in the hawkish regime (i.e., $\theta^{**} \geq \overline{\theta}$)). To answer this question, let $\theta_c < \overline{\theta}$ be the unique type corresponding to the tightest inflation cap that all types $\theta \in \Theta$ would be willing to respect:

$$-\frac{(\pi^f(\theta_c))^2}{2} + \gamma\overline{\theta}\pi^f\left(\theta_c\right) + \beta\overline{V} = -\frac{(\pi^f(\overline{\theta}))^2}{2} + \gamma\overline{\theta}\pi^f\left(\overline{\theta}\right) + \beta\underline{V}. \tag{18}$$

Note that $\theta_c \leq 0$ whenever the perfect-enforcement inflation cap of 0 is enforceable given $\{\underline{V}, \overline{V}\}$, and $\theta_c > 0$ otherwise. By using this definition of θ_c, the next proposition provides a necessary and sufficient condition for punishment to be optimally imposed along the equilibrium path.

Proposition 3 (use of punishment). *If* $\{\pi(\theta), V(\theta)\}_{\theta\in\Theta}$ *is a solution to* (11) *with* $\pi(\theta) \in (\underline{\pi}, \overline{\pi})$ *for all* $\theta \in \Theta$*, then it is the unique such solution. Moreover, if*

$$\left(\overline{\theta} - \theta_c\right)\overline{\theta}\frac{f\left(\overline{\theta}\right)}{1 - F\left(\theta_c\right)} \geq \theta_c, \tag{19}$$

this solution is a maximally enforced inflation cap with $\theta^* = \max\{\theta_c, 0\}$ *and* $\theta^{**} \geq \overline{\theta}$*. Otherwise, this solution is a maximally enforced inflation cap with* $\theta^* \in (0, \theta_c)$ *and* $\theta^{**} < \overline{\theta}$.

Whenever the perfect-enforcement cap is enforceable ($\theta_c \leq 0$), condition (19) is satisfied and the optimal rule coincides with that under perfect enforcement. If, instead, the perfect-enforcement cap is not enforceable ($\theta_c > 0$), then the following tradeoff arises. On the one hand, the monetary rule can raise the value of θ^* to the point that the associated cap $\pi^f(\theta^*)$ satisfies the enforcement constraint of type $\overline{\theta}$ and thus of all types $\theta \in \Theta$. This option entails setting $\theta^* = \theta_c$ and $\theta^{**} = \overline{\theta}$ and has the benefit of avoiding socially costly punishment along the equilibrium path, albeit at the cost of potentially allowing significant overinflation within the relaxed inflation cap. On the other hand, the monetary rule can specify a tighter cap $\pi^f(\theta^*)$ that does not satisfy the enforcement constraint of all types. This option sets $\theta^* < \theta_c$ and $\theta^{**} < \overline{\theta}$ and induces higher discipline on types $\theta \leq \theta^{**}$, but at the cost of transitioning to punishment whenever a shock $\theta > \theta^{**}$ is realized.

Proposition 3 tells us that which of these two options is optimal depends on whether the inequality in (19) holds or not. To analyze this condition, keep fixed the support $[\underline{\theta}, \overline{\theta}]$ and the value of θ_c. Then condition (19) shows how the use of punishment depends on the distribution of political shocks. The condition implies that punishment is not imposed on path if high political shocks are relatively likely, namely, if $f(\overline{\theta})/(1-F(\theta_c))$ is sufficiently high. This situation arises, for example, under a uniform distribution of shocks. In this case, it is optimal to set a relaxed inflation cap that is never violated, as punishing the central bank following high shocks would be too costly.

In contrast, punishment is optimally imposed on path if high political shocks are relatively unlikely, namely if $f(\overline{\theta})/(1-F(\theta_c))$ is sufficiently low. This situation arises whenever the perfect-enforcement inflation cap is not enforceable ($\theta_c > 0$) and $\lim_{\theta \to \overline{\theta}} f(\theta) = 0$, as is true, for example, under a beta distribution with a shape parameter greater than one. In this case, it is optimal to set a tight inflation cap that is violated following high-enough political shocks, as such events are sufficiently rare that the expected cost of punishing the central bank is then relatively low.

4. Concluding Remarks

This paper has studied optimal monetary policy when the central bank lacks commitment to policies and is subject to privately observed, time-varying political pressure. We showed that a maximally enforced inflation cap mitigates the political pressure to inflate in a hawkish regime. A temporary abandonment of the inflation cap accommodates the political pressure in a dovish regime and serves as a punishment for violations of the inflation cap in the hawkish regime. We examined the conditions for regime transitions to occur on path and how they depend on the distribution of political shocks.

Our analysis takes political pressure as given and explores how central banks optimally respond to it. A remaining question of interest concerns the underlying nature of political shocks and the extent to which central-bank policy can endogenously affect their distribution. In fact, political shocks may themselves be endogenous to economic shocks that also impact the central bank's welfare. Studying how central-bank behavior can affect the nature of political and economic shocks jointly may be an interesting direction for future research.

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The Fiscal Footprint of Macroprudential Policy

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Monetary policies leave a fiscal footprint. When the central bank cuts the policy interest rate, this footprint comes through multiple channels: The demand for currency rises, so the central bank prints more banknotes to accommodate it, and this creates seignorage revenues. Inflation unexpectedly rises and this lowers the real value of public debt. Rolling over this debt is cheaper as the price of newly issued debt rises. And finally, economic activity rises, so tax revenues increase and social spending falls.

A central result of the Ramsey literature on optimal monetary and fiscal policy under commitment is that inflation should be volatile and serially uncorrelated. This way, monetary policy can exploit its fiscal footprint and obtain fiscal revenues with minimal distortions. In turn, an important argument for the independence of a central bank is the potential (mis)use of the footprint, which leads to unpleasant monetarist arithmetics. When the fiscal authority does not collect enough revenues to pay for spending, then a monetary authority that wants to prevent sovereign default must sacrifice the control of inflation in favour of creating the needed fiscal footprint. One of the tell tales of an independent central bank is that it can focus on inflation while ignoring the fiscal footprint of its policies.[1]

This paper asks whether similar unpleasantries affect macroprudential policies in a simple model that characterizes their fiscal footprint. It focuses on three channels: first, macroprudential policies affect the

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For the channels of the fiscal footprint of monetary policy, see Reis (2019); for the Ramey optimal policy they imply, see Chari and Kehoe (1999); and for unpleasant monetarist arithmetics see Sargent and Wallace (1981).

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price at which government bonds sell, and thus the cost of rolling over the government debt; second, macroprudential policies affect lending in the economy, which impacts real activity and fiscal surpluses; third, macroprudential policies prevent financial crises or alleviate their fiscal costs when they occur.

Given these channels, the paper first studies the interaction of macroprudential policy with both conventional and unconventional monetary policy. All these policies have effects on bond prices, as well as on inflation and on the dividends that the central bank distributes to fiscal authorities. Because monetary policy will tend to have a larger fiscal footprint, all else equal, fiscal authorities would turn first to the central bank in search of fiscal relief. However, because their fiscal channels are similar, in practice one would expect to see both policies used together during fiscal crises. The fiscal footprint of macroprudential policy on the constraint of the monetary policymaker is significant. When the balance sheet of the central bank is large, this provides a fiscal argument for having the central bank set both monetary and macroprudential policies.

The paper then studies the interaction between fiscal and macroprudential authorities, by describing when they will have their interests aligned, clashing, or feeding off each other's actions to amplify shocks. It turns out to depend on whether the economy is going through a fiscal crisis, a financial crisis, neither, or both. Sometimes interests are aligned, and fiscal authorities are happy to interact with an independent macroprudential regulator. Other times, the two authorities are in a conflict, and an unpleasant macroprudential arithmetic can take over whereby regulation becomes active repression aiming at maximizing the fiscal impact. Some other times, the interaction is more subtle, with politicians wanting a loose macroprudential policy well before the elections, that reverts into tight macroprudential policy near the elections, to minimize the fiscal burden. The different cases shed light on a few instances in the history of financial regulation (or repression), from Latin America in the 1980s, to the barriers to a European banking union, or the independence of the Reserve Bank of India. This provides building blocks to study the independence of macroprudential policy and the scope for it to become fiscally dominated.

Macroprudential policy is a wide umbrella under which fall many, often disparate, policies. The direct focus of this paper is on policies that affect the share of government bonds that banks must hold. I denote this by β_t. Strictly speaking, policies that most directly affect

β_t are liquidity policies, such as liquidity coverage ratios or reserve requirements. These policies require banks to hold a share of their assets in liquid instruments, which invariably consist of government liabilities. More broadly, many macroprudential policies try to make the banking system safer by increasing its holdings of safe assets, which regulators invariably interpret as government bonds. In times of fiscal crisis, fiscal authorities often take over financial regulation to place the government debt. From this broader perspective,β_t is a proxy variable for the effects of several macroprudential policies. For instance, tighter capital requirements combined with zero-risk weights given to national government bonds, in practice often raise β_t. From the opposite perspective, limits on leverage lower the demand for all assets by banks, including government bonds. Many macroprudential policies have in common that they affect β_t, and this link is central to the fiscal footprint of these policies.

The other distinguishing focus of this paper is on the fiscal burden. This is defined as the resources the government must raise in order to satisfy the government budget constraint. Changes in β_t change either the tax rates in the present or the public debt that is left for the future. Macroprudential policy has a positive fiscal footprint if it increases the fiscal burden, so it tightens the resource constraint of the government and forces it to either leave more debt or raise taxes.

These two focuses—on β_t and on the fiscal footprint—distinguish this paper from much of the literature studying macroprudential policy. A large strand of it—Farhi and Werning (2016), Bianchi and Mendoza (2018), Jeanne and Korinek (2019)—studies macroprudential policies as Pigouvian taxes and subsidies that correct externalities. The resulting fiscal footprint of these policies is then set to zero through offsetting lump-sum transfers. This paper instead focuses on the macroprudential-derived demand for safety, and on measuring their fiscal footprint. Another strand of the literature—Svensson (2018), Peydro and others (2019)—focuses on the redistributive effects of macroprudential policies, with an emphasis on housing markets. It typically ignores tax revenues as policies are implemented through quotas rather than taxes.

The model builds on three strands of literature. The demand for government bonds and their liquidity (or safety) premium follows Krishnamurthy and Vissing-Jorgensen (2015). The interaction between fiscal and financial crises creating a diabolic loop follows Bolton and Jeanne (2011) and Balloch (2015), and is inspired by the facts reported in Benetrix and Lane (2015) and Bordo and Meissner

(2016). The justification for bailouts and the need for regulation is akin to that in Farhi and Tirole (2018).

The paper is organized as follows. Section 1 introduces a simple partial equilibrium model of the government-bond market. This provides the first channel for the fiscal footprint of macroprudential policy: its effect on bond prices. Section 2 introduces a central bank and compares its fiscal footprint with that of macroprudential policy. The two channels considered work through inflation and through the net income of the central bank. Section 3 has a general-equilibrium model of bank credit, investment, real activity, tax revenues, and bailouts. Macroprudential policy now has an effect on the tax base and on bailout costs, new channels for its fiscal footprint. With these channels described, section 4 considers the interaction between fiscal and macroprudential authorities, and shows when their interests are aligned or not. This depends on whether there is a fiscal or a financial crisis, or neither, and different cases can be applied to shed light on specific policy episodes in history. Section 5 studies the particularly interesting case where there are both crises, fiscal and financial, in which case the model generates a diabolic loop where the two crises amplify each other. Section 6 concludes.

1. The Fiscal Footprint via the Bond Market

A study of the fiscal footprint of policies must start by defining the footprint. Consider a government that collects real fiscal surpluses of s_t together with real dividends from the central bank z_t. It issues nominal bonds B_t which sell for a price q_t, where the price level is p_t. Bonds pay one unit if there is no default, otherwise, they pay only a fraction of their face value: $0 < \delta_{t+1} < 1$. The government budget constraint at date $t+1$ determines how much it needs to borrow this period:

$$\frac{q_{t+1}B_{t+1}}{p_{t+1}} = \delta_{t+1}\left(\frac{B_t}{p_{t+1}}\right) - z_{t+1} - s_{t+1} \equiv \Phi_{t+1}. \tag{1}$$

The left-hand side is the debt left for the future, so the right-hand side is the fiscal burden, denoted by Φ_{t+1}. The fiscal footprint of a macroprudential policy is its effect on the right-hand side: $\frac{\partial \Phi_{t+1}}{\partial \beta_t}$. The footprint of a policy is positive if the fiscal burden on the fiscal authorities increases as a result of the policy. It is negative if the policy loosens the fiscal constraint, making the job of the fiscal authority easier in terms of the surpluses that it will have to raise in the future to repay the lower debt.[2]

1.1 The Demand for Bonds: Households

A representative household maximizes utility subject to a sequence of budget constraints:

$$\sum_{t=0}^{\infty} \psi^t u\left(c_t + \ell\left(\frac{b_t}{p_t}\right)\right) \text{ subject to:} \tag{2}$$

$$p_t c_t + d_t + q_t b_t \le \left(1 + i_{t-1}^d\right) d_{t-1} + b_{t-1}\delta_t + w_t. \tag{3}$$

The household receives utility from both consumption c_t and the liquidity benefits provided by the holdings of government bonds b_t through the increasing concave function $\ell(.)$. Deposits in banks d_t earn an interest rate i_t^d. Finally, the household receives dividends from firms, banks, and the financial sector w_t.

The more uncommon part of this problem is the liquidity benefits from bonds. A recent literature[3] has made this assumption in order to make sense of the observed downward-sloping relation between outstanding U.S. Treasury bonds and the difference between their yield and the yield on corporate bonds. This is also the reason why the assumption is made here.

Optimal behaviour implies a no-arbitrage condition between the two forms of savings:

$$q_t = \ell'\left(\frac{b_t}{p_t}\right) + \frac{\delta_{t+1}}{1 + i_t^d}. \tag{4}$$

2. An intertemporal definition of the fiscal burden and footprint would rely instead on the intertemporal budget constraint of the government. I focus on the period-version of the constraint because it allows for studying how short-sighted authorities may view the footprint.

3. For example, see Krishnamurthy and Vissing-Jorgensen (2012).

Government bonds earn a premium over the yield on deposits through two channels. First, insofar as the government defaults on its bonds, their price is lower. With uncertainty, there would also be a risk premium associated with it. Second, because of their liquidity benefits, bonds command a premium over deposits.

Importantly for this paper, this premium falls as the household holds more bonds because of diminishing marginal utility for the liquidity they provide. Thus, the demand function for government bonds by households is downward-sloping, as the empirical literature has found.[4]

1.2 The Net Supply of Bonds: Banks and Central Banks

Macroprudential policy forces banks to hold an amount of bonds that is at least β_t. Because the marginal source of funds for banks are deposits and the yield on bonds is lower, banks would not want to hold any bonds at all. Therefore, macroprudential policies directly set the amount of bonds they hold, β_t.

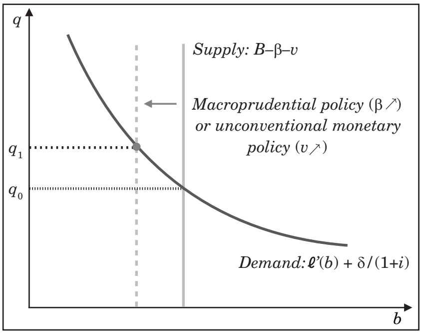
In reality, of course, the effect of policy on banks' bond holdings is surely not so precise. Even in the case of liquidity regulations, regulators often cannot use β_t as a direct policy tool, and at best only indirectly target it. But this stark result in a simple model is consistent with treating β_t as a proxy for macroprudential policies as a whole.

Besides households and banks, central banks are the third holder of government bonds, in the amount ν_t. Market clearing defines the supply curve of bonds:

$$b_t = B_t - \beta_t - \nu_t. \tag{5}$$

4. This downward-sloping demand curve is the key result, and the only one of substance, for the model that follows. A more complete comparison between deposits and bonds would also include a liquidity benefit to deposits, so that the premium could be positive or negative. As long as q_t falls with an increase in b_t, the results below will follow.

Figure 1. The Market for Government Bonds



Source: Authors' calculations.

1.3 Macroprudential Policy and the Price of Bonds

Figure 1 plots the supply and demand for government bonds. The supply curve comes from equation (5) and the demand curve, from equation (4).

A tighter macroprudential policy, by raising β_t, shifts the supply to the left. It therefore raises the price of bonds q_t by increasing the liquidity premium. More bonds are now held by banks, and fewer are held by households.

1.4 The Fiscal Footprint via the Bond Market

The first effect of macroprudential policy on the fiscal footprint is through this rise in the price of bonds. This works through the first term on the right-hand side of equation (1): $\frac{\delta_{t+1}B_t}{p_{t+1}}$.

From the budget constraint of the previous period, $\Phi_t = \frac{q_t B_t}{p_t}$ depends on δ_t, s_t, z_t. Macroprudential policy β_t is an *ex ante* policy, set at date t, so it should not affect any of these variables. Therefore we assume that it does not affect this term (or, equivalently, it is kept fixed in the partial derivatives that will follow). In turn, fiscal policy determines the future surpluses (s_{t+1}) and the repayment on bonds (δ_{t+1}), while monetary policy determines the inflation rate $\pi_{t+1} = \frac{p_{t+1}}{p_t}$ and the central bank's dividends (z_{t+1}). Differentiating equation (1) with respect to β_t while keeping these other policies fixed, then tighter macroprudential policy has a fiscal footprint of:

$$\frac{\partial \Phi_{t+1}}{\partial \beta_t} |_{s_{t+1}, \delta_{t+1}, \pi_{t+1}, z_{t+1}} = -\left(\frac{\delta_{t+1} B_t}{q_t p_{t+1}}\right) \frac{\partial q_t}{\partial \beta_t} < 0. \quad (6)$$

Macroprudential policy raises the price of government bonds. By making banks hold more government bonds, the financing needs of the government are partially met. This allows the government to roll over its debt at a better price, and so it loosens the constraint facing the fiscal authority, leaving a direct negative footprint.

2. Comparing Macroprudential and Monetary Policies

The monetary authority takes deposits from some banks in the amount ν_t / q_t in order to buy the bonds. Bonds pay back δ_{t+1}, while reserves at the central bank pay an interest rate i_t^{ν}. Therefore the net income of the central bank is:

$$p_{t+1} z_{t+1} = \left[\delta_{t+1} - \left(1 + i_t^{v}\right) q_t\right] v_t. \quad (7)$$

This assumes that the central bank follows a net-income dividend rule, so that its solvency is always guaranteed and all fiscal consequences are immediately transmitted to the government.[5]

Dividends can be positive or negative depending on whether reserves earn a positive or negative premium. Usually, on average, this premium is positive for two reasons. First, reserves provide extra liquidity services over bonds, as they are the unit of account in the economy and can be used to settle any interbank debt. Second, the average duration of government bonds held by central banks is above one year, while reserves are overnight, and there is typically a positive term premium. Modelling this premium is beyond the scope of this paper, so I simply assume that it equals a function $\mathcal{L}(\beta_t, \nu_t)$. It depends on the relative holdings of reserves and government bonds by banks, insofar as this affects the liquidity services they provide.

Conventional monetary policy targets the inflation rate π_{t+1} by varying the interest rate on deposits. There are many different ways of modelling the link between inflation and interest rates. All of them share the prediction (which fits the facts) that, in order to raise

5. See Hall and Reis (2015).

inflation in the short run, the central bank must target a lower interest rate: $\partial\pi_{t+1} / \partial i_t^d < 0$. Before 2008, this was partly done by varying the amount of reserves, but in the past decade the major central banks have kept the reserves market satiated, varying instead the interest on reserves. I assume they will continue to do so, so conventional monetary policy is understood here as varying inflation while keeping reserves fixed.

Unconventional monetary policy, as a complement, is then understood as choosing ν_t while keeping inflation π_{t+1} fixed. This can be described as a pure form of quantitative easing: an increase in the size of the balance sheet of the central bank while adjusting conventional tools to keep inflation unchanged. Most actual monetary policies will therefore have both a conventional and an unconventional component. The separation is useful because it will lead these two policies to affect the fiscal burden through two separate channels: inflation and the central bank's net income.

2.1 The Fiscal Footprint of Macroprudential Policy

With the description of monetary policy above, the fiscal burden becomes:

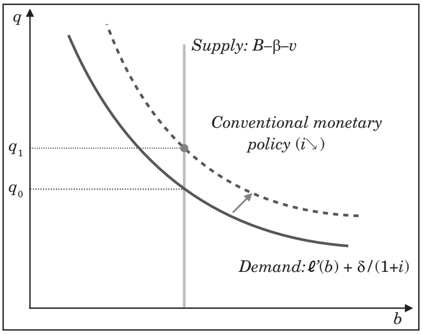
$$\Phi_{t+1} = \left(\frac{\delta_{t+1}}{q_t \pi_{t+1}}\right)\left(\frac{q_t B_t}{p_t}\right) - \mathcal{L}(\beta_t, v_t)\left(\frac{\frac{v_t}{p_t}}{\pi_{t+1}}\right) - s_{t+1}. \tag{8}$$

The fiscal footprint of macroprudential policy (β_t) when keeping fiscal policy (s_{t+1}, δ_{t+1}) and monetary policy (π_{t+1}, ν_t) both fixed is:

$$\frac{\partial \Phi_{t+1}}{\partial \beta_t}\Big|_{s_{t+1},\delta_{t+1},\pi_{t+1},v_t} = -\left(\frac{\delta_{t+1} B_t}{q_t p_{t+1}}\right)\left(\frac{\partial q_t}{\partial \beta_t}\right) - \left(\frac{v_t}{p_{t+1}}\right)\left(\frac{\partial \mathcal{L}(\beta_t, v_t)}{\partial \beta_t}\right). \tag{9}$$

Relative to the previous section, the last term on the right-hand side is new. If tighter macroprudential regulation lowers the return earned on bonds relative to the return earned on reserves (so $\mathcal{L}(.)$ falls), then the fiscal footprint through this term is positive. In this case, macroprudential regulation lowers the net profits of the central bank.

Figure 2. Effect of Conventional Monetary Policy



Source: Authors' calculations.

From the perspective of the fiscal authority, the revenues that come from central bank dividends have typically been small, so the extra fiscal footprint from this term is not significant relative to the first one. However, from the perspective of the central bank, this fiscal footprint of macroprudential policy is indeed significant, especially if its balance sheet is sizeable. That is, the impact of β_t on z_{t+1} can be proportionately large, and it is larger the higher ν_t is. The actions of the macroprudential authority can have a substantial effect on the central bank's net income, its solvency, and correspondingly its own independence from fiscal authorities.[6]

2.2 The Fiscal Footprint of Conventional Monetary Policy

Conventional monetary policy that aims at lowering inflation will lower the interest rate on deposits. In the market for government bonds, this shifts the demand curve to the right, just as in figure 2. It raises the price of bonds just like tighter macroprudential policy did. However, now there is no change in the bond holdings of banks or households, so there is no effect on liquidity premia.

Using the formulae derived so far, the fiscal footprint of conventional monetary policy is:

6. See Hall and Reis (2015) on the link between net income, solvency, and independence.

$$\frac{\partial \Phi_{t+1}}{\partial \pi_{t+1}}\Big|_{s_t,\delta_{t+1},\upsilon_t,\beta_t} = -\left(\frac{\delta_{t+1}B_t}{q_t p_{t+1}}\right)\left(\frac{\partial q_t}{\partial i_t^d}\right)\left(\frac{\partial i_t^d}{\partial \pi_{t+1}}\right) + \mathcal{L}(\beta_t,\upsilon_t)\left(\frac{\upsilon_t}{p_{t+1}\pi_{t+1}}\right) - \left(\frac{\delta_{t+1}B_t}{p_{t+1}}\right)\left(\frac{1}{\pi_{t+1}}\right). \tag{10}$$

The first term in equation (10) is similar to the footprint left by macroprudential policy in equation (6) highlighted in the previous section. In fact, if the two policies have the same impact on bond yields, they are identical.

The second term measures the impact that higher inflation has by lowering the real value of any positive profits of the central bank. This effect is likely quantitatively small.

The third term is more interesting as it distinguishes conventional monetary policy from macroprudential policy. It comes from inflating away some of the public debt, which produces a negative fiscal footprint. This effect can be large or small depending on how the increase in inflation persists over time and how it interacts with the maturity of the debt.[7] Either way, it always contributes to making the fiscal footprint more negative.[8]

2.3 The Fiscal Footprint of Unconventional Monetary Policy

Unconventional policy raises ν_t. Just like macroprudential policy in figure 1, this raises the price of bonds by shifting the supply to the left and raising the liquidity premium. Differently to macroprudential policy, the bond holdings of banks are unchanged, as it is the central bank that holds the extra bonds. This leads to a difference in its fiscal footprint.

7. See Hilscher and others (2014).

8. Left out of the analysis is seignorage from printing banknotes that pay no interest. It would show up as another source of net income of the central bank and add another negative fiscal footprint of conventional monetary policy, as higher inflation comes with higher seignorage revenues.

The fiscal footprint of unconventional monetary policy is:

$$\frac{\partial \Phi_{t+1}}{\partial v_t}\Big|_{s_{t+1},\delta_{t+1},\pi_{t+1},\beta_t} = -\left(\frac{\delta_{t+1}B_t}{q_t p_{t+1}}\right)\left(\frac{\partial q_t}{\partial v_t}\right) - \frac{\mathcal{L}(\beta_t, v_t)}{p_{t+1}} - \frac{v_t}{p_{t+1}}\left(\frac{\partial \mathcal{L}(\beta_t, v_t)}{\partial v_t}\right). \tag{11}$$

The first term is again the same as with macroprudential policy, so that if the policies have the same impact on bond prices, they leave the same footprint. The second term reflects the fact that with a larger balance sheet and a fixed profit margin, the central bank's net income will rise.[9]

The third term captures the change in this profit margin, which mirrors the change in the reserves-bonds return premium. If neither reserves nor bonds provide any liquidity services, then the Modigliani-Miller result of Wallace (1981) would hold and this term would be zero. Otherwise, it is likely small from the perspective of the fiscal authority since the net income of the central bank may not be so large to start with it. However, comparing this term with the similar term in equation (9) shows the interaction between unconventional monetary policy and macroprudential policy when it comes to the net income of the central bank. These two different policies will affect the reserves-bonds premium, which likely mirrors the term premium. In the last decade, central banks have gone long by targeting this premium as part of monetary policy. An independent macroprudential regulator can, if mis-coordinated with monetary policy, make these policies ineffective. Because this has a direct impact on the net income of the central bank, it can leave a significant fiscal footprint on the central bank.

2.4 General Lessons

From the perspective of the fiscal authority, both types of monetary policy have an extra negative footprint as compared to macroprudential policy. Usually, these extra terms are relatively small when compared to the common term relating to the price of debt. Thus, the model suggests that a government that is solely focused on the fiscal footprint

9. If there is an unexpected default of the government on its bonds, then the net income of the central bank may be negative and a larger balance sheet makes this worse. This is an extra positive footprint of a larger central-bank balance sheet.

would turn to monetary policy more often than to macroprudential policy when it comes to generating needed revenues. Yet, since both policies have their major fiscal footprint working through the price of the debt, the model suggests that they will be more likely used in conjunction with that target in mind.

In 1959 the Radcliffe Report made its recommendations on how the Bank of England should conduct policy. It guided monetary and macroprudential policy for the next decade and influenced debates about their role across the world for many years. At the time, the stock of public debt was very large, and the main goal of policy was to keep unemployment low with fiscal policy seen as the major tool to achieve it. Aside from controlling inflation, the task of the Bank of England was to manage the public debt, and especially to assist the Treasury in its goal of extending the maturity of the outstanding debt.[10]

To achieve this explicitly fiscal goal, the report recommended the use of a combination of setting interest rates, managing the balance sheet of the central bank, and a series of credit policies that today we would call macroprudential policy. The target of all of them was to keep the price of government bonds high. These tools worked through the functioning of the bond market, similar to the model in this paper. The conclusion that a combination of these tools was best is what these results suggest. The second lesson from the analysis above is that macroprudential policy has an impact on the spread between the return on government bonds and the return on central bank reserves and, as a result, on the net income of the central bank. This fiscal footprint of macroprudential policy on the central bank can be large, even if it seems small from the perspective of the government budget as a whole. It is particularly visible when central banks have a large balance sheet, when they are targeting long-term government bond rates, and when fiscal authorities are less supportive of fluctuations in central banks' dividends and less willing to recapitalize the central banks after losses.

Arguably, all these conditions were present after the 2008 financial crisis. During this period, most major central banks around the world gained responsibility over macroprudential tools. Where they existed, some independent financial regulators were absorbed into the central bank. Monetary and macroprudential policy became more integrated.

10. See the original report Committee on the Working of the Monetary System (1959), Goodhart (1999) or, more recently, Aikman, Bush and Taylor (2016).

The analysis above suggests that this is consistent with the fiscal footprint of these policies.

3. The Fiscal Footprint via Fiscal Surpluses

Having understood the effect of monetary policy, from now onwards this paper abstracts from it. It assumes a central bank with a minimal balance sheet (of $\nu_t = 0$) that is entirely committed to price stability, so $\pi_{t+1} = 1$, and $p_t = 1$ as a normalisation. The Fisher equation implies that $1 + i_t^d = \psi^{-1}$, so bond prices are $q_t = \ell'(.) + \psi\delta_{t+1}$ and the fiscal burden from before $\Phi_t = q_t B_t$. The fiscal burden is the simpler expression:

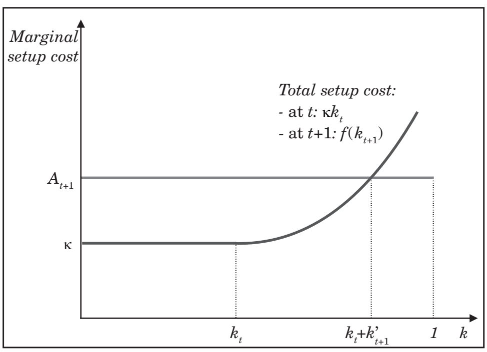
$$\Phi_{t+1} = \left(\frac{\delta_{t+1}}{\ell'(.) + \psi\delta_{t+1}} \right) \Phi_t - s_{t+1}. \tag{12}$$

We have already studied the first term on the right-hand side. This section integrates the model of households and bonds into a general-equilibrium model of banks, firms, and real activity to study the impact of macroprudential policy on the fiscal surpluses.

3.1 Model of the Real Economy: Firms and Production

There is a measure one of atomistic entrepreneurs. They maximize profits, which are then returned to the households. They have access to a production technology that will produce the goods that households can consume. Each firm's net output of goods is A_{t+1}.

Figure 3. Investment Costs



Source: Authors' calculations.

Production requires setting up a firm, which takes a capital investment. If the firm is set up in period t to engage in production at $t+1$, this capital is a fixed amount κ. Therefore, the profits from having k_t firms set up is: $(A_{t+1} - \kappa)k_t - 0$.

Were it not for financial constraints, then all resources available would be employed in this investment technology. Given financial constraints, some entrepreneurs are unable to secure financing at date t. They can make up for it, and still produce, by investing capital at $t+1$, right before production takes place. The set-up costs of this make-do investment are higher, and they rise convexly with the amount of make-do investment in the overall economy, due to aggregate decreasing returns to scale in matching capital to these firms. Letting k'_{t+1} denote make-do investment in setting up these firms, then the profits from it are: $A_{t+1} k'_{t+1} - f(k'_{t+1})$ where the function $f(.)$ has the properties: $f'(0) = \kappa$ and $f''(.) > 0$.

Figure 3 plots the marginal cost of production. As all firms are equally productive, a social planner would choose $k_t = 1$ and every entrepreneur would produce, with no need for make-do investment. With financial frictions, k_t will be lower, and some firms will still seek finance next period, so that $k'_{t+1} > 0$. The constrained optimal amount of make-do investment is: $f'(k^*_{t+1}) = A_{t+1}$, as long as $k_t + k^*_{t+1} < 1$, so not every single firm is financed. I assume this is always the case. However, entrepreneurs have no capital: they must get it as credit from banks.

3.2 Model of the Real Economy: Banks and Credit

A representative bank has a monitoring technology that allows it to collect payments from credit to firms. If depositors lent to firms directly, they would not be repaid, so banks are the only way to have access to the returns from production. For simplicity I assume that, in the relation with the entrepreneurs, the bank has all of the bargaining power and so collects all the profits, but this is immaterial to the results.

The representative bank has access to two sources of funding: its net worth n_t and the deposits it collected from the household d_t. The use of funds is either to give credit to firms to fund their investment or to hold government bonds. The resource constraint of the banking sector therefore is:

$$\kappa k_t + q_t \beta_t = n_t + d_t. \tag{13}$$

In attracting depositors, the banker suffers from a commitment problem. Before paying depositors, it can abscond with part of the payoff from the loan paid by the entrepreneurs. However, absconding implies losing a fraction γ of the loans payoff, as well as all of the bonds being held by the bank, which can be captured by the depositors. The incentive constraint for the banker not to abscond with the deposits, after paying taxes at rate τ_{t+1}, is therefore:

$$(1-\gamma)(1-\tau_{t+1})(A_{t+1}-\kappa)k_t \leq (1-\tau_{t+1}) \\ (A_{t+1}-\kappa)k_t + \delta_{t+1}\beta_t - \left(1+i_t^d\right)d_t. \tag{14}$$

On the left-hand side is the bank's payoff from absconding, retaining a share $1-\gamma$ of loan repayments. On the right-hand side is the payoff from paying depositors and keeping the residual profit from credit and from the payout on government bonds. Holding with equality, this puts a constraint on the leverage of the bank. I assume throughout that $1 < \psi(A_{t+1} / \kappa - 1) < [\gamma(1 - \tau_{t+1})]^{-1}$, so that production is always profitable and the financial friction is not too extreme, and so the leverage constraint holds with equality.

3.3 Model of the Real Economy: Financial Markets and Bailouts

The final agent is a representative financier. It received capital n' at date t, but was unable to match with a firm to become a bank. In period $t+1$, its capital can only be used to lend to the bank in a financial market before it gets returned to the household at the end of the period. The bank prefers to use its own net worth and deposits to finance regular investment, so it has no capital of its own left. Through the financial market, it can get an additional x_{t+1} of capital with which to fund make-do investment.

Financiers are senior creditors relative to depositors. As in the real world, on account of being better informed, wholesale funders of banks are quicker to run on the banks than depositors. Moreover, make-do investment cannot be absconded with by the banker making the loans, since the financier can also perfectly monitor and seize the projects if the bank does not repay them. Therefore, the financier captures all of the payoff from the financial market and thus from make-do investment. However, when the financier seizes the loan, a fraction $1-\xi$ of it gets destroyed. As a result, the bank has to post a margin in the form of government loans, the only traded financial asset in the economy that can be fully seized with no loss.

The incentive constraint for the financial investments to be paid by the banker then is:

$$(1-\xi)x_{t+1} \leq \beta_t \delta_{t+1}. \tag{15}$$

I assume this will always bind or, equivalently, that financiers have enough capital: $n' > \beta_t \delta_{t+1} / (1-\xi)$.

Recall that it is socially optimal to undertake k^* of make-do investment. If the bankers do not have the capital to do so, the government will want to cover the missing capital by bailing out the banks so that investment is optimal. The government cannot commit not to bail out the banks. Letting T_{t+1} denote the bailout funds, they therefore equal:

$$T_{t+1} = \max\{f(k^*_{t+1}) - x_{t+1}, 0\}, \tag{16}$$

thus covering the gap between the capital needs of firms and the investment made by banks financed by financiers.

This is the fundamental moral hazard problem in the model: banks prefer to hold no bonds, thus being unable to use capital markets to finance make-do investment, and later be bailed out by the government. The model, in a stark form, captures this important driver of financial regulation. Macroprudential policies force banks to hold liquid government bonds so that they can perform their role of channelling credit from the financial system into firms. When banks hold too little liquidity, the financial system grinds to a halt, with capital locked in with potential creditors in spite of the profitable use it could have in financing ideas.

3.4 The Fiscal Surplus and Fiscal Policy

Tax revenues are given by the function

$$R\left(\tau_{t+1},\beta_t,\delta_{t+1}\right) = \tau_{t+1}\left(A_{t+1} - \kappa\right)k_t + \tau_{t+1}\left(A_{t+1}k^*_{t+1} - f\left(k^*_{t+1}\right)\right). \tag{17}$$

The first term captures the taxes collected on the returns from set-up investment; the second, the tax revenues on make-do investment. Because the government always provides for the social optimum amount of make-do investment, $A_{t+1}k^*_{t+1}$ is independent of macroprudential (or tax) policy. Set-up investment, on the other hand, will depend on macroprudential policy, as well as on tax rates and default.[11]

In turn, government bailouts are given by:

$$T\left(\beta_t, \delta_{t+1}\right) = \max\left\{f\left(k_{t+1}^*\right) - \frac{\beta_t \delta_{t+1}}{1-\xi}, 0\right\}. \tag{18}$$

Macroprudential policy affects this by changing the likelihood that defaults happen and the size of the bailout they require if they happen.

Therefore, the primary surplus, allowing for some exogenous public spending (g_{t+1}), is:

$$s_{t+1} = R\left(\tau_{t+1}, \beta_t, \delta_{t+1}\right) - T\left(\delta_{t+1}, \beta_t\right) - g_{t+1}. \tag{19}$$

Fiscal policy is now understood as the choice of the tax rate and of the repayment rate on the bonds.

3.5 The Impact of Macroprudential Policy

The bank holds as few bonds as it can. Financing regular investment is more lucrative than make-do investment, so it wants to employ all of its net worth and deposits in regular credit to firms. The financier will not want to give the bank a side payment to convince it to hold bonds, since it can just let the government finance the make-do investment later on. Moreover, because of the liquidity premium of bonds, raising deposits to hold bonds is a loss-making activity. As a result, β_t is chosen by the macroprudential authority.

The benefit of tighter macroprudential policy is that it allows for the make-do investment to be borne by the financiers, as opposed to relying on bailouts from the government. It follows from equation (18) directly that:

$$\frac{\partial T(.)}{\beta_t} = \begin{cases} -\dfrac{\delta_{t+1}}{1-\xi} & \text{if } \beta_t < \bar{\beta}, \\ 0 & \text{otherwise.} \end{cases} \tag{20}$$

11. A simple extension of the model would have the government only partially bail out the banks, and instead make-do investment being too low: $k_{t+1}^{'} < k_{t+1}^{*}$. Since this would lower the tax revenues from the resulting output, it would leave a similar footprint as the cost of bailouts.

Thus, tighter macroprudential policy weakly raises fiscal surplus and so has a negative fiscal footprint because it reduces bailouts.

The costly side of macroprudential policies is that banks investing in bonds provide less credit to firms. Combining equations (13) and (14), and replacing for the price of bonds, credit and investment become:

$$\kappa k_t = \underbrace{\left(\frac{1}{1-\psi\gamma\left(\frac{A_{t+1}}{\kappa}-1\right)\left(1-\tau_{t+1}\right)} \right)}_{\geq 1 \text{leverage}} n_t - \underbrace{\left(\frac{\ell_t'}{1-\psi\gamma\left(\frac{A_{t+1}}{\kappa}-1\right)\left(1-\tau_{t+1}\right)} \right)}_{\leq 0 \text{leveraged safety premium}} \beta_t. \tag{21}$$

The term multiplying β_t is negative through two economic channels. The first is that, for a fixed amount of deposits, more of them being used to extend credit to the government means fewer funds are available to give credit to the entrepreneurs. The second is that the holding of more bonds lowers banks' profits and also lowers their ability to raise deposits to make loans. Combined, the overall effect of macroprudential policy on investment is negative.

As a result, the impact of tighter macroprudential policy on fiscal revenues is:

$$\frac{\partial R(.)}{\partial \beta_t} = -\tau_{t+1}\left(\frac{A_{t+1}}{\kappa}-1\right)\left(\frac{\ell_t' - \beta_t \ell_t''}{1-\psi\gamma\left(\frac{A_{t+1}}{\kappa}-1\right)\left(1-\tau_{t+1}\right)} \right) \leq 0. \tag{22}$$

Tighter macroprudential policy lowers credit, which lowers tax revenues and so leads to smaller fiscal surpluses through the two channels just described. At the same time, it raises the price of bonds, which works in the opposite direction.

Combining the two results in equations (20) and (22), the fiscal footprint of macroprudential policy through the fiscal surplus may be positive if $-\partial R(.) / \partial \beta_t > -\partial T(.) / \partial \beta_t$, or negative otherwise. Which case prevails depends on whether there is a financial crisis or not.

I define an economy as being in a financial crisis if $T_{t+1} > 0$ so that a bailout is needed. If there is no financial crisis, then macroprudential policy lowers lending, lowers investment, lowers production, and so lowers tax revenues. The fiscal footprint is positive. With a financial crisis, tighter macroprudential policy lowers not only tax revenues, but also the chances and extent of a bailout. Of course, a crisis happens when macroprudential policy is too lax to start with, so there are not enough bonds to provide as collateral for the optimal level of make-do investment.[12]

4. The Interaction between Fiscal and Macroprudential Policies

If the main objective of macroprudential authorities is to avoid a financial crisis, they will want to set a high β_t, high enough to make sure there is enough make-do investment in the economy so that a bailout is never needed. However, such a tight policy may have a large impact on economic activity, lowering fiscal revenues, and having a large positive fiscal footprint.

Such a large footprint would require either a large amount of future borrowing by the government or an increase in tax rates this period to offset the lost revenue. A third possibility is that such tight policy causes a default on the government bonds. I define an economy as being in a *fiscal crisis* if $\delta_{t+1} < 1$ so government bonds do not repay in full. The fiscal authority may want to avoid this happening. However, there is a limit on the taxes it can charge: $\tau \leq \bar{\tau} \leq 1$, understood as a limit on the ability to collect taxes and get the economic agents to comply, after which point default may be inevitable. In turn, government default affects the profits of banks, the functioning of financial markets, and thus the chances and extent of a financial crisis.

This section studies these interactions between fiscal and macroprudential policy. Going back to the definition of the fiscal burden in equation (12), and combining it with the definition of fiscal surpluses in equation (19), the fiscal burden in the model when there is price stability and a minimal central bank is:

$$\Phi_{t+1} = \left(\frac{\delta_{t+1}}{\ell'(.) + \psi \delta_{t+1}} \right) \Phi_t - R(.) + T(.) + g_{t+1}. \tag{23}$$

This section assumes that the fiscal burden is kept constant, so no extra debt is left to the future as a result of policy today. Therefore,

12. In a stochastic model, this tradeoff might show up as a mean-variance tradeoff. On the one hand, macroprudential policies may lower the expected mean of tax collections, but, on the other hand, they lower the incidence and severity of the tail events when bailouts are needed.

any fiscal footprint of macroprudential policy must be offset by higher taxes or, if tax rates are at their maximum, by a decline in the recovery of the face value of the debt. There are two types of crisis possible, and so four possible scenarios to consider.

4.1 The Present-bias for Tighter Macroprudential Policy in Quiet Times

In quiet times, when there is no default on government bonds and no bailouts, tighter macroprudential policy on the one hand raises the price of government bonds, which makes rolling over the debt cheaper. On the other hand, it represses economic activity, which lowers tax revenues. Which effect prevails determines whether the fiscal footprint is positive or not, and so whether taxes must rise or not. By using the results previously derived, the following result ensues:

Proposition 1. *If there is no fiscal or financial crisis, then tighter macroprudential policies (higher* β*) leads taxes to rise (higher* τ*) to keep the fiscal burden fixed if the crowding-out of lending is larger than the price impact, which happens if the elasticity of the safety premium is small enough:*

$$\frac{\tau_{t+1}\left(\frac{A_{t+1}}{\kappa}-1\right)}{1-\psi\gamma(1+\tau_{t+1})\left(\frac{A_{t+1}}{\kappa}-1\right)} > \left(-\frac{\ell_t''(.)}{\ell_t'(.)-\beta_t\ell_t''(.)}\right)\frac{B_t}{q_t}. \tag{24}$$

There is a subtle interaction of the footprint with time. A tighter macroprudential policy (β_t) raises bond prices (q_t) right away, which immediately makes rolling over the debt easier for the fiscal authority. Yet, it lowers credit and capital today, which are only felt in lower output next period, thus lowering revenues ($R(.)$) only one period after. The negative fiscal footprint is realised right away, while the positive one comes with the delay of production.

A present-biased politician that, in the extreme, cares only about taxes at date t, will therefore be biased towards tighter macroprudential policy, as the negative effects on financial and real activity are only felt in the future. The positive effects of being able to sustain lower taxes while leaving the same fiscal burden are felt today. Tighter macroprudential policy becomes a tool of financial repression that a present-biased fiscal authority would be tempted to use so as to place its bonds more easily. Countries with short-horizon politicians due to coalition government and high electoral turnover are associated in the data with higher public debt.[13] In these countries, the government also actively uses tools of financial repression to be able to roll over public debt.[14]

More sophisticated politicians that are focused on winning elections can sequence these decisions. One period before the elections, they will want to have loose macroprudential policy to boost credit and investment during the election year. In the period of the elections, they will shift to favour tighter policy that raises bond prices and eases the financing of the government debt. In 2018, almost one year before the Indian elections, the government of India "...urged the Reserve Bank of India to make it easier for financially troubled banks to lend more, despite their bad debt problems."[15]

These results provide some justification for an independent macroprudential regulator that has a long horizon and avoids these temptations, following arguments similar to those used in discussions of central bank independence.

4.2 The Present Absence of Conflict

Consider now the case where there is still no fiscal crisis, but instead a financial crisis, so government bonds pay in full ($\delta_{t+1} = 1$), but the financial system requires a bailout ($T_{t+1} > 0$).

Proposition 2. *If there is a financial but no fiscal crisis, then tighter macroprudential policies (higher* β*) lead taxes to rise (higher* τ*) to keep the fiscal burden fixed if the crowding-out of lending* exceeds *the price impact plus the lowering of the bailout size:*

$$\frac{\tau_{t+1}\left(\frac{A_{t+1}}{\kappa}-1\right)}{1-\psi\gamma\left(1+\tau_{t+1}\left(\frac{A_{t+1}}{\kappa}-1\right)\right)} > \left(-\frac{\ell_t''(.)}{\ell_t'(.)-\beta_t\ell_t''(.)}\right)\frac{B_t}{q_t}+\frac{1}{(1-\xi)\left(\ell_t'(.)-\beta_t\ell_t''(.)\right)}. \qquad (25)$$

In a financial crisis, the negative fiscal footprint of macroprudential policy through bailouts becomes active. Tighter policy lowers the size

13. See Alesina and Tabellini (1990), and Grilli and others (2014).
14. See Reinhart and Sbrancia (2015).
15. See Financial Times (2018).

of the needed bailout, thus lowering the fiscal burden. Whether this is enough for tighter policy to lower or raise taxes depends on the condition in the proposition, but $\partial\tau/\partial\beta$ is unambiguously lower relative to the previous proposition. Tighter policy is more likely to be fiscally beneficial than before because it lowers the costs of financial resolution.

Following the financial crisis of 2008–10, macroprudential policies became tighter in most financial centres. Policies such as the introduction of liquidity coverage ratios were introduced, capital requirements were raised, and new macroprudential authorities were created while existing ones were expanded. In the United Kingdom, the Financial Services Act of 2012 gave the independent Bank of England an explicit statutory objective to achieve financial stability. It created both a subsidiary of the central bank, the Prudential Regulation Authority, and a new policy committee within the central bank, the Financial Policy Committee, that had a wide toolkit of microprudential and macroprudential policies at their disposal, respectively. In the European Union, a new supra-national regulator independent from national authorities was created, the Single Supervisory Mechanism, to supervise systemic institutions. All combined, national fiscal authorities across developed countries were willing to give more independence, power, and tools to independent macroprudential policymakers.

Proposition 2 rationalizes this movement of power. The prospect of a new financial crisis might have driven these changes. The fiscal footprint of these tighter policies was smaller and maybe even negative during these times. Thus, there was no conflict between fiscal and macroprudential policymakers. Both agreed with tighter policies since financial and fiscal goals coincided.

4.3 Unpleasant Macroprudential Arithmetics

In a fiscal crisis, taxes are at their limit ($\tau = \overline{\tau}$), and yet default happens ($\delta < 1$).

Proposition 3. *If there is a fiscal but no financial crisis, then tighter macroprudential policies (higher* β*) make the fiscal crisis more severe (lower* δ*) if the price impact is smaller than the crowding-out of lending.*

$$\frac{\overline{\tau}\left(\frac{A_{t+1}}{\kappa}-1\right)}{1-\psi\gamma\left(\frac{A_{t+1}}{\kappa}-1\right)\left(1+\overline{\tau}\right)} > \left(-\frac{\ell_t''(.)}{\ell_t'(.)-\beta_t\ell_t''(.)}\right)\frac{\delta_{t+1}B_t}{q_t}. \tag{26}$$

The channels at play are the same as in quiet times, but now a positive fiscal footprint of macroprudential policy no longer raises taxes, but instead makes default worse. If condition (26) holds, then tighter macroprudential policy tightens the budget constraint of the government and leads to a lower recovery rate on the government bonds.

A broader mandate of macroprudential policy could interpret financial stability as avoiding not just a crisis and bailouts in financial markets, but also a crisis in the government bond market. In this case, tighter macroprudential policy is contributing to creating a financial crisis in the government bond market.

Imagine now a situation where the fiscal authority commits to cause a fiscal crisis. One scenario in which this happens is when a fiscally irresponsible politician raises government spending g_t. Another is when a small-government politician purposefully lowers the upper limit on taxes by making it legislatively harder to approve tax increases. This can also come about through a crisis in the collection of fiscal revenues as a result of civil unrest or other institutional failures. More indirect, but with similar effects, would be a sudden realisation that the amount of inherited debt to pay is higher than was previously anticipated. All of these scenarios are typical of countries going through severe fiscal crises.

The macroprudential policymaker will then face a dilemma. Avoiding a banking crisis may require some relatively high β_t. But avoiding a sovereign debt crisis calls for a lower β_t if the condition in the proposition is met and the total fiscal footprint is positive. The policymaker then faces unpleasant arithmetics, much like the central bank did in Sargent and Wallace (1981). Preventing a government default requires it to have looser macroprudential policy than it might have wanted, even if this gets it closer to potentially causing a financial crisis. Macroprudential policy can unpleasantly become financial repression under the justification of fighting the crisis in the government bond market.

The experience of Latin America in the 1980s illustrates this tradeoff. At the time, reserve requirements were high and would vary in response to expansionary fiscal policies. Moreover, as Morris and others (1990) write: "In addition to required reserves, Latin American governments also very often have requirements that banks invest a percentage of their deposits in bonds issued by the government..." They report that in Argentina in 1987, reserve requirements were 16 percent of deposits, and forced investments took another 50 percent. Via the central bank and the power of regulation, governments subordinated the banking sector to a primary role of generating a negative direct fiscal footprint as needed. An evaluation by the Bank of International Settlements of the time concludes: “Banks thus became ‘quasi-fiscal’ agents for the government.”[16]

The data show a positive association between financial repression and inflation, with both combining to explain low growth, especially in Latin America.[17] It is well understood that fiscal crises activate unpleasant arithmetics on the monetary side. Less appreciated is that, at the same time, unpleasant arithmetics in financial regulation are also present. Under pressure to generate fiscal revenues, central banks lose their independence, and this reflects itself as much in high inflation as it does in using regulatory tools to leave a negative footprint. Taxing the financial system, directly or indirectly through regulation, is a source of revenue that can be as effective as, and generate more revenue than, surprise inflation. More generally, the line that separates macroprudential policies from financial repression is a thin one.

5. The Diabolic Loop

The final case is when there is both a financial and a fiscal crisis. The extent of the crisis comes from the solution of a system of two equations, the government budget constraint, and the financing needs for make-do investment:

$$\left(\frac{\delta_{t+1}}{\ell'(.)+\psi\delta_{t+1}}\right)\Phi_t = R\left(\tau_{t+1},\beta_t,\delta_{t+1}\right) - T_{t+1} - g_{t+1} + \Phi_{t+1}, \tag{27}$$

$$T_{t+1} = f\left(k^*_{t+1}\right) - \frac{\delta_{t+1}\beta_t}{1-\xi}. \tag{28}$$

The two endogenous variables to solve for are T_{t+1} and δ_{t+1}, which measure the extent of the financial and fiscal crises, respectively. The exogenous variables are macroprudential policy β_t and government spending g_t. The first equation features a negative relation between

16. See Goldstein and Turner (1996).
17. See Roubini and Sala-i-Martin (1992).

T_{t+1} and δ_{t+1}: a larger bailout increases fiscal spending, which lowers the recovery rate on government bonds. The second equation also shows a negative relation: a worse default lowers the available collateral for financial markets, which leads to less private make-do investment and raises the extent of the bailout. A worse financial crisis makes the fiscal crisis worse and *vice versa*.

Both equations are plotted in the top panel of figure 4 for the relevant case where frictions in the financial market are not too severe (ξ is small enough). The intersection of the two lines—the budget line corresponding to the first equation above and the bailout line corresponding to the second one—gives the equilibrium extent of the two crises.

5.1 The Effect of Macroprudential Policy

Keeping T_{t+1} fixed, a higher β_t lowers the recovery rate δ_{t+1} from Proposition 3. Graphically, this shows as a shift inwards in the budget line. It is depicted in the bottom panel of figure 4. If there was no financial crisis, then the increase in the extent of the financial crisis would be given by the vertical dislocation of the budget line. The new equilibrium, keeping the financial crisis fixed, would be at point B.

However, for a fixed bailout line, the new equilibrium would move from point A to point C instead, so the fall in δ_{t+1} would be larger. The intuition is that a deeper fiscal crisis lowers the value of the bonds that are being used to make the capital market function. Thus, make-do investment falls shorter of the optimal level and bailouts rise. Since higher bailouts make the fiscal crisis worse, this mechanism amplifies the initial shock. Point C implies a larger fall in the recovery rate of government bonds than what Proposition 3 would have suggested. This amplification has been called the diabolic loop in the literature, linking fiscal crises to financial crises.

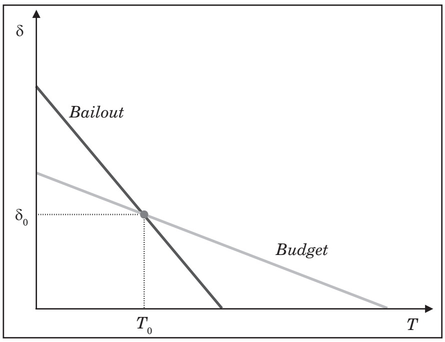
However, macroprudential policy has a second effect. It also makes the bailout line flatter for the same horizontal intercept. This is because, for a fixed extent of default, more bank holdings of bonds mean more collateral, more financial market activity, and so lower public bailouts. Considering this effect alone, if the budget line had not shifted, the new equilibrium would be at point D. Since macroprudential policy makes the financial crisis less severe, through the diabolic loop this means that the fiscal crisis is less severe as well.

There are then two forces at play relative to the case of no financial crisis: on the one hand, the diabolic loop amplifies the fiscal impact, while on the other hand lower bailouts attenuate it. Combining the two, the new equilibrium is instead at point E. The figure plots the case where the first effect is larger than the second, so that the impact on δ_{t+1} of a higher β_t is larger than the one given in Proposition 3. In general the effect may be larger or smaller depending on the interaction of these two forces.

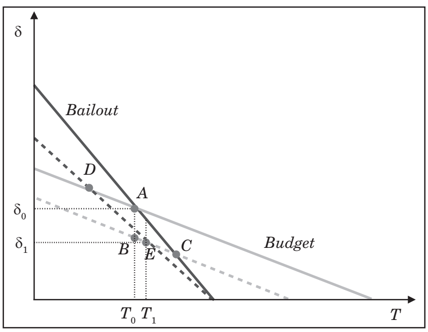
With a twin crisis, the model suggests that the macroprudential authority faces a difficult challenge. If it ignores its fiscal footprint, it might believe that tighter policy lowers the extent of both the financial and fiscal crises, aiming for point D. But, taking into account the footprint, tighter macroprudential policy instead makes the fiscal crisis worse and may even make the financial crisis worse as well, ending up in point E instead. The fiscal footprint becomes relevant even for an independent macroprudential authority solely focused on avoiding a financial crisis. It can no longer operate ignoring its fiscal footprint.

Figure 4. The Diabolic Loop and Macroprudential Policy

(a) Equilibrium extent of the fiscal and financial crises



(b) The effect of tighter macroprudential policy



Source: Authors' calculations.

5.2 Macroprudential Policy and the Amplification of Shocks

Figure 5 considers what happens when there is an increase in public spending g. This shifts the budget constraint curve inwards, towards the origin. Without a financial crisis, then the fiscal impact would be on default δ_{t+1} and could be read from the difference in intercepts of the budget line with the vertical axis. With a financial crisis, the new equilibrium implies instead a larger fall in δ_{t+1} or a larger fiscal footprint. The reason is again the diabolic loop: a worsening of public finances lowers the recovery rate on government bonds, which hurts financial markets, lowers private investment, and increases the size of bailouts, thus amplifying the initial fiscal footprint. This is shown in the top panel of the figure as the economy moves from point A to point B.

The bottom panel repeats the experiment when β_t is higher. Starting from the same point A, the bailout line is flatter, so it rotates counterclockwise relative to the one with looser macroprudential policy. Tighter macroprudential policy makes the amplification of the diabolic loop larger. The equilibrium is now in point C, which involves a larger extent of both crises. Because banks hold more bonds, the link connecting the financial health of banks and the financial health of the government is tighter.

If the g_t shocks dominate the variation in the data, then tighter macroprudential policy would raise volatility in fiscal outcomes and in the yield on government bonds. If macroprudential policy is slow to adjust, then the diabolic loop provides an argument for looser policy if the economy is likely to experience twin crises driven by fiscal spending shocks.

5.3 Discussion

The European sovereign debt crisis of 2010–12 had the diabolic loop at its centre.[18] Discussion of the reform of the euro architecture has therefore focused on whether to introduce concentration limits on the amount of national debt a bank can hold and on whether national government debt should stop receiving a zero risk weight in banking

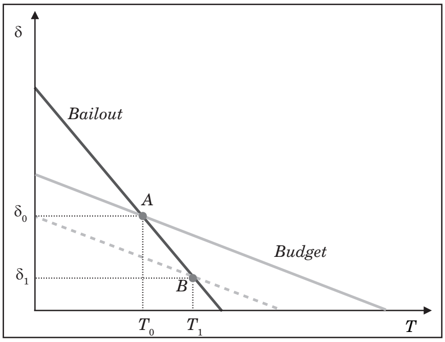
18. See Brunnermeier and others (2011, 2016).

regulation. Three arguments are often raised in these policy debates, which match the different cases captured in this section.

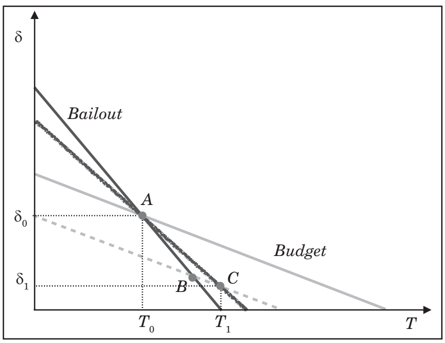
The argument for the policy reforms is captured by figure 5. Lowering β_t would reduce the diabolic loop, and stabilize these economies, especially in countries that are prone to pro-cyclical fiscal spending causing frequent fiscal crises. Replacing this risky national debt with a safe euro-wide alternative would break the diabolic loop and the amplification that is captured in the figure.

Figure 5. Government Spending Shocks

(a) The diabolic loop after a shock to government spending



(b) Amplification of spending shocks



Source: Authors' calculations.

Critics of the policy reform instead focus on figure 4 and argue for continuing the practice of letting national regulators use direct macroprudential policy, or indirect "moral suasion", in order to raise β_t of national government bonds during a crisis. From a fiscal perspective, one argument that is related to the present-bias discussed before highlights the negative fiscal footprint of macroprudential policy. It argues for using macroprudential policy in a fiscal crisis since forcing banks to hold more government bonds will right away raise their price and make the rollover of debt easier. Seeing such policy as shifting the budget line outwards, as opposed to inwards, the diabolic loop can be perceived as being beneficial. After all, it amplifies the fiscal footprint and thus gives extra leverage for fighting the fiscal crisis. This fiscal argument might be popular with debt management offices, for whom the immediate negative fiscal footprint of macroprudential policy is salient.

A second distinct argument comes from financial regulators that ignore the fiscal footprint of their actions. This argument for keeping national regulators with the power to affect bank holdings of government bonds during a crisis relies on the bottom panel of figure 4. From the perspective of a financial regulator who worries about financial crises exclusively, while ignoring the fiscal footprint of its policies, tightening policy will lower the extent of the financial crisis. The focus will be on achieving point D in the figure. A focus that would prove misguided during a crisis as the fiscal footprint of the policy leads to point E, with deeper financial and fiscal crises.

6. Conclusion

The model in this paper developed three fiscal footprints of macroprudential policy. First, tighter policy makes rolling over the public debt easier by raising the price of government bonds. Second, tighter policy reduces bank lending, investment, real activity, and future tax collections. Third, tighter policy lowers bailout costs, or their likelihood.

These channels suggested two facets of the fiscal interaction between macroprudential and monetary policy. From the perspective of the fiscal policymaker, the footprint from both policies is likely quantitatively similar and relies mostly on both achieving lower yields on government bonds. This provides some justification for using both when generating fiscal revenues becomes a government priority. From the perspective of the central bank, the choices of macroprudential policy can have a large impact on its net profits, especially when the balance sheet of the central bank is large. This provides an argument for having the central bank take charge of both policies so that it internalizes these effects.

The interaction between macroprudential policy and fiscal policy takes different shapes inside or outside of a crisis. If there is neither a financial nor a fiscal crisis, the analysis suggests that politicians focused on winning elections and, judged by their fiscal legacy, may alternate between tight and loose macroprudential policy, depending on how far the election is. This can provide an argument for an independent macroprudential authority that is immune to the political cycle.

If a financial crisis is in the horizon, instead there is no conflict between fiscal and macroprudential goals, which rationalizes the movement in the last decade of fiscal authorities giving increasing power to independent macroprudential policymakers. If instead it is a fiscal crisis that dominates attention, unpleasant macroprudential arithmetics sets in: to avoid a sovereign debt crisis, the macroprudential authority will be induced to use macroprudential policy to exploit its fiscal footprint, turning it effectively into financial repression. The use of financial regulation in Latin American in the 1980s illustrates this outcome.

When there is a twin crisis, a diabolic loop between banks and the government amplifies the fiscal impact of macroprudential policy and spending shocks. If macroprudential authorities ignore their fiscal footprint and focus solely on the financial sector, then they may actually set policies that worsen both crises. In economies subject to frequent fiscal spending shocks, tighter macroprudential policy may contribute to raising the volatility of these economies, and their proclivity to enter a crisis. These two insights provide some understanding of different points of view in the eurozone debate on how to complete the banking union.

Altogether, this rich set of interactions can serve as the foundation for future work to study the adequate institutional design of macroprudential policy. Should this policy be part of the mandate of the Treasury, the central bank, or an independent authority? If the latter, how much coordination should it have with these authorities, or how should its independence be designed? How would other links between these policies interact with the ones discussed in this paper?

For each individual macroprudential policy, what is its quantitative effect on the share of government liabilities held by banks, and how does it compare with its effect on lending, output, and tax revenues? Future research can build on this paper to answer these questions.

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APPENDICES

This appendix contains proofs and additional derivations.

APPENDIX A

Derive Pricing Equation (4) for Bonds

The Euler equations associated with the optimal choices by the household are:

$$u_t'(.) = \frac{\psi\left(1+i_t^d\right)u_{t+1}'(.)\,p_t}{p_{t+1}}, \tag{A1}$$

$$u_t'(.)\left(\ell'\left(\frac{b_t}{p_t}\right)-q_t\right) = \frac{\psi u_{t+1}'(.)\,p_t\delta_{t+1}}{p_{t+1}}. \tag{A2}$$

The first Euler equation captures indifference with depositing one more unit in the banks. The second one reflects the indifference with holding one more government bond. Relative to deposits, bonds may not pay in full because of default, but they provide liquidity benefits. Combining the two gives equation (4).

APPENDIX B

Proof of Equation (21)

Rearranging equation (14) gives:

$$-\psi\gamma\left(1-\ \tau_{t+1}\right)\left(\frac{A_{t+1}}{\kappa}-1\right)\kappa k_t = \psi\delta_{t+1}\beta_t -\ d_t. \tag{A3}$$

Similarly, equation (13) can be rewritten as:

$$\kappa k_t = n_t + d_t - l_t'(.)\beta_t - \psi\delta_{t+1}\beta_t. \tag{A4}$$

Adding up those two equations and rearranging gives equation (21).

Appendix C

Proof that Banks Only Hold Bonds if Required

The payoff of a bank from regular investment is given by:

$$\left(1-\tau_{t+1}\right)\left(A_{t+1}-\kappa\right)k_t+\delta_{t+1}\beta_t-\psi^{-1}d_t. \tag{A5}$$

Replacing out for k_t given equation (21) and for d_t given equation (13) gives profits as a function of β_t and n_t:

$$\left(\frac{1-\gamma}{\frac{1}{\left(1-\tau_{t+1}\right)\left(\frac{A_{t+1}}{\kappa}-1\right)}-\gamma\psi}\right)n_t-\left(\frac{\left(1-\gamma\right)\ell'_t}{\frac{1}{\left(1-\tau_{t+1}\right)\left(\frac{A_{t+1}}{\kappa}-1\right)}-\gamma\psi}\right)\beta_t. \tag{A6}$$

The term multiplying β_t is strictly negative. Thus, raising bond holdings lowers the payout and the bank will never choose to voluntarily hold bonds.

On make-do investment, the lower the β_t, the lower the cost of investment x_t, for a fixed payout $\left(1-\tau_{t+1}\right)\left(A_{t+1}k^*_{t+1}-f\left(k^*_{t+1}\right)\right)$ and thus the higher the profits as well.

Appendix D

Proof that Higher Tax Rates Raise Tax Revenues

Differentiating the expression for revenue in equation (17) yields:

$$\frac{\partial R(.)}{\partial\tau_{t+1}}=\left(\frac{A_{t+1}}{\kappa}-1\right)\left(\frac{1-\gamma\psi\left(\frac{A_{t+1}}{\kappa}-1\right)}{1-\gamma\psi\left(\frac{A_{t+1}}{\kappa}-1\right)\left(1-\tau_{t+1}\right)}\right)+A_{t+1}k^*_{t+1}-f\left(k^*_{t+1}\right). \tag{A7}$$

From here, if $A_{t+1}>k$ we have that revenue rises with tax rates.

Appendix E

Proof of Proposition 1

Keeping fixed the left-hand side of equation (23), then the derivative of the right-hand side with respect to β_t must be zero. Doing so and keeping $T = 0$ and $\delta = 1$ gives:

$$\frac{\partial R(.)}{\partial \tau_{t+1}} \frac{d\tau_{t+1}(.)}{d\beta_t} = \ell_t'' \Phi_t - \frac{\partial R(.)}{\partial \beta_t}. \tag{A8}$$

Since the term $\partial R(.)/\partial \tau_{t+1}$ is strictly positive, taxes increase if and only if the left-hand side of equation (A8) is positive. Rearranging equation (22) gives the desired result.

Appendix F

Proof of Proposition 2

Again differentiating the right-hand side of equation (23) with respect to β_t, but now using the expression for $\partial T(.) / \partial \beta_t$ in equation (20) with $\delta_{t+1} = 1$ gives:

$$\frac{\partial R(.)}{\partial \tau_{t+1}} \frac{\partial \tau_{t+1}(.)}{\partial \beta_t} = \ell_t'' \frac{B_t}{q_t} - \frac{\partial R(.)}{\partial \beta_t} - \frac{1}{1+\xi}. \tag{A9}$$

As before, the sign of $\partial \tau / \partial \beta_t$ is the same as the sign on the right-hand side and, therefore, replacing for $\partial R(.)/\partial \beta_t$ and rearranging gives the desired result.

Appendix G

Proof of Proposition 3

Differentiating equation (23) with respect to β_t while keeping $T = 0$ but now with $\delta_{t+1} < 1$ and rearranging gives:

$$-\frac{\partial\delta_{t+1}}{\partial\beta_t}\left(1-\frac{1}{\dfrac{\ell'_t}{\psi\delta_{t+1}}+1}\right)=\delta_{t+1}\ell''_t\frac{B_t}{q_t}-\frac{\partial R(.)}{\partial\beta_t}. \tag{A10}$$

Since the sign of $-\partial\delta/\partial\beta$ is the same as the sign on the right-hand side, replacing for $\partial R(.)/\partial\beta$ yields the desired expression.

Fiscal Inflation and Cosmetic Defaults in a Small Open Economy

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For a small open economy, maintaining a stable exchange rate and moderate levels of inflation is often a goal of primary importance. At the same time, the profession has recognized the tight link between fiscal and monetary policies in determining inflation dynamics. Thus, the goal of a stable exchange rate requires a certain level of coordination between the monetary and fiscal authorities. This paper builds on recent advancements in the literature on monetary-fiscal policy interaction to formalize this idea. We study the origins of fiscal inflation, the possibility of stagflation as a result of policy uncertainty, and the role of default on sovereign debt crises that stem from lack of fiscal discipline. We then use the model to interpret the different periods of the Chilean economic history starting from the 1960s.

We model the interaction between the monetary and fiscal authorities in a small open economy, allowing for default and changes in the level of spending. When policymakers follow an exchange-rate-targeting policy mix, in which the central bank is focused on maintaining a stable exchange rate and the fiscal authority makes sure that debt remains on a stable path, fiscal imbalances are irrelevant for the macroeconomy. Thus, if agents are confident that such policy mix will be maintained in the future, the central bank is able to reach the goal of a stable exchange rate and moderate inflation. However, this result disappears as soon as we introduce uncertainty about policymakers' behavior. The possibility of deviations from fiscal discipline generates inflationary pressure that leads to output losses.

Independence, Credibility, and Communication of Central Banking edited by Ernesto Pastén and Ricardo Reis, Santiago, Chile.

If the fiscal authority moves away from a policy of debt stabilization, a sovereign debt crisis arises, with mounting inflationary pressure that implies a nominal devaluation. If the central bank remains committed to stabilizing the exchange rate, a vicious circle of large debt accumulation, inflation, and contractions in real activity arises.

In this scenario, we introduce the notion of cosmetic default as a default that does not resolve the underlying fiscal problem that led to the crisis. A cosmetic default is unable to remove the contractionary effects arising from the conflicting goals of a stable exchange rate and freedom in the conduct of fiscal policy. On the contrary, the possibility of a cosmetic default exacerbates the vicious circle because it determines an increase in sovereign spreads and, as a result, faster debt accumulation. In this scenario, the lack of coordination between the monetary and fiscal authorities becomes two-dimensional. First, policymakers are not able to implement policies that are consistent with a stable exchange rate and low inflation. Second, policymakers do not provide a clear path to resolve the latent conflict between the two authorities.

To illustrate these and other ideas, we build a model of a small open economy similar to the one used by Kriwoluzky and others (2015), who, in turn, combine ingredients from Galí and Monacelli (2008), Uribe (2006), and Bianchi and Ilut (2017). With respect to these papers, we introduce recurrent changes in the level of fiscal spending and link such changes to the monetary-fiscal policy mix and the occurrence of default. When spending is low, the fiscal authority follows a policy of debt stabilization and the central bank targets the exchange rate. We label this policy mix exchange-rate targeting. When spending is high, deviations from the exchange-rate-targeting regime become possible. Specifically, the fiscal authority might stop responding to the level of debt, perhaps because of political considerations not modeled in this paper. This situation determines a sovereign debt crisis with debt on an unstable path. This crisis cannot persist forever because the ability of the monetary authority to target a stable exchange rate requires the fiscal authority to keep debt on a stable path.

Three scenarios can follow the sovereign debt crisis. First, the fiscal authority can simply revert to a policy of debt stabilization. The economy in this case returns to the exchange-rate-targeting regime. Second, policymakers can decide to default on the existing stock of debt. Third, policymakers might switch to a fiscally-led regime in which the central bank abandons exchange-rate targeting, and inflation is then free to move and stabilize the fiscal burden. This last scenario has pervasive consequences for the model dynamics. If policymakers were to move to the fiscally-led regime, the sovereign debt crisis would be resolved by a large increase in inflation and a consequent large devaluation. The central bank accommodates these events, with a resulting drop in the real interest rate and an expansion. The cost of such policy is represented by the loss of exchange-rate stability and by an overall increase in macroeconomic volatility.

The expectation that such scenario might follow the sovereign debt crisis creates a vicious circle of large debt accumulation, inflation, and contraction in real activity. The possibility of a switch to the fiscally-led regime creates inflationary pressure and, as a consequence, devaluationary pressure on the exchange rate. Given that the central bank is still trying to keep a stable exchange rate, this leads to an increase in interest rates to prevent depreciation, which in turn results in recession and real appreciation. The recession and the high real interest rate determine further debt accumulation and a consequent increase in inflationary pressure.

The possibility that the crisis might be resolved with a default instead of a switch to the fiscally-led regime exacerbates the vicious circle instead of mitigating it. In this context, a default is only cosmetic because it implies repudiating a certain amount of the existing debt but not a change in the policy mix or in the expected policy mix. Thus, a default only has a limited effect on the expected fiscal burden because it does not address the original sin at the root of the sovereign crisis. When agents expect that policymakers might default on the existing debt, they demand to be compensated for such a possibility and sovereign spreads go up. This makes the cost of financing debt larger, thus increasing the overall amount of debt that policymakers need to stabilize. The spiral of debt accumulation and increasing output losses persists until the economy enters default. Default determines a temporary recovery in the economy because it curbs the current amount of debt that needs to be inflated away. However, given that it does not resolve the underlying fiscal issue, the recovery does not last, the debt-to-GDP starts increasing again, and so does inflation. In other words, the economy experiences a cosmetic default: A drop in the fiscal burden that does not resolve the underlying problem represented by the lack of coordination between the monetary and fiscal authorities.

Even when the economy is not currently experiencing a crisis, the possibility that this might arise in the future determines output losses. When the economy enters a period of high spending, agents understand that there is an increase in the probability of policymakers' deviating from the exchange-rate-targeting regime. This causes inflationary pressure and a nominal depreciation. The central bank increases the policy rate to counteract the depreciation, thus causing a real appreciation and a recession. Stagflation is now driven by the expectation that a crisis might occur in the future, even if policymakers are currently following the exchange-rate-targeting policy mix. Finally, the losses arising during the high-spending period spill over into the low-spending regime. Thus, fiscal inflation is always present, even if its magnitude varies depending on the current behavior of the monetary and fiscal authorities.

This result also suggests that a sovereign debt crisis with stagflation can arise even if policymakers keep following the exchange-rate-targeting policy mix. To trigger the crisis, it is enough that agents experience a loss of confidence about future policymakers' actions. The loss of confidence implies an increase in the probabilities assigned to default and a switch to the fiscally-led regime. The key mechanism is identical to what has been illustrated for the benchmark case. The possibility of moving away from fiscal discipline causes inflationary pressure that the central bank tries to contain, thus pushing the economy in a recession. Of course, the severity of the crisis is in this case reduced because the actions of the fiscal authority limit the speed with which debt is accumulated. However, this case illustrates how stagflation can arise simply as a result of changes in agents' beliefs, which highlights the importance of clear policy communication about the way spending programs will be financed in the future.

It is then interesting to study when a default is more likely to put a stop to a sovereign crisis. We argue that a default is more likely to mark the end of a sovereign debt crisis if it is paired with a policy reform. In other words, a default can put a stop to the crisis if it is not purely cosmetic, but it also implies a change in the policy mix going forward. We argue that this seems a realistic scenario only if the large debt accumulation is the result of an exceptional event that is not likely to occur again soon, like an unusually large recession or a disaster (like a war). Instead, if the large debt accumulation is the result of high spending, it might be harder to convince agents that the same problem will not occur again in the future.

When the large stock of debt is the result of an exceptional event and not a systematic fiscal problem, a shift to the fiscally-led regime might be perceived as too costly because it requires accepting high exchange-rate volatility for many periods to come. Instead, a default that reduces the existing stock of debt without changing expectations about future fiscal discipline might seem a better option. The model presented in this paper cannot be used to quantify the advantages and disadvantages of a default with respect to a switch to the fiscally-led regime because default is not costly in the model. Nevertheless, the model can be used to understand the existing tradeoffs from a qualitative point of view. On the one hand, a cosmetic default cannot be the solution to a fiscal issue. On the contrary, a cosmetic default exacerbates the cost associated with policy uncertainty. Introducing a cost of default would not change this result. On the other hand, moving to a fiscally-led regime implies abandoning exchange-rate stability. Thus, the only effective solution for a small open economy is to implement reforms that can create confidence in the fiscal sustainability of the existing levels of spending.

We use the model to study key steps in the Chilean quest for low and stable inflation. In this respect, Chilean economic history starting from 1960 can be divided into four distinct periods. During the 1960s Chile struggled to contain inflation. Interestingly, the government was able to recognize early on that a low inflation rate requires keeping fiscal deficits under control. High fiscal inflation turned into fiscal hyperinflation in the early 1970s as a result of a large increase in primary deficits. The second period, from 1974 to 1981, was characterized by a shift toward conservative fiscal policy and a progressive change in the conduct of monetary policy toward exchange-rate targeting. These two changes led to a significant reduction in inflation, consistently with the model. However, a drastic shift in the conduct of U.S. monetary policy in the early 1980s combined with the exchange-rate-targeting regime determined a banking crisis. The rescue plan implemented by the Chilean government resulted in a large increase in fiscal obligations. Thus, over the period from 1982 to 1988, the Chilean government acted forcefully to avoid a cosmetic default and instead implemented policies meant to build a reputation for fiscal discipline. Inflation remained high but relatively moderate. Finally, the last period, starting in 1989, was characterized by a return to democracy and two major institutional changes. First, the Central Bank of Chile was granted independence. Second, a fiscal rule meant to guarantee long-run fiscal sustainability was introduced. As implied by the model, once the central bank obtained the necessary fiscal backing, it was able to gain control of inflation and guarantee a stable exchange rate.

This paper builds on the work of Bianchi and Ilut (2017), who study the role of fiscal policy in explaining the rise in inflation in the

1970s in the United States; Bianchi and Melosi (2017b), who study the problem of the lack of coordination between the monetary and fiscal authorities for a closed economy; and Kriwoluzky and others (2015), who extend the analysis to a currency union to study the experience of Greece during the recent financial crisis. In this respect, the paper is also related to Woodford (2001) and Loyo (1999), who use a perfect foresight endowment economy to show that, if the central bank follows the Taylor principle while the fiscal authority does not stabilize debt, an explosive path for the price level arises. In our model, the possibility of recurrent changes in the policy mix guarantees that a stationary equilibrium still exists, while allowing for temporarily explosive dynamics. Furthermore, the New-Keynesian framework makes the lack of coordination more costly than in an endowment economy.

Our notion of cosmetic default builds on the idea of Marcet and Nicolini (2003) of a monetary reform that introduces an exchange-rate-targeting policy to counteract hyperinflation. Sargent and others (2009) label such monetary reform cosmetic because it does not address the real reason behind the high inflation: a high level of seigniorage used to finance large fiscal deficits. Cosmetic reforms are more likely to be followed by new episodes of hyperinflation, unless they are able to signal future changes in fundamentals. In a similar fashion, our cosmetic defaults are conducive to new sovereign debt crises. Sargent and others (2009) conduct an empirical study of hyperinflation episodes in several South American countries and show that hyperinflation can arise as the result of government deficits that are monetized but also from destabilizing expectations dynamics that can occasionally divorce inflation from fundamentals. The model presented in this paper can deliver similar results for inflation dynamics and also generate contractions in real activity.

The mechanisms outlined here do not explicitly involve seigniorage, even if we could derive an implied path for money supply. Fiscal inflation instead arises as a result of real or perceived fiscal imbalances. The fact that no explicit link between inflation and seigniorage is required is consistent with the observation made by Marcet and Nicolini (2003) that episodes of hyperinflation can arise with no apparent changes in the level of seigniorage. The authors explain this stylized fact in the light of bounded rationality. In the current paper, the disconnect between seigniorage and inflation is explained by taking a different perspective on the ultimate source of fiscal pressure. In particular, we build on the literature that studies the interaction between fiscal and monetary policies in determining inflation dynamics: Sargent and Wallace (1981), who consider the problem in a deterministic environment; Leeper (1991), Sims (1994), Cochrane (1998, 2001), and Woodford (1994, 1995, 2001), who focus on the problem of price determinacy; and Bassetto (2002), who studies the game-theoretical aspect of the fiscal theory of price level.

Finally, our results are also related to the important work by Dornbusch (1982). He argues that the prediction of the Mundell-Fleming model that an increase in government spending leads to an appreciation seems at odds with the empirical evidence. He then introduces the possibility that an increase in government spending creates an expectation of future debt monetization. Like in Dornbush's model, our model generates a depreciation of the exchange rate stemming from the lack of fiscal discipline, even if the mechanisms at play are quite different.

The content of this paper can be summarized as follows: Section 1 describes the model. Section 2 discusses the results. Section 3 uses the model to interpret the key steps in Chilean economic history. Section 4 concludes.

1. The Model

We make use of a New-Keynesian model similar to the one employed by Kriwoluzky and others (2015). Specifically, the model builds on the work of Galí and Monacelli (2008) and Corsetti and others (2013), with respect to the modeling of a small open economy. As in Uribe (2006), the government can default on its liabilities. Finally, we follow Bianchi and Ilut (2017) and Bianchi and Melosi (2017b) in modeling periods of lack of coordination between the monetary and fiscal authorities. An important innovation with respect to these contributions is that deviations from fiscal discipline depend on the level of spending: Policymakers default or move to a fiscally-led policy mix only when spending is high. This dependence between policymakers' behavior and spending level is at the center of the results of the paper and the notion of cosmetic default.

We keep the model parsimonious and we only consider changes in nondistortionary spending as a source of fiscal imbalance. This allows us to zoom in on the role of fiscal discipline and agents' expectations. The main results would still hold if the increase in the fiscal burden were driven by contractionary shocks. However, it would become more complicated to disentangle the direct impact of the shock and the indirect effects stemming from policy uncertainty and default.

1.1 Model Description

Households. The representative household maximizes the following utility function:

$$\mathbb{E}_0\left[\sum_{t=0}^{\infty}\beta^t\left[\log\left(C_t\right)-\left(1+\varphi\right)^{-1}H_t^{1+\varphi}\right]\right] \tag{1}$$

subject to the budget constraint:

$$\int_0^1 P_{H,t}(i)C_{H,t}(i)di+\int_0^1 P_{F,t}(i)C_{F,t}(i)di+\mathbb{E}_t\left[\rho_{t,t+1}X_{t+1}\right]$$
$$=W_tH_t+\mathcal{Y}_t-\left(T_t-S_t\right)+X_t$$

where C_t is consumption, H_t is hours, β is the household discount factor, φ is the inverse of the Frisch elasticity of labor supply, P_t is the price index. The variables $C_{H,t}(i)$ and $C_{F,t}(i)$ denote consumption of domestically produced and imported varieties with $i\in[0, 1]$, while $P_{H,t}(i)$ and $P_{F,t}(i)$ are the corresponding price indices. The household has access to a portfolio of state-contingent claims X_{t+1} priced with the nominal stochastic discount factor $\rho_{t,t+1}$. Finally, the household receives the hourly nominal wage W_t and firm profits $\mathcal{Y}_t$, while it has to pay new lump-sum taxes $(T_t - S_t)$.

Aggregate consumption is defined as

$$C_t\equiv\left[(1-\omega)^{\frac{1}{\sigma}}C_{H,t}^{\frac{\sigma-1}{\sigma}}+\omega^{\frac{1}{\sigma}}C_{H,t}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

where aggregate consumption of domestic goods $C_{H,t}$ consists of varieties

$$C_{H,t}\equiv\left[\int_0^1 C_{H,t}(i)^{\frac{\gamma-1}{\gamma}}di\right]^{\frac{\gamma}{\gamma-1}}$$

and aggregate consumption of foreign goods $C_{F,t}$ consists of varieties

$$C_{F,t}\equiv\left[\int_0^1 C_{F,t}(i)^{\frac{\gamma-1}{\gamma}}di\right]^{\frac{\gamma}{\gamma-1}}.$$

The parameter $\omega\in(0,1)$ controls the import weight of consumption, $\sigma>0$ is the elasticity between domestic goods and imports, and $\gamma>1$ is the price elasticity of demand across varieties. Finally, the consumer price index is

$$P_t \equiv \left[(1-\omega) P_{H,t}^{1-\sigma} + \omega P_{F,t}^{1-\sigma}\right]^{\frac{1}{1-\sigma}}.$$

Intertemporal consumption smoothing combined with the presence of state-contingent assets implies:

$$\rho_{t,t+1} = \beta \left(\frac{C_{t+1}}{C_t}\right)^{-1} \frac{P_t}{P_{t+1}}. \tag{2}$$

Following Uribe (2006), we can use this expression to define the yield on a nominal risk-free domestic-currency bond as $R_t \equiv \frac{1}{\mathbb{E}_t\left[\rho_{t,t+1}\right]}$.

Foreign households face a symmetric problem:

$$\rho_{t,t+1} = \beta \left(\frac{C_{t+1}^*}{C_t^*}\right)^{-1} \frac{P_t^*}{P_{t+1}^*} \frac{E_t}{E_{t+1}}. \tag{3}$$

where C_t^* and P_t^* denote consumption and price level for the foreign country, respectively, and E_t is the nominal exchange rate, defined as the price of foreign currency in terms of domestic currency. Combining the intertemporal optimality conditions (2) and (3) leads to the risk-sharing condition $\frac{C_t}{C_t^*} = \upsilon Q_t$, where the real exchange rate $Q_t \equiv \frac{P_t^* E_t}{P_t}$ corresponds to the price of foreign consumption in terms of domestic consumption, while the constant $\upsilon \equiv \left(\frac{C_{-1}}{C_{-1}^*}\right)\left(\frac{P_{-1}}{E_{-1} P_{-1}^*}\right)$ captures initial conditions.

Firms. The representative monopolistically competitive firm i faces sticky prices *a la Calvo* with probability of adjustment $(1-\theta)$ and a downward-sloping demand curve arising from the household optimization problem. Specifically, the demand function at time $t+k$ for a firm $j \in [0,1]$ that last adjusted prices k periods ago is given by:

$$Y_{t+k|t}(i) = \left(\frac{P_{H,t}(i)}{P_{H,t+k}}\right)^{-\gamma} \left((1-\varpi) \left(\frac{P_{H,t+k}}{P_{t+k}}\right)^{-\sigma} C_{t+k} + \varpi \left(\frac{\frac{P_{H,t+k}}{E_{t+k}}}{P_{t+k}}\right)^{-\sigma} C_{t+k}^* \right)^{-\gamma} \tag{4}$$

where we took into account that prices are set in the domestic currency.

A firm i that can change its price at time t chooses the optimal price $P_{H,t}(i) = \tilde{P}_{H,t}(i)$ to maximize the expected present discounted value of profits by using the household stochastic discount factor $\rho_{t,t+k}$ and taking into account that, in every period, there is a probability θ that it will not be able to adjust the price:

$$\max_{P_{H,t}(i)} \mathbb{E}_t\left[\sum_{k=0}^{\infty}\theta^k \rho_{t,t+k}\mathcal{Y}_{t+k|t}(i)\right]$$

$$= \max_{P_{H,t}} \mathbb{E}_t\left[\sum_{k=0}^{\infty}\theta^k \rho_{t,t+k}\left(P_{H,t}(i)Y_{t+k|t}(i) - \mathcal{C}\left(Y_{t+k|t}(i)\right)\right)\right]$$

where the cost function $\mathcal{C}\left(Y_{t+k|t}(i)\right) = W_{t+k}Y_{t+k|t}(i)$ depends on the price chosen at time t as exemplified above.

Because all firms that adjust their prices at time t face the same optimization problem, they all choose the same optimal price $\tilde{P}_{H,t}(i)$. Thus, the domestic price index evolves as:

$$P_{H,t}^{1-\gamma} = (1-\theta)\tilde{P}_{H,t}^{1-\gamma} + \theta P_{H,t-1}^{1-\gamma}$$

where we have taken into account that, in every period, a randomly selected fraction $(1-\theta)$ is chosen to re-optimize the price, while the rest of the firms leave their prices unchanged.

Policymakers. The fiscal authority issues one-period bonds with price I_t^{-1}. These bonds are risky because, in every period, the government might default on a fraction D_{t+1} of the outstanding debt. Thus, government debt evolves according to the following law of motion:

$$I_t^{-1}B_t = B_{t-1}(1 - D_t) - T_t + S_t.$$

We can rewrite the government budget constraint as a fraction of GDP:

$$b_t = \left(\frac{Y_t}{Y_{t-1}}\right)^{-1} I_{t-1}\Pi_t^{-1}b_{t-1}\left(1-D_t\right) - \tau_t + s_t$$

where $b_t \equiv \dfrac{I_t^{-1}B_t}{Y_tP_{H,t}}$, $\tau_t \equiv \dfrac{T_t}{Y_tP_{H,t}}$ and $s_t \equiv \dfrac{S_t}{Y_tP_{H,t}}$. As in Bianchi and Ilut (2017), the term s_t reflects a persistent shock to spending. Here, we model the shock as Markov-switching process $s_t = s_{\xi_\tau^s}$ controlled by a transition matrix $\mathcal{P}^s$. Modeling the shock as a Markov-switching process allows us to easily break the orthogonality between shocks and policy behavior.

The term τ_t reflects the systematic component of taxation. For simplicity, we assume that τ_t only responds to the debt-to-GDP ratio, but richer policy rules could be considered:[1]

$$(\tau_t - \tau) = \delta_{\xi_\tau^p}(b_{t-1} - b)$$

where τ and $b \equiv \frac{\tau}{1-\beta}$ are the steady-state values for the tax-to-GDP and debt-to-GDP ratios. The parameter controlling the response of taxation to debt, $\delta_{\xi_\tau^p}$, can change over time and is controlled by the Markov-switching variable ξ_t^p with transition matrix $\mathcal{P}^p$.

The central bank moves the policy rate according to a modified Taylor rule:

$$\frac{R_t}{R} = \left(\frac{\Pi_{H,t}}{\Pi_H}\right)^{\phi_{\pi,\xi_t^p}} \left(\frac{E_t}{E}\right)^{\phi_{e,\xi_t^p}} \tag{5}$$

where R is the steady-state gross nominal interest rate, $\Pi_{H,t} \equiv \frac{P_{H,t}}{P_{H,t-1}}$ is the domestic gross inflation rate, Π_H is the steady-state gross domestic inflation rate, E is the steady-state exchange rate. As for the fiscal rule, the Taylor-rule parameters are allowed to change over time based on the Markov-switching variable ξ_t^p.

A nonarbitrage condition pins down the return on government bonds:

$$I_t \mathbb{E}_t (1 - D_{t+1}) = \frac{1}{\mathbb{E}_t[\rho_{t,t+1}]} = R_t .$$

This implies that the sovereign yield is higher than the risk-free rate R_t by an amount that reflects the probability and the size of default.

1. See Bianchi and Ilut (2017).

Table 1. Partition of the Parameter Space

	Active Fiscal (AF) ($\delta_b < \beta^{-1}-1$)	*Passive Fiscal (PF)* ($\delta_b > \beta^{-1}-1$)
Active Monetary ($\phi_{\pi,\xi_t^p} > 1, \phi_e > 0$)	No Solution	**Determinacy**
Passive Monetary ($\phi_{\pi,\xi_t^p} < 1, \phi_e = 0$)	**Determinacy**	Indeterminacy

Source: Author's research.
Partition of the parameter space according to the existence and uniqueness of a solution in a model without regime changes.

Market clearing. The good market clears as

$$Y_t = (1-\varpi)\left(\frac{P_{H,t}}{P_t}\right)^{-\sigma} C_t + \varpi\left(\frac{P_{H,t}}{P_{F,t}}\right)^{-\sigma} C_t^*$$

where we have used the assumption that $P_{F,t} = E_t P_t^*$. This holds approximately given that the domestic country is small.[2] Market clearing in the asset market implies:

$$\mathbb{E}_t\left[\rho_{t,t+1}X_{t+1}\right] - X_t = I_t^{-1}B_t - B_{t-1}\left(1-D_t\right) + P_{H,t}Y_t - P_tC_t.$$

Finally, market clearing in the labor market requires $H_t = \int_0^1 H_t(i)di = \int_0^1 Y_t(i)di = Y_t\Delta_t$, where Δ_t is a measure of price dispersion that is equal to 1 up to a first-order approximation around a zero-inflation steady state.

1.2 Conditionally Linear Model

Before discussing policy changes, we present the linearized system of equations conditional on being in a certain regime. The private-sector equilibrium conditions lead to a linearized Euler equation and an expectation augmented Phillips curve:

2. See Kriwoluzky and others (2015) and De Paoli (2009).

$$y_t = E_t y_{t+1} - \bar{\omega}\left(r_t - E_t \pi_{H,t+1}\right)$$

$$\pi_{H,t} = \beta E_t \pi_{H,t+1} + \kappa\left(\varphi + \bar{\omega}^{-1}\right) y_t$$

where $\bar{\omega} \equiv 1 + \omega(2-\omega)(\sigma-1)$ and $\kappa \equiv \dfrac{(1-\beta\theta)(1-\theta)}{\theta}$.

Because of the assumption of complete international markets, domestic output is tightly linked to the behavior of the real exchange rate q_t:

$$y_t = \frac{\bar{\omega}}{1-\omega} q_t$$

where $q_t = (1-\omega)\,(e_t - p_{H,t})$, with e_t the nominal exchange rate.

The linearized government budget constraint reads:

$$b_t = \left(\frac{b}{\beta}\right)\left(i_{t-1} - \pi_{H,t} - d_t - y_t + y_{t-1}\right) + \left(\frac{1}{\beta}\right) b_{t-1} - \tau_t + s_t$$

with τ_t controlled by the linearized fiscal rule:

$$\tau_t = \delta_{b,\xi_t^p} b_{t-1}$$

where, to keep notation simple, we now use τ_t and b_t to denote linear deviations from the corresponding steady states.

The monetary-policy rule reads:

$$r_t = \phi_{\pi,\xi_t^p} \pi_{H,t} + \phi_{e,\xi_t^p} e_t$$

while the sovereign yield is pinned down by:

$$i_t = r_t + E_t d_{t+1}.$$

Thus, the expected size of the default determines the sovereign yield spread.

1.3 Monetary-fiscal Policy Mix and Default

Before describing the regime changes that we allow for, we illustrate the consequences of explicitly modeling the behavior of the fiscal authority. If we substitute the tax rule in the linearized law of motion for the debt-to-GDP ratio and isolate the resulting coefficient for lagged debt, we get:

$$b_t = (\beta^{-1} - \delta_{b,\xi_t^p})\, b_{t-1} + \ldots$$

This expression makes clear that debt stability can be achieved through the behavior of the fiscal authority by making sure that the process for the debt-to-GDP ratio is mean reverting. This requires the coefficient $\delta_{b,\xi_t^p}>1-\beta^{-1}$. In the language of Leeper (1991), fiscal policy is in this case passive, in the sense that it passively accommodates the behavior of the monetary authority by making sure that debt is always on a stable path. If the fiscal authority violates this condition, we say that it is active.

Similarly, we can distinguish between active and passive monetary policy. In a closed economy, the distinction revolves around the Taylor principle, i.e., the response of the monetary-policy rate to inflation has to be more than one-to-one in order for monetary policy to be active: $\phi_{\pi,\xi_t^p}>1$. In an open economy as the one presented above, monetary policy can be active if the central bank targets the exchange rate. In other words, monetary policy is active as long as the response to deviations of the nominal exchange rate to the target is larger than zero (Benigno and others, 2007): $\phi_{e,\xi_t^p}>0$. This is consistent with the fact that an exchange-rate target requires the central bank to commit to return the price level to its original value following any shock. Thus, exchange-rate targeting can be thought of as a form of price-level targeting. This result has the important implication that the properties of existence and uniqueness of a solution described above extend to the case of an open economy in which the central bank reacts to the exchange rate instead of reacting to inflation. Accordingly, passive monetary policy arises if $\phi_{\pi,\xi_t^p} < 1$ and $\phi_{e,\xi_t^p} = 0$.

For a closed economy, in absence of regime changes, Leeper (1991) shows that the distinction between active and passive policies leads to a partition of the parameter space in four areas depending on the existence and uniqueness of a solution. The same partition exists in an open economy, once we recognize that monetary policy can be active as a result of its response to the exchange rate. Thus, a unique solution arises when monetary policy is active and fiscal policy is passive (AM/PF), or in the symmetric case of passive monetary policy and active fiscal policy (PM/AF). When both authorities are conducting passive policies (PM/PF) we have multiple solutions. Finally, when both authorities are conducting active policies, no stable solution exists. These regions are summarized in table 1.

The first determinacy region, Active Monetary/Passive Fiscal (AM/PF), is the most familiar one. The Taylor principle is satisfied and the fiscal authority moves taxes in order to keep debt on a stable path: $\psi_{\pi,\xi_t^p} > 1$ or $\psi_{e,\xi_t^p} > 0$ and $\delta_{b,\xi_t^p} > \beta^{-1} - 1$. This last condition guarantees that the coefficient $\beta^{-1} - \delta_{b,\xi_t^p}$ is smaller than one, so that debt is mean reverting. Therefore, we can think of fiscal policy as passive to the extent that it passively accommodates the behavior of the monetary authority ensuring debt stability. We can think about this policy mix as a monetarily-led regime. The second determinacy region, Passive Monetary/Active Fiscal (PM/AF), is less familiar and corresponds to the case in which the fiscal authority is not committed to stabilizing the process for debt: $\delta_{b,\xi_t^p} < \beta^{-1} - 1$. Now it is the monetary authority that passively accommodates the behavior of the fiscal authority, allowing inflation to move in order to stabilize the process for debt: $\psi_{\pi,\xi_t^p} < 1$ and $\psi_{e,\xi_t^p} = 0$. As we shall see, under this regime, fiscal imbalances can have an impact on the macroeconomy as agents understand that they will not be followed by future offsetting changes in the fiscal variables. We can think about this policy mix as a fiscally-led regime.

To gain the intuition about why when both authorities are active (AM/AF) no *stationary* equilibrium exists, suppose that inflation is above target and that the central bank tries to lower it by increasing the policy rate more than one-to-one in response to the observed deviation. This action prompts an increase in the real interest rate, a contraction in output and, consequently, an increase in the debt-to-GDP ratio. This increase in the debt-to-GDP ratio would require an increase in taxation, but agents know that this is not going to happen because the fiscal authority is active. Therefore, the adjustment has to come through an increase in inflation that triggers an even larger increase in the interest rate and so on. Clearly, the economy is on an explosive path and, if this situation were to persist, no *stationary* solution would exist. Thus, we can think about this policy mix as a conflict regime in which the two authorities fail to coordinate which other.

As explained in Bianchi and Melosi (2017b), if the conflict regime is expected to eventually end, the model can still admit a stable and unique rational-expectations equilibrium. The model can present temporary explosive dynamics, but as long as these are not expected to last for too long, a stationary solution would still exist. This is the key insight that allows us to solve the model allowing for periods during which the monetary and fiscal authorities are implementing policies that are not compatible in the long run.

We use the solution algorithm proposed by Farmer and others (2009). This method requires the solution to satisfy mean square stability: First and second moments need to be stationary when taking into account the possibility of regime changes. However, quite importantly, the solution method does not impose that all regimes taken in isolation must be stationary, allowing for temporary explosive dynamics. Given that agents form expectations by taking into account the possibility of regime changes, their expectations are still finite at every horizon, even when the economy is temporarily on an explosive path because of the conflict between the two authorities. As we shall see, the properties of the solution depend on agents' expectations about the way the conflict between monetary and fiscal authorities will be resolved.

The other important change with respect to most of the literature that studies monetary-fiscal policy interaction is that the model presented above also allows for default. As we shall see, the possibility of default can exacerbate the effects of a conflict between the monetary and fiscal authorities. To see why, let's consider a simplified version of default. We assume that if default occurs, this will be equal to the ratio between the past stock of debt (in deviations from steady state) and the steady-state debt-to-GDP ratio. In other words, $d_t = b_{t-1}/b$ if a default occurs. In the linearized budget constraint, we then have:

$$b_t = \left(\frac{b}{\beta}\right)\left(i_{t-1} - \pi_{H,t} - d_t - y_t + y_{t-1}\right) + \beta^{-1} b_{t-1} - \tau_t + s_t$$

$$= \left(\beta^{-1} + P_{t-1}\left(d_t > 0\right) - \delta_{b,\xi_t^p}\right) b_{t-1} + \left(\frac{b}{\beta}\right)\left(r_{t-1} - \pi_{H,t} - d_t - y_t + y_{t-1}\right) + s_t$$

where $P_{t-1}(d_t > 0)$ is the probability of default at time t conditional on the information at time $t-1$. In deriving the second expression, we have used the fact that $i_{t-1} = r_{t-1} + E_{t-1} d_t = r_{t-1} + \frac{P_{t-1}\left(d_t > 0\right) b_{t-1}}{b}$. Thus, the possibility of default makes the process for debt more unstable during regular times and calls for stronger fiscal interventions. Obviously, if default in fact occurs $d_t = \frac{b_{t-1}}{b}$, the process for debt gets reset:

where we have assumed that, in case of default, there is no response to debt ($\delta_{b,\xi_t^p} = 0$). Thus, when default does not interact with the lack of fiscal discipline, it can be considered as a regime change that implies a zero net gain. During regular times debt accumulates faster, but once default in fact occurs, debt gets reset to a value that exactly compensates for the faster accumulation.

In this paper, we do not model a cost of default. There is a vast literature that discusses why default is costly. Introducing a cost of default would be relevant to explain why countries are reluctant to default and help matching actual data. However, it would not affect the discussion that we want to put forward in this paper. First, we want to argue that default cannot be the solution of a sovereign debt crisis if it does not address the causes of the crisis. Second, cosmetic defaults, i.e., defaults that only imply repudiating debt without a policy reform, can be costly if combined with policy uncertainty because they imply faster debt accumulation. The fiscal burden, in turn, creates inflationary pressure that jeopardizes the ability of the central bank to control inflation.

1.4 Policy Changes

We study a situation in which the economy is subject to persistent changes in the level of spending. Specifically, the spending shock s_t can assume two values, high or low, controlled by the transition matrix $\mathcal{P}^s : s_t = s_h \text{ if } \xi_t^s = h, s_t = s_l \text{ if } \xi_t^s = l$. We then study the effects of this shock for different scenarios regarding policymakers' behavior.

We assume that when spending is low, there are no incentives for policymakers to deviate from fiscal discipline. Thus, conditional on spending being low, policymakers implement an exchange-rate-targeting regime. The central bank moves the nominal interest rate to stabilize the exchange rate around its target value and the fiscal authority takes care of debt stability. When spending is high, policymakers might deviate from exchange-rate targeting. This assumption is supposed to capture the idea that high spending requires the fiscal authority to increase the level of taxation and this might be perceived as not politically feasible or popular. Thus, when spending is high, a conflict between the two authorities could arise: The central bank wants to keep the exchange rate stable or inflation low, but the fiscal authority is not willing to move taxes to stabilize debt. From this situation, three scenarios can occur: Default, switch to a fiscally-led regime, or return to fiscal discipline in the form of the exchange-rate-targeting regime. In the rest of the paper, we consider different scenarios with respect to the relative probability of these events.

We parameterize the different regimes as follows. Under the *exchange-rate-targeting regime*, the central bank implements an active monetary policy by moving the nominal interest rate to stabilize the exchange rate around its target value ($\psi_{e,\xi_t^p} > 0$) and the fiscal authority implements a passive fiscal rule ($\delta_{b,\xi_t^p} > \beta^{-1} - 1$). This can be considered a monetarily-led regime, in the sense that the monetary authority is the leading authority. A conflict between the two authorities arises when fiscal policy moves to an active rule ($\delta_{b,\xi_t^p} > \beta^{-1} - 1$), while monetary policy keeps responding to the exchange rate. This leads to a sovereign debt crisis regime in which debt is on an unstable path. This *crisis regime* can be followed by a return to the exchange-rate-targeting regime, by a default, or by a switch to a *fiscally-led regime* in which the monetary authority abandons exchange-rate targeting to accommodate the behavior of the fiscal authority.

We assume that a default can occur only after a conflict between the monetary and fiscal authorities arises. When default occurs, we assume that this is large enough to bring the debt-to-GDP ratio back to the steady state as in Uribe (2006).[3] Specifically, when default occurs, its size is endogenously pinned down by the following equilibrium condition:

$$1_{\xi_t^p} b_t + \left(1 - 1_{\xi_t^p}\right) d_t = 0.$$

Note that when a default does not occur, $1_{\xi_t^p} = 0$ and $d_t = 0$, while when a default occurs, d^* is such that the debt-to-GDP ratio is back to its steady state, $1_{\xi_t^p} = 1$ and $b_t = 0$. We also assume that, under this regime, the response of the monetary and fiscal authorities does not change with respect to the conflict regime.

The joint evolution of policymakers' behavior and the discrete preference shock is controlled by the combined chain $\xi_t \equiv \left[\xi_t^p, \xi_t^s\right]$. As explained above, the probabilities of moving across the policy regimes are not invariant with respect to the level of spending. This feature of the model is obtained by introducing two transition matrices, $\mathcal{P}_l^p$

3. We also experimented with other specifications that involve default on a fixed amount plus a state-dependent amount of debt. These specifications are useful to make sure that default is always on a positive amount of debt when simulating the model, but they do not change the insights presented below. Thus, in the benchmark version of the model, we opted for this traditional formulation.

and $\mathcal{P}_h^p$; that control the transition probabilities during low and high spending, respectively. The overall transition matrix $\mathcal{P}$ is obtained by combining the transition matrices $\mathcal{P}_l^p$; $\mathcal{P}_h^p$; and $\mathcal{P}^s$s:

$$\mathcal{P} = \begin{bmatrix} p_{ll}^s \mathcal{P}_l^p & \left(1 - p_{hh}^s\right) \mathcal{P}_l^p \\ \left(1 - p_{hh}^s\right) \mathcal{P}_h^p & p_{hh}^s \mathcal{P}_h^p \end{bmatrix}.$$

The benchmark model is solved with the following transition matrices for the policy regimes:

$$\mathcal{P}_l^p \begin{array}{cc} & \begin{array}{cccc} E & C & D & F \end{array} \\ \begin{array}{c} E \\ C \\ D \\ F \end{array} & \begin{bmatrix} 1 & 1 & 1 & .01 \\ & & & \\ & & & \\ & & & .99 \end{bmatrix} \end{array} \text{ and } \mathcal{P}_h^p = \begin{array}{cc} & \begin{array}{cccc} E & C & D & F \end{array} \\ \begin{array}{c} E \\ C \\ D \\ F \end{array} & \begin{bmatrix} .96 & .05 & & \\ .04 & .85 & 1 & \\ & .05 & & \\ & .05 & & 1 \end{bmatrix} \end{array}.$$

Table 2. Calibration

Policy Regime	$\mathbf{1}_{\xi_t^p}$	ϕ_{e,ξ_t^p}	ϕ_{π,ξ_t^p}	δ_{b,ξ_t^p}
ER targeting (E)	0	0.5	0	0.07
Crisis (C)	0	0.5	0	0
Default (D)	1	0.5	0	0
Fiscally-led (F)	0	0	0.68	0

Parameter	*Value*	*Parameter*	*Value*	*Parameter*	*Value*
ω	0.28	φ	4	p_{ll}^s	0.98
σ	1.50	β	0.99	p_{hh}^s	0.99
θ	0.875	b/4	50%	s_t	-0.04
γ	11			s_h	0.02

Source: Author's calculations.
Parameter values used to calibrate the benchmark model used for the simulations presented in the paper.

These transition matrices capture a series of intuitive properties of the model. As explained above, crises emerge only when spending is high. The probability of entering a sovereign crisis when spending is high is 4 percent. From the crisis, there is the probability (5 percent) of moving to the exchange-rate-targeting regime, experiencing default, or moving to the fiscally-led regime. To capture the idea of a cosmetic default, we assume that, after a default, the economy goes back to the crisis regime, in which fiscal policy is not behaving in a way consistent with long-run fiscal sustainability. If instead policymakers move to the fiscally-led regime, they are expected to remain in such regime for at least the whole remaining duration of the high-spending period. Once spending becomes low, policymakers move back to the exchange-rate regime with 1 percent probability. When spending is low, policymakers never deviate from the exchange-rate regime if they were following such regime in the past. Finally, policymakers move immediately to the exchange-rate-targeting regime if a change from high to low spending just occurred and they were not following the fiscally-led regime.

1.5 Calibration

We calibrate the model by using Chilean data whenever possible. A full estimation of the model using Chilean data proved challenging because of data availability, especially when it comes to fiscal aggregates. Nevertheless, we consider a full estimation exercise as an interesting direction for future research.

The calibration of the model is summarized in table 2. We assume a small Frisch elasticity of labor supply by setting $\varphi = 4$. We also tried $\varphi = 2$, with no significant change in the results. We set the trade-price elasticity to 1.5 and we assume $\omega = 0.28$, a value in line with the average export-to-GDP ratio of Chile for the post-1970s period. We set $\gamma = 11$ implying a 10 percent steady-state markup. We choose a moderate steady-state debt-to-GDP ratio: 50 percent.

For the policy parameters, we follow the work of Bianchi and Melosi (2017a), and Bianchi and Ilut (2017), who estimate policy rules for the United States. For the parameter controlling the response of taxation to debt, we set $\delta_{b,\xi_t^p} = .07$ under passive fiscal policy and $\delta_{b,\xi_t^p} = 0$ under active fiscal policy. Passive monetary policy is obtained by setting $\phi_{\pi,\xi_t^p} = .68$; while active monetary policy is obtained with $\phi_{\pi,\xi_t^p} = .5$. We also studied specifications in which the central bank reacts to inflation or nominal depreciation of the exchange rate under the active fiscal rule. The results are qualitatively in line with what is presented below.

1.6 Solving the MS-DSGE Model

The model can be solved with any of the solution methods developed for Markov-switching DSGE models. We use the solution method of Farmer and others (2009). It is worth emphasizing that, in our model, agents form expectations while taking into account the possibility of regime changes. They understand that, when spending is high, policymakers might deviate from the exchange-rate-targeting regime and that this might trigger a default or a switch from the exchange-rate-targeting regime in favor of the fiscally-led regime. In other words, our approach allows us to model recurrent crises and defaults and to capture the impact of different exit strategies for policymakers' behavior during a crisis. The solution can be characterized as an MS-VAR:

$$S_t = c\left(\xi_t, \theta, \mathcal{P}\right) + T\left(\xi_t, \theta, \mathcal{P}\right) S_{t-1} + R\left(\xi_t, \theta, \mathcal{P}\right) Q\left(\theta^v\right) \varepsilon_t \tag{6}$$

where θ, θ^v, and S_t are vectors that contain the structural parameters, the stochastic volatilities, and all the variables of the model, respectively. The appendix provides more details about the linearization and the solution algorithm.

The behavior of the economy at each point in time depends on the structural parameters (θ), the regime in place (ξ_t), and the probability of moving across regimes ($\mathcal{P}$). Thus, the properties of one regime depend not only on the structural parameters describing that particular regime but also on what agents expect is going to happen under alternative regimes and on how likely it is that a regime change will occur in the future. In other words, agents' beliefs about future regime changes matter for the law of motion governing the economy.

2. Results

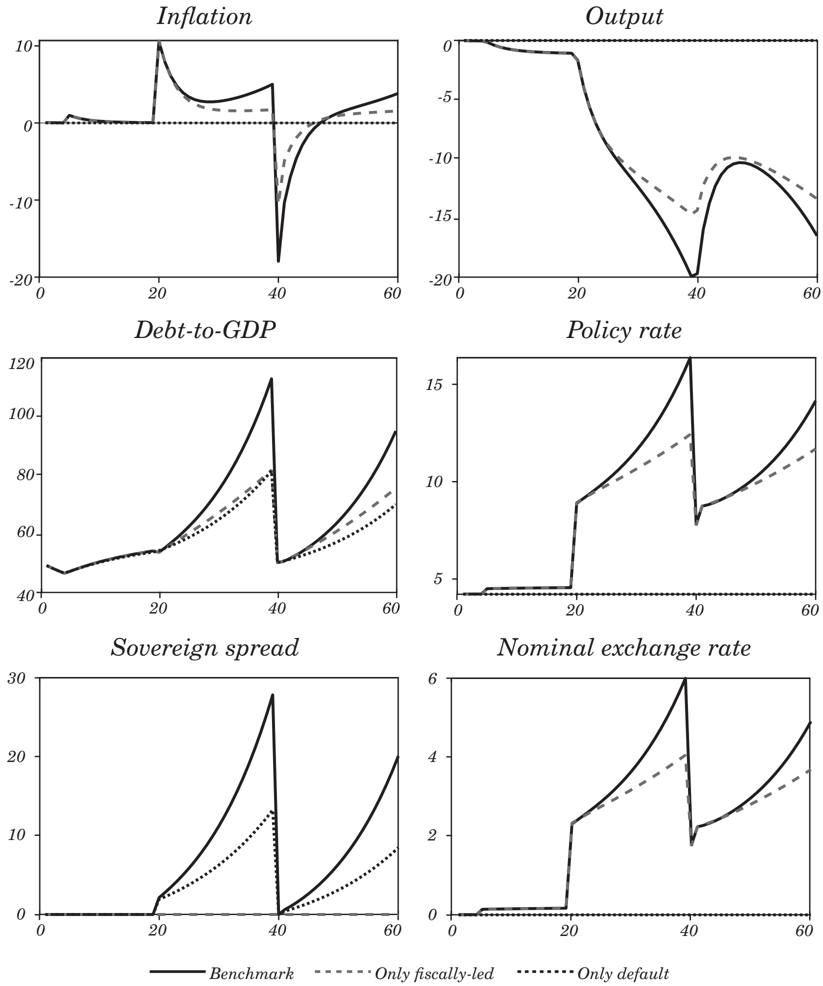
In what follows, we present a series of results based on the benchmark calibration presented in table 2. We start by discussing the implications of the fiscal authority deviating from fiscal discipline. This leads to a sovereign debt crisis. We argue that a cosmetic default does not represent a solution to the crisis. In subsection 2.2, we show that fiscal inflation is always present, even when the economy is following the exchange-rate-targeting regime, because agents anticipate the possibility of future deviations. Consistently with this result, we discuss how a sovereign crisis can arise as a result of a loss of confidence about future fiscal policy. Finally, we discuss when default is more likely to resolve a sovereign debt crisis.

2.1 Sovereign Crises and Cosmetic Defaults

We start by considering a sovereign crisis triggered by a deviation from fiscal discipline. This is a useful exercise because many of the results that will follow can be understood in light of the findings presented here. We consider the following simulation. At time zero, spending is low and policymakers follow the exchange-rate-targeting policy mix. In period 3, the economy moves from the low-spending regime to the high-spending state. Initially, policymakers keep following the exchange-rate regime. In period 20, the fiscal authority starts deviating from passive fiscal policy, while the monetary authority remains committed to stabilizing the exchange rate. As explained above, this corresponds to the crisis regime because both authorities are implementing active policies and such situation cannot continue indefinitely, given that the economy is on an explosive path. In period 40 the economy goes into default and then returns to the crisis regime until the end of the simulation.

Figure 1 reports the results for the benchmark model (solid line) and for two alternative specifications that are useful to understand the key mechanisms at play. These alternative specifications imply the same sequence of events, but different agents' beliefs about the way the crisis is going to be resolved. In the first counterfactual scenario (dashed line), agents expect that the crisis regime can only be followed by a return to fiscal discipline or to a shift to the fiscally-led regime. Note that in this scenario, default comes as a surprise. In the second alternative scenario (dotted line), agents expect that the crisis can only be followed by a return to fiscal discipline or default. In other words, agents attach zero probability to a shift to the fiscally-led regime.

Figure 1. Fiscal Inflation and Cosmetic Defaults



Source: Author's research.
The figure reports three simulations based on the same sequence of events but under different assumptions about agents' beliefs. We start the simulation assuming that spending is low and that policymakers follow the exchange-rate-targeting policy mix. In period 3, the economy moves from the low-spending to the high-spending state. Initially, policymakers keep following the exchange-rate regime. In period 20, the fiscal authority starts deviating from passive fiscal policy, while monetary remains active. Therefore, the economy enters the crisis regime. In period 40 the economy goes into default and then returns to the crisis regime until the end of the simulation. Three alternative scenarios about agents' beliefs are considered. The first scenario (solid line) corresponds to the benchmark model in which agents expect that a crisis can lead to both default and a switch to the fiscally-led regime. In the second scenario (dashed line), agents expect that the crisis regime can only be followed by a return to fiscal discipline or to a shift to the fiscally-led regime. Note that, in this scenario, default comes as a surprise because agents form expectations thinking that this event will not occur. In the third and last scenario (dotted line), agents expect that the crisis can be only be followed by a return to fiscal discipline or default.

We shall start with the benchmark case. As soon as policymakers increase spending, the economy slightly slows down and inflation experiences a modest increase. As studied in detail in the next subsection, this is because now that spending is high, agents attach a larger probability to the possibility of a change in policy. However, these effects are modest when compared to the consequences of a deviation from fiscal discipline that implies a conflict between the monetary and fiscal authorities. Once the fiscal authority starts deviating from the passive rule, inflation jumps because agents understand that the possibility of moving to the fiscally-led regime just went up. At the same time, agents take into account the possibility of a default and this leads to an increase in the sovereign spread and a faster debt accumulation. Agents understand that under the fiscally-led regime the fiscal burden is relieved via an increase in inflation and a large depreciation. This creates inflationary pressure and a nominal depreciation. The central bank acts against the depreciation of the currency by increasing the short-term interest rate, causing a recession and a real appreciation.

These dynamics gain momentum as more time is spent in the crisis regime. The output loss is large and increasing over time. This spiral of debt accumulation and increasing output losses persists until the economy enters default. Default determines a temporary recovery in the economy because it lowers the inflationary pressure stemming from the existing fiscal burden. However, given that after the default the economy returns to the crisis regime, the recovery does not last, the debt-to-GDP starts increasing again and so does inflation. In other words, the economy experiences a *cosmetic default*: a drop in the fiscal burden that does not resolve the actual cause of the sovereign crisis and a lack of coordination between the monetary and fiscal authorities.

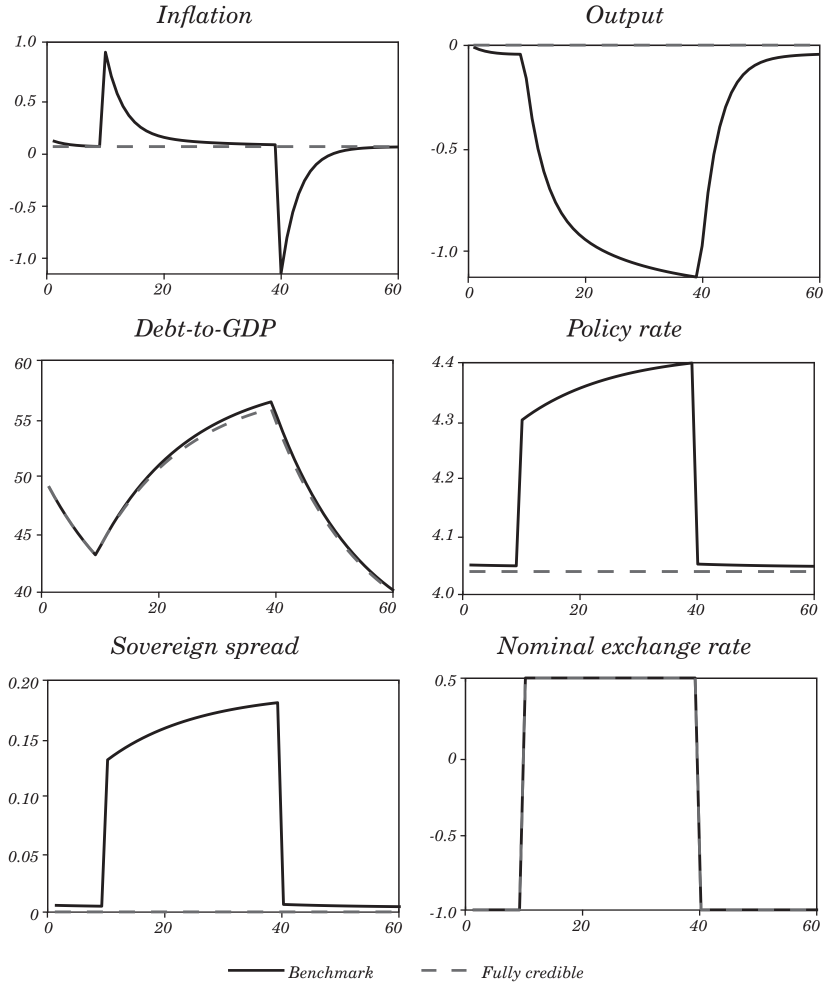
To understand the interaction between the possibility of moving to the fiscally-led regime and default, it is useful to analyze the behavior of the economy in the two alternative scenarios presented in figure 1. We start by considering the “only-default” case, in which agents believe that the conflict between the two authorities can lead to default, but not to a switch to the fiscally-led regime (dashed line). In this case, there is no drop in output or increase in inflation. This is because, in this model, default in itself is not costly. From the agents’ point of view, Ricardian equivalence holds: a default comes with an equal reduction in the future fiscal burden. We could easily introduce an exogenous cost of default as done in the sovereign-debt literature but, for the mechanism that we aim to highlight here, such change would not make a difference. What matters is that default implies a faster debt accumulation because of the increase in the sovereign spread. The larger spread, in turn, reflects the size of the eventual default that keeps increasing with time.

Now we shall consider the "only-fiscally-led" case, in which agents believe that the crisis cannot result in a default, but only in a switch to the fiscally-led regime. As before, high spending with no fiscal adjustment implies debt accumulation. However, now the large debt accumulation translates into stagflation because the expectation of moving to the fiscally-led regime implies inflationary pressure and a nominal depreciation. The central bank tries to contrast the devaluation, with a consequent increase in real interest rates. This contributes to further debt accumulation in a way similar to what is shown in Bianchi and Melosi (2017a). Note that because agents do not anticipate the possibility of a default, there is no increase in the sovereign spread. Thus, while the increase in the debt-to-GDP ratio is similar in magnitude to the previous case, the mechanism is quite different. In the only-default scenario, the increase is driven by the lack of fiscal adjustment and the increase in the sovereign spread. In the only-fiscally-led scenario, the increase is driven by the fall in output and the lack of fiscal adjustment.

In the "only-fiscally-led" scenario default comes as a surprise. Like in the benchmark scenario, default implies a partial relief in output dynamics because the amount of debt that needs to be stabilized is largely reduced. The drop in inflation is not large enough to bring the price level back to its pre-crisis value. This explains why the exchange rate and output do not jump back to their pre-crisis values. In a sense, the losses experienced during the crisis have memory, despite the fact that default brings the debt-to-GDP ratio back to its steady-state value. Intuitively this happens because the initial inflationary pressure was driven by a stock of debt that was large with respect to a larger GDP. The drop in the debt-to-GDP ratio removes part of the inflationary pressure, but with respect to a smaller level of output. Finally, even in this second alternative scenario, the default is just cosmetic. It does not resolve the underlying fiscal issues. Stagflation resumes after a short period of time, as the debt-to-GDP ratio starts increasing again.

We are now ready to understand how default and the possibility of moving to the fiscally-led policy mix interact with each other. Output losses are visibly larger in the benchmark case when compared to the only-fiscally-led case. This is because the possibility of default leads to larger debt accumulation as a consequence of the increase in the sovereign spread. Thus, while default in itself is not costly in this model, the possibility of default is. Furthermore, not only are output losses larger, but also the crisis accelerates over time. This can be seen both in the dynamics of inflation and output. Inflation, instead of stabilizing on a higher value as in the only-fiscally-led case, presents a hump shape. Symmetrically, the output loss increases with an accelerating pace. Thus, the lack of a clear resolution to the debt crisis leads to increasingly larger output losses as debt keeps growing at an increasing rate.

Figure 2. The Effects of High Spending during Regular Times



Source: Author's research.
The figure considers a simulation in which policymakers always follow the exchange-rate-targeting policy mix and spending moves from low to high (in period 10) and back from high to low (in period 40). The simulation is conducted for the benchmark model in which policy changes can occur (solid line) and for an alternative model in which the exchange-rate-targeting regime is assumed fully credible and always in place.

The current framework could be extended in a number of directions. For example, while short-lasting deviations from fiscal responsibility might not be problematic, prolonged deviations might lead to a progressive deterioration in agents' beliefs about the effective ability of policymakers to implement the necessary fiscal adjustments in a way similar to what is studied in Bianchi and Melosi (2013). Such framework would lead to a progressive deterioration of agents' confidence about future policymakers' behavior as opposed to jumps as modeled in this paper. However, the key message of the paper would not change: Lack of coordination between the monetary and fiscal authorities lead to stagflation and the possibility of sovereign debt crises.

2.2 Output Losses from Fiscal Inflation

As a second exercise, we focus on the behavior of the economy when no crisis occurs but agents understand that high spending might trigger a crisis in the future. For example, agents might think that political pressure might prevent the high level of taxation necessary to finance the larger spending level. We consider the benchmark model and an alternative calibration in which agents are fully confident that policymakers will always behave according to the exchange-rate-targeting regime. In other words, the exchange-rate-targeting regime is the only possible policy mix and it is therefore perceived to be in place for the infinite future. We call this scenario fully credible exchange-rate targeting. It is worth mentioning that this corresponds to a traditional small open economy DSGE model with fixed coefficients in which the monetary authority targets the exchange rate.

Figure 2 shows the behavior of the main variables as the economy moves between low spending and high spending. Under the benchmark scenario, when the economy enters a period of high spending, agents understand that the probability of policymakers deviating from the exchange-rate-targeting regime just went up. This causes inflationary pressure and a nominal depreciation. The central bank increases the policy rate to counteract the depreciation. This results in a recession and a real appreciation. Note that policymakers are still following the exchange-rate-targeting regime. Stagflation is driven by the expectation that a crisis might occur in the future. To see this, note that under the alternative scenario in which the exchange-rate-targeting regime is fully credible, Ricardian equivalence holds and we do not see any effect of the change in spending on the real economy.

The effects of the risk of entering a crisis are asymmetric. When spending is low, output is still below trend. This is so because of two reasons. First, agents do not expect policymakers to abandon the regime when spending is low. Thus, there is no deflationary pressure that the central bank might try to counteract by lifting the economy. Second, agents are forward-looking and they anticipate the poor economic performance associated with high spending. Thus, unlike most models studied in the literature, fiscal inflation is not neutral, in the sense that we never have beneficial effects on real activity arising from fiscal inflation if the central bank remains committed to stabilizing the exchange rate (or any other active monetary-policy rule). This result derives from the realistic assumption that policymakers have incentives to deviate from active fiscal stabilization only when spending is high, because high spending requires increasing taxation. Thus, policy uncertainty leads to both a more volatile environment and output losses. On the one hand, the economy is not insulated with respect to fiscal imbalances. On the other hand, fiscal imbalances do not act symmetrically. Summarizing, even when no crisis occurs, the lack of a fully credible commitment to the exchange-rate regime represents a drag on the economy. To insulate the economy from fiscal disturbances, policymakers need to keep the level of spending under control or provide credible plans for how high spending will be financed.

2.3 Confidence Crisis

The previous section has shown that the current framework is able to generate inflationary pressure even when policymakers implement a passive fiscal policy. Agents take into account the possibility that when spending is high policymakers might eventually abandon the necessary policy of high taxation. In this section, we go one step further and show that a sovereign crisis with large increases in inflation can occur even when fundamentals are strong as a result of a shift in agents' beliefs.

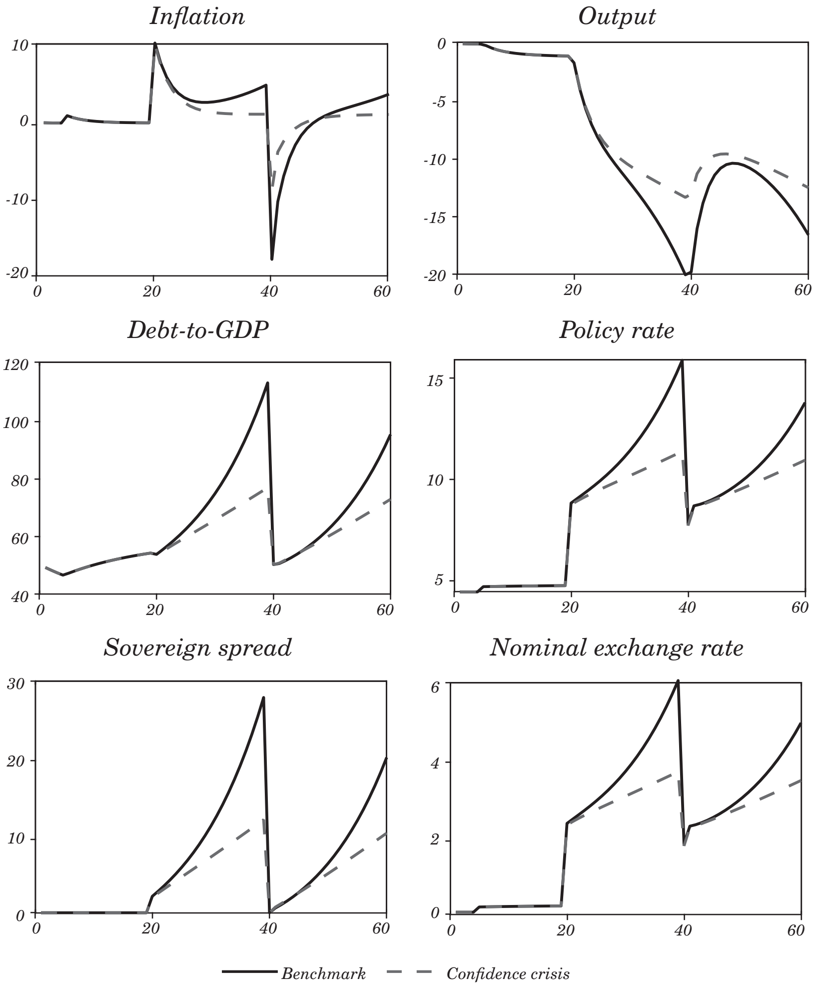
In order to do so, we modify the benchmark model in a parsimonious way. We assume that during the crisis regime, the behavior of policymakers is unchanged with respect to the exchange-rate-targeting regime, whereas agents' beliefs about future policies experience the same change assumed in the benchmark model. This implies that the expectations of a default or of a switch to the fiscally-led regime present a discrete jump as in the benchmark model despite the fact that policymakers' behavior is unchanged. How should we interpret this scenario? In the benchmark model, agents become more pessimistic about long-run fiscal sustainability because of a change in the current fiscal stance. However, in reality, agents' expectations about future fiscal developments can change even as a result of announcements, news, or political events such as a change in the ruling party. Countries around the world present a plethora of such situations: A new party wins the elections and spreads jump to reflect markets' expectations about the policies that such party is expected to implement.

Figure 3 revisits the benchmark simulation of subsection 2.1 under these modified assumptions. The solid line corresponds to the benchmark case studied before. The dashed line considers the alternative scenario in which the crisis originates from a lack of confidence with respect to future fiscal behavior, without a change in current policymakers' behavior. As in the benchmark case, entering the crisis determines a large jump in inflation and an immediate depreciation. The real exchange rate appreciates as a consequence of the high inflation. As in the benchmark case, the high spread and the contraction in real activity determine a large accumulation of debt. This is despite the fact that policymakers are actually increasing the level of taxation as the debt-to-GDP ratio increases. Policymakers' actions are not enough to prevent the increase in debt, but they are able to prevent the explosive dynamics observed under the benchmark case. Thus, there is no acceleration in the downward spiral of large debt accumulation and stagflation dynamics.

The fact that a crisis can arise from lack of confidence about long-run fiscal sustainability highlights the importance of policymakers' communication. The key mechanism is similar to what we illustrated for the benchmark model: If agents start expecting that a switch to a fiscally-led regime will be implemented eventually to curb the fiscal burden, inflationary pressure arises today. In this situation, monetary-policy interventions prevent a full depreciation of the nominal exchange rate, thus causing a real appreciation and a recession.

Interestingly, this exercise shows that an economy can end up in a situation in which debt keeps increasing despite the fact that stabilizing fiscal policies are in place. This is important because the level of taxation necessary to prevent accelerating increases in the debt-to-GDP ratio can become very large. In this model, there is no explicit feedback from the level of taxation to the switch to fiscally-led regime. But in reality, high levels of taxation might be politically unsustainable and lead to a switch to the fiscally-led regime, thus making the initial deterioration in confidence self-fulfilling.

Figure 3. The Effects of a Confidence Crisis



Source: Author's research.

The figure compares a sovereign debt crisis under the benchmark model (solid line) with an alternative scenario in which the crisis is triggered by loss of confidence about future policymakers' behavior (dashed line). Spending is initially low and policymakers follow the exchange-rate-targeting policy mix. In period 3, the economy moves from the low-spending to the high-spending state. Initially, policymakers keep following the exchange-rate regime and agents are confident that they will keep doing this in the future. In period 20, agents become pessimistic about future policymakers' behavior and expect that a default or a switch to the fiscally-led regime might occur in the future. Thus, the economy enters the crisis regime. In period 40, the economy goes into default and then returns to the crisis regime until the end of the simulation. In the benchmark scenario, policymakers deviate from fiscal stabilization, while in the confidence crisis policymakers keep following the same rule.

2.4 When a Default can Resolve a Crisis

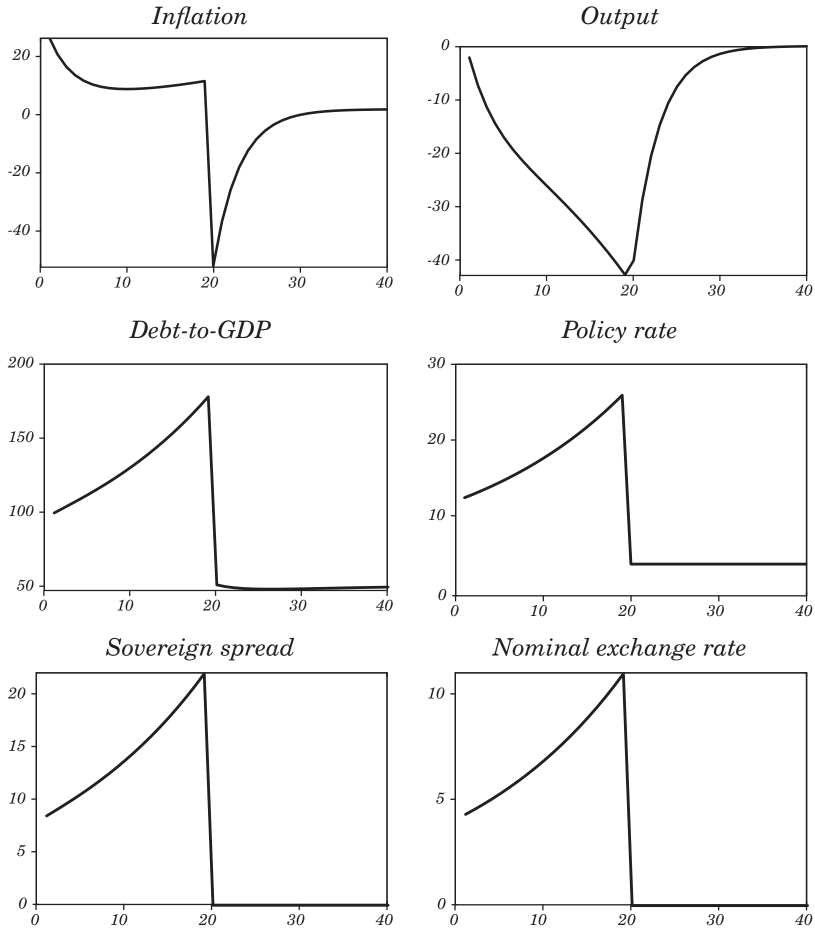
In this section, we discuss when a default is more likely to resolve a sovereign debt crisis. Intuitively, a default can facilitate a resolution of a sovereign debt crisis if the original sin that led to the crisis is not related to future policymakers' behavior. Moreover, as we argued above, a default cannot be the solution to the fiscal burden arising from future fiscal developments. Thus, a default is more likely to pave the way to fiscal discipline if the reason why the economy entered a sovereign debt crisis is related to an exogenous exceptional event, such as an unusually large recession or a rare disaster. Admittedly, the occurrence of one of these circumstances is not common. Nevertheless, it is instructive to review this thought experiment.

To capture this idea, we modify the benchmark model in the following way: We assume that the economy is currently in a sovereign debt crisis with a large stock of debt (100 percent of GDP). From the crisis regime, the economy can move to the fiscally-led regime, in which case the stock of debt will be stabilized with inflation, or enter default and then move to the exchange-rate-targeting regime, in which case default will be used to erase the fiscal burden. We do not explicitly model what caused the large debt accumulation in the first place because it is not relevant for the results discussed below. What is instead important is that we remove the persistent shocks to government spending and the possibility of moving away from fiscal discipline once the economy enters the exchange-rate-targeting regime. These changes are supposed to capture the idea that there is no systemic problem of long-run fiscal sustainability, but rather a contingent issue caused by the exceptionally large stock of debt. Summarizing, the transition matrix controlling regime changes is now given by:

$$\mathcal{P} = \mathcal{P}^p = \begin{array}{c|cccc} & E & C & D & F \\ \hline E & 1 & & 1 & 0 \\ C & & .96 & & \\ D & & .02 & & \\ F & & .02 & & 1 \end{array}$$

Note that both the exchange-rate-targeting regime and the fiscally-led regime are now absorbing states and that we do not have discrete shocks to spending anymore. Once the current crisis is resolved, the economy will remain in one of the two absorbing regimes and no further crises will arise.

Figure 4. Non-Cosmetic Defaults



Source: Author's research.
We consider a case in which the economy is currently in a sovereign crisis due to a large debt accumulation that occurred in the past, as opposed to a systematic fiscal issue. From the crisis regime the economy can move to the fiscally-led regime or to the default regime and from there to the exchange-rate-targeting regime. The economy experiences default in period 20 and then moves to the exchange-rate-targeting regime.

Figure 4 presents the results for a simulation in which the economy inherits a large stock of debt (100 percent of GDP) and for the first 20 quarters the economy is in the crisis regime. As before, this means that the fiscal authority refuses to make the necessary fiscal adjustments, while the monetary authority insists on a stable exchange rate. During the crisis period, the economy behaves in a way that is very similar to what was described before. The possibility of moving to the fiscally-led regime creates inflationary pressure that the central bank tries to counteract to avoid a depreciation of the exchange rate. Once again, the economy enters a spiral of inflation, contractions in real activity, and further debt accumulation. In period 20, the economy enters default and then moves to the exchange-rate-targeting regime. Unlike the benchmark scenario studied above, now when the economy enters default, the spiral of stagflation and debt accumulation ends. This is because in this case the economy does not just experience a cosmetic default. Instead, the default paves the way to a shift to the exchange-rate-targeting regime. The sovereign spread goes to zero, debt jumps to its steady-state value, and the economy progressively recovers.

What about a shift to the fiscally-led regime? In this case, such regime change might be perceived as very costly. First, such shift implies abandoning the exchange-rate target. Furthermore, a shift to the fiscally-led regime makes the economy more volatile. In the future all fiscal disturbances will affect the macroeconomy, while under the exchange-rate-targeting regime the macroeconomy is insulated against fiscal disturbances. Bianchi and Melosi (2017b) discuss how these issues can be circumnavigated by implementing a shock-specific rule that boils down to generating enough inflation to stabilize the existing stock of debt without affecting future fiscal discipline. However, if policymakers lack the ability to communicate a credible plan for future inflation and debt stabilization, default might be the only remaining option.

The analysis here is simplified in a number of dimensions. In practice, it can be hard to establish whether the current fiscal situation is in fact the result of a purely exogenous event. Furthermore, a default might create expectations of future defaults, while here we assume that, once the existing stock of debt is stabilized, no further fiscal imbalances arise. Finally, as mentioned repeatedly in the paper, default is not costly in this model. Nevertheless, the simple simulation presented here presents a case in which a country might prefer default over moving to a fiscally-led regime. Changing the policy mix implies a persistent shift in agents' expectations about future policymakers' behavior. In fact, a switch to the fiscally-led regime works in curbing the fiscal burden only if it is perceived to be very persistent. Instead, default does not require a change in expectations about future policymakers' behavior.

3. The Chilean Experience

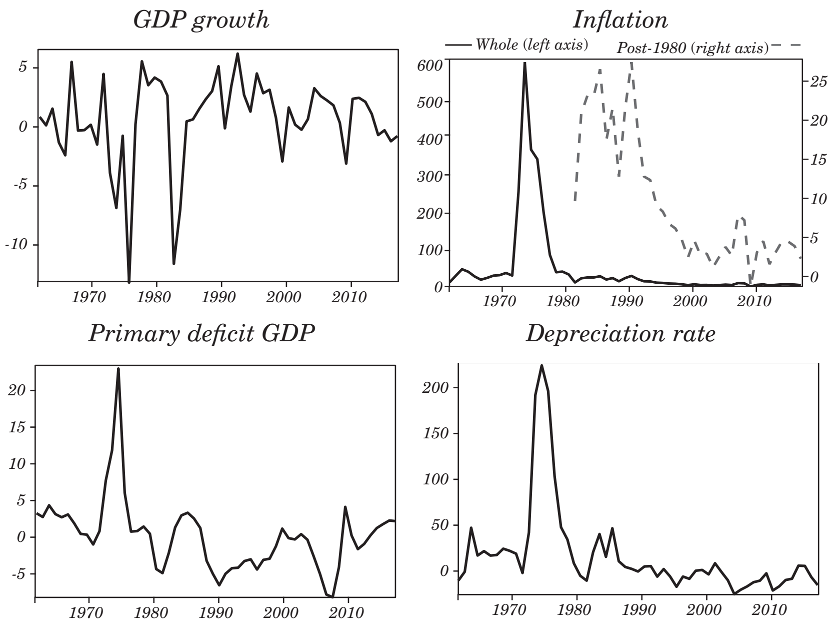
In this section, we review some key moments of the Chilean economic history and explain how they can be mapped into the model presented above. Caputo and Saravia (2018), whom I use as main reference here, provide a more comprehensive exposition of Chilean economy history. A full estimation of the model proved challenging due to data availability and because the model is to some extent stylized. However, as we shall see, the model can still be useful to interpret different moments of Chilean economic history.

As guidance for our discussion, figure 5 reports GDP growth, inflation, primary deficit-to-GDP ratio, and the depreciation rate against the dollar. All data are at annual frequency and expressed in percentage points. For inflation, we report the series for the whole sample (solid line and scale on the left axis) and for the post-1980s period (dashed line and scale on the right axis) to facilitate the analysis for the post-1980s period, given that the hyperinflation of the 1970s is an order of magnitude larger than what was experienced over the rest of the sample. We cover the period from 1960 to 2018.

From fiscal inflation to fiscal hyperinflation (1960–1973) The Chilean economy had been struggling with the problem of controlling high inflation rates since before the period considered in this paper. Quite interestingly, this was not because of a lack of understanding about the origins of inflation. Already in 1955, the consulting firm Klein-Saks had brought to the attention of the government the tight connection between high fiscal deficits and inflation. In the late 1950s, Alessandri's administration tried to remedy these issues by introducing fiscal adjustments and a fixed exchange-rate regime. These policies were initially successful in lowering inflation to single digits, but the success did not last. Already in the early 1960s, primary deficits jumped back to values around 3 percent of GDP, thus creating significant inflationary pressure. Consistently with the predictions of the model, lack of credibility about the commitment to fiscal discipline makes a fixed exchange rate unsustainable. Thus, following a balance of payments crisis, the fixed exchange rate was abandoned.

Frei's administration took over in 1964 and started implementing a vast series of reforms. The administration took a pragmatic approach to the goal of curbing inflation. From a fiscal point of view, deficits were progressively reduced. Accordingly, inflation started drifting down. However, the adjustment eventually failed in part because of a policy of constant devaluation that put upward pressure on inflation, as shown in the lower-right panel of figure 5. In other words, the nominal anchor represented by the nominal exchange rate was abandoned and not adequately replaced by an alternative one. As explained by Caputo and Saravia (2018), extraordinary transfers, defined as additional obligations not accounted in the central government primary deficit, kept increasing over this period. These extraordinary transfers represent an additional fiscal burden and create inflationary pressure. As a result of the hyperinflation, the peso experienced a very large devaluation.

Figure 5. Chilean Macroeconomic Data



Source: Author's research.
The figure reports the growth rate of GDP per capita, inflation, the primary deficit-to-GDP ratio, and the depreciation rate of the Chilean peso against the U.S. dollar. All variables are computed at annual frequency and expressed in percentage points. For inflation, we report the series for the whole sample (solid line and scale on the left axis) and for the post-1980s period (dashed line and scale on the right axis) to facilitate the analysis for the post-1980s period, given that the hyperinflation of the 1970s is an order of magnitude larger than what was experienced over the rest of the sample.

It is well known that the period that followed was one of great political instability. President Allende took office in 1970 and his administration ended in 1973 following a military coup. Allende's administration implemented an aggressive fiscal expansion. The primary deficit reached unprecedented levels. Initially, the fiscal expansion led to an increase in output with no significant increase in inflation. This was in part due to price controls. However, the successive acceleration in fiscal deficits led to hyperinflation. In 1973, the primary deficit-to-GDP ratio reached 23 percent, and inflation took off and reached a staggering 600 percent. This also came with a contraction in output, consistently with what was shown before. However, it is important to keep in mind that this was a period of great turmoil. This implies that some of the output losses experienced during these years cannot be captured by a simple economic model that abstracts from the consequences of a severe political conflict.

Ending hyperinflation (1974–1981) General Pinochet took power in September 1973 after a military coup. Pinochet's administration implemented a stabilization policy. Note that the primary deficit-to-GDP ratio declined abruptly from 22.5 percent of GDP in 1973 to a 0.4 percent in 1975. The result was accomplished by a combination of cuts to transfers and tax increases. The government also proceeded to liberalize the prices that were previously regulated. Despite the change in the conduct of fiscal policy, inflation remained extremely high. The fact that the change in fiscal stance did not immediately lead to a drop in inflation can be interpreted in light of the results of subsection 2.3: High inflation can arise despite the current fiscal stance if agents are not confident about future fiscal interventions. The high levels of inflation persisted even though the economy experienced a large contraction due to external shocks and fiscal consolidation. In the model, a large recession induces inflationary pressure by increasing the fiscal burden as a result of the increase in the debt-to-GDP ratio.

In the late 1970s, the effort on the fiscal side was combined with a change in the conduct of monetary policy. The goal was to provide a nominal anchor for inflation expectations. Specifically, the central bank started targeting a known devaluation rate and eventually moved to a fixed exchange-rate target regime in June 1979. In the context of the model presented above, such change indicated a shift to active monetary policy, while the policy of primary surpluses indicated a change to passive fiscal policy. Thus, the economy effectively moved to an exchange-rate-targeting regime that then morphed into a fixed exchange-rate regime. The change in the policy mix led to a stabilization of inflation, that in 1981 fell to a single digit value (9.53 percent). Importantly, and consistently with the model, the stabilization of inflation involved a change in both monetary and fiscal policy. By 1980, the government was running a large primary surplus.

Debt crisis and its aftermath (1982–1988) The fixed exchange-rate regime came to an abrupt end in the early 1980s. A fixed exchange rate implies tieing domestic monetary policy to foreign monetary policy. In the early 1980s, President Reagan provided the necessary political support for the Fed Chairman Paul Volcker to engineer a drastic change in the conduct of monetary policy. A prolonged period of low real interest rates came to an end. Bianchi and Ilut (2017) interpret these events in light of a shift in the monetary-fiscal policy mix in the United States. This change had severe repercussions on the world economy, with a sharp increase in world interest rates. Chile, like many other countries around the world, found itself in a difficult situation, and expectations about the sustainability of the fixed exchange rate suddenly shifted. As in the model, such shift in expectations contributed to an economic slowdown and an increase in inflation. The fixed exchange-rate regime was abandoned in 1982.

The Chilean government moved quickly to rescue the banking sector that had contracted obligations in U.S. dollars. Even if these interventions were operationally conducted by the central bank, the policies were actually sustained by the fiscal authority. The implied increase in the fiscal burden created inflationary pressure. As argued above, in this situation a cosmetic default would not be able to solve the financial crisis. Instead, the possibility of a cosmetic default exacerbates the vicious circle of stagflation and debt accumulation arising from the crisis. In light of this result, it is extremely interesting that the Chilean government moved forcefully in the direction of removing default as a possible outcome of the crisis. A very rigid and unpopular fiscal plan was put into place to sustain the cost of rescuing the private sector. These policies, even if not popular, were arguably better suited to deal with the underlying cause of the inflationary pressure and created the basis for the subsequent conquest of inflation. Nevertheless, until the early 1990s, inflation remained high, in part reflecting policy uncertainty linked to the return to democracy in 1989.

The conquest of Chilean inflation (1989–2018) The governments that followed the return to democracy maintained a conservative fiscal stance, with a sequence of primary surpluses meant to pay the obligations contracted by the government to cover the losses of the private sector in the early 1980s. This conservative fiscal policy was combined with an exchange-rate-targeting policy implemented by a now independent central bank (1989). The two policies led to a progressive reduction of inflation, consistently with the implications of a monetarily-led policy mix.

The Asian crisis came to challenge the sustainability of the exchange-rate-targeting regime. Thus, in September 1999, the central bank moved to an inflation-targeting regime. Note that this regime, if combined with a low-inflation target, effectively delivers exchange-rate stability without the constraints of a formal exchange-rate-targeting regime. Importantly, while the central bank was undergoing this transition, the fiscal authority implemented an equally important change. The government introduced a fiscal rule meant to stabilize spending over the business cycle and guarantee long-run fiscal sustainability. The rule implies that the government runs primary surpluses during expansions and use the corresponding savings to mitigate recessions.

As predicted by the model, a now independent central bank was able to attain stable inflation at the moment the fiscal authority provided the necessary fiscal backing. Furthermore, the exchange rate has been quite stable over the past twenty years, despite the fact that the central bank is not explicitly targeting it. This suggests that an inflation-targeting monetary-policy rule can be quite successful in delivering a stable exchange rate. In fact, inflation targeting might be better suited to achieve a stable exchange rate given that it is a more flexible policy regime. Countries often choose an exchange-rate monetary rule to acquire credibility. But, as shown in this paper, such policy can quickly become unsuccessful if not supported by a credible fiscal policy. The experience of Chile confirms that a stable macroeconomic environment requires coordination between the monetary and fiscal authorities.

4. Conclusions

In this paper, we studied the interaction between the monetary and fiscal authorities in a small open economy in presence of default. Fiscal inflation arises whenever the commitment of the fiscal authority to stabilize debt is not fully credible. Deviations from fiscal discipline can arise from various events. For example, an unusually large recession might limit the ability or willingness of the fiscal authority to raise large primary surpluses. We decided to focus on a situation in which fiscal inflation stems from high levels of spending. This is arguably a situation that has been relevant for several countries at different points in time. Unlike the case in which fiscal inflation arises from an exceptional event, this scenario is likely to lead to prolonged and repeated periods of economic and financial turmoil because the roots of fiscal inflation are systemic.

We discussed that if the fiscal authority deviates from fiscal discipline and the central bank tries to rein in inflation and a devaluation, the economy enters a sovereign debt crisis characterized by a spiral of debt accumulation, recession, and further debt accumulation. Importantly, a cosmetic default does not represent a solution to the sovereign debt crisis. A cosmetic default is unable to stop the vicious circle of debt accumulation and stagflation because it does not resolve the underlying fiscal issues that are creating inflationary pressure. In fact, the possibility of a cosmetic default exacerbates the vicious circle because it determines an increase in sovereign spreads and, as a result, faster debt accumulation.

The analysis presented in the paper could be extended in a number of directions. First, it would be interesting to go beyond the assumption of complete markets. Removing this assumption would not change the key lessons of the paper, but it would rather make the model more realistic and suitable for a structural estimation. Second, default could be made costly, in a way to account for the fact that countries are reluctant to declare default. This change would arguably reinforce the results of the paper because it would make the role of the fiscally-led regime even more prominent. Third, it would be interesting to explicitly model the feedback from the level of taxation to the probability of moving away from fiscal discipline. Right now the model captures this link by making the probability of moving away from fiscal discipline dependent on the level of spending, but more sophisticated formulations could be considered. Even in this case, the results presented in this paper would still hold, but new interesting results would arise such as self-fulfilling sovereign crises and policy changes.

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Appendix

1. The Model

In this appendix, we present the model equations for the model used in the paper.

A. Nonlinear First-Order Condition

1. Household:

$$\rho_{t,t+1} = \beta\left(\frac{C_{t+1}}{C_t}\right)^{-1}\frac{P_t}{P_{t+1}}.$$

2. Risk-free rate:

$$R_t \equiv \frac{1}{E_t\left[\rho_{t,t+1}\right]}$$

3. Risk-sharing:

$$\frac{C_t}{C_t^*} = \upsilon Q_t = \frac{\upsilon P_t^* \chi_t}{P_t}$$

where $\upsilon = \left(\frac{C_{-1}}{C_{-1}^*}\right)\left(\frac{P_{-1}}{\chi_{-1}P_{-1}^*}\right)$ reflects initial conditions and it is normalized to 1.

4. Labor supply:

$$\frac{W_t}{P_t} = \frac{C_t}{N_t^{\varphi}}$$

5. Taylor rule:

$$R_t = \beta^{-1}\Pi_{H,t}^{\phi_{\pi,\xi_t^p}} E_t^{\phi_{e,\xi_t^p}}$$

6. Government budget constraint as in Bianchi-Ilut:

$$I_t^{-1}B_t = B_{t-1}\left(1-D_t\right) - T_t + S_t$$

where S_t is a spending shock with mean zero.

7. Fiscal rule in terms of debt-to-GDP (with debt at market value):

$$\tau_t - \tau = \delta_b \left(\frac{I_{t-1}^{-1} B_{t-1}}{Y_{t-1} P_{t-1}^H} - \frac{\tau}{\frac{1}{\beta} - 1} \right)$$

$$\tau_t - \tau = \delta_b \left(b_{t-1} - b \right)$$

with $\tau_t = \dfrac{T_t}{Y_t P_t^H}$ and $b = \dfrac{\tau}{\frac{1}{\beta} - 1}$ is the steady-state value of the debt-to-GDP ratio.

B. Linearized Model

The model is linearized with respect to taxes, government expenditure, and debt, whereas it is log-linearized with respect to all the other variables. We obtain a system of equations:

1. Linearized system of equations:

$$y_t = E_t y_{t+1} - \bar{\omega}\left(r_t - E_t \pi_{H,t+1}\right)$$

where $\bar{\omega} \equiv 1 + \omega(2 - \omega)(\sigma - 1)$.

2. New-Keynesian Phillips curve:

$$\pi_{H,t} = \beta E_t \pi_{H,t+1} + \kappa\left(\varphi + \bar{\omega}^{-1}\right) y_t$$

where $\kappa \equiv \dfrac{(1 - \beta\theta)(1 - \theta)}{\theta}$.

3. Real exchange rate and production under complete markets:

$$y_t = \frac{\bar{\omega}}{1 - \omega} q_t.$$

4. Real and nominal exchange rate:

$$q_t = (1 - \omega)\left(e_t - p_{H,t}\right).$$

5. Government budget constraint:

$$b_t = \left(\frac{b}{\beta}\right)\left(i_{t-1} - \pi_{H,t} - d_t - y_t + y_{t-1}\right) + \left(\frac{1}{\beta}\right) b_{t-1} - \tau_t + s_t.$$

where we linearize with respect to the fiscal variables and log-linearize with respect to the other variables. For simplicity, we now use lower case letters x_t to denote linear or log-linear deviations from steady state.

6. Fiscal rule:

$$\tau_t = \delta_b b_{t-1}.$$

7. Sovereign-bond yield:

$$i_t = r_t + E_t d_{t+1}.$$

8. Monetary policy:

$$r_t = \phi_{\pi,\xi_t} \pi_{H,t} + \phi_{e,\xi_t} e_t.$$

9. Default:

$$1_{\xi_t} b_t + \left(1 - 1_{\xi_t}\right) d_t = 0.$$

10. Definition of inflation:

$$\pi_{H,t} = p_{H,t} - p_{H,t-1}.$$

11. Expectation error for inflation:

$$\eta_{\pi,t} = \pi_{H,t} - E_{t-1}\pi_{H,t}.$$

12. Expectation error for output:

$$\eta_{y,t} = y_{H,t} - E_{t-1} y_{H,t}.$$

13. Expectation error for default:

$$\eta_{d,t} = d_t - E_{t-1} d_t.$$

Central Banking with Many Voices: The Communications Arms Race

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Around the world, most central banks set policy by committee. This is motivated in part by the idea that groups reach better decisions than individuals and in part by a desire for representation of different geographical areas and economic constituencies in policymaking. The Bank for International Settlements (2009) documents that across central banks, the median number of members on monetary policy boards is eight. The Federal Reserve and the European Central Bank (ECB) have substantially more decision-makers than the median, with 19 members of the Federal Open Market Committee (FOMC) (of which 12 vote at any given time) and 25 members of the ECB's Governing Council (of which 21 vote at any given time).

An emerging literature recognizes the tension between decision-making by committee and effective monetary-policy communication. I focus my analysis on the Federal Reserve and start from the observation that most policymakers give frequent public appearances or comments to discuss their views of the economy and the appropriate policy response. This is the much lamented "cacophony" of speeches and comments by Federal Reserve officials. Faust (2016) argues that the cacophony can be viewed as a tug-of-war over public sector expectations, with these expectations affecting future policy. He calls

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for game-theoretical work to understand this communications arms race better.[1]

In this paper, I argue empirically and theoretically that the cacophony problem is even worse than commonly appreciated. In particular, the tug-of-war over public sector expectations results not only in a public cacophony of Fed voices but also in a "quiet cacophony" of Fed policymakers seeking to drive market expectations via informal channels, such as the media and market newsletters. I review recent work in asset pricing that documents large asset-price movements at times of Federal Reserve debate and decision-making that are not associated with public Fed communications. The main papers are Lucca and Moench (2015) on the pre-FOMC drift, Cieslak, Morse and Vissing-Jorgensen (2019) on stock returns over the FOMC cycle, and Morse and Vissing-Jorgensen (2019) on abnormal stock returns on days with private interactions (calls/meetings) between Federal Reserve Board governors and Federal Reserve Bank presidents.

I then provide a history of leak discussions in FOMC documents for the period 1948–2013 in order to show that the FOMC itself expresses frequent concerns about leaks. I draw on these leak discussions to understand what motivates leaks. My reading suggests that leaks are often motivated by disagreement between policymakers and are used for tactical advantage in the policymaking process. The attractiveness to the individual policymaker appears to stem from the FOMC's view that prior disclosure about policy to some extent ties the hands of the committee. Therefore, policymakers may seek to advocate for their preferred policy by selectively disclosing internally known information that supports their view—what one could refer to as "spin". Crucially, if advocacy relies on the disclosure of internal (confidential) information (about the views of colleagues, internal projections, etc.), then it must be done via informal channels, such as newspaper and financial-market newsletters, through which the policymakers disclosing the information can remain anonymous and thus unpunishable. To support the claim that advocacy is more effective if supported by confidential information, I review work from the political science literature.

1. Recent speeches by policymakers recognize the difficulty of communicating with many voices. Examples include speeches by Fischer and Powell available at https://www.federalreserve.gov/newsevents/speech/fischer20170303a.htm and https://www.federalreserve.gov/newsevents/speech/powell20161130a.htm.

I use the insights gained from studying FOMC documents to provide a simple game-theoretic model of the communication arms race in order to understand the equilibrium outcome. Consistent with my reading of the FOMC narrative, the model relies on two assumptions. First, policymakers' care about not being viewed as "flip-flopping", in the sense of choosing a policy that differs from prior policymaker guidance about policy preferences. Therefore, providing information about policymaker preferences reduces policy flexibility by creating a loss from setting a policy rate that differs from market expectations formed based on that information. Second, policymakers with access to internal central-bank deliberations are to some extent able to distort (spin) market perceptions of policy preferences. Specifically, given a true average policy preference (known internally to policymakers), any policymaker can advocate for their preferred direction by selectively revealing internal information that supports a claim that the average preferred policy rate is different from the actual one (higher or lower).

If communication reduces flexibility and spin is possible, any given policymaker has an incentive to distort market perceptions about the average policy preference in their preferred direction, because this will tend to move the actual policy rate chosen in this direction. In the model, two policymakers decide what to communicate to the public at an intermediate date between policy meetings. If either of them communicates with the public, policymakers incur a loss if the chosen policy rate deviates from the average preferred policy rate communicated at the intermediate date. As a result, with communication, the chosen policy rate is a weighted average of the average preferred policy rate at the time of the meeting and the markets' perceived average preferred policy rate communicated at the intermediate date. If disagreement is sufficiently strong (judged relative to the amount of news that may arrive before the next policy meeting) and sufficient spin is possible, the unique Nash equilibrium is that each policymaker communicates with their own preferred spin. However, since policymakers seek to drive market expectations in opposite directions, their advocacy cancels each other out. The net effect of communication is to reveal all internal information about average policy preferences. This disclosure reduces the ability to react to information arriving between the intermediate date and the next policy meeting, and results in both policymakers being worse off than they would be if they could each commit to not using informal communication. The model is analog to a prisoners' dilemma in which both prisoners would be better off if neither confessed, but both confess in equilibrium.

The theoretical result that informal communication can lead policymakers to be worse off in equilibrium is consistent with the repeated frustration about leaks expressed in FOMC transcripts. The welfare loss from leaks in the model stems from lost policy flexibility. In addition to concerns about effects on policy flexibility, the FOMC documents reveal policymakers' concern about leaks damaging both the Fed's reputation (as market integrity suffers if some in the market obtain confidential information) and the Fed's decision-making process (as worries about leaks threaten the free give-and-take of ideas that are at the heart of group decision-making). The model focuses on the cost from lost flexibility since this is what induces the temptation to leak. However, the other two costs are potentially equally important from a welfare perspective. For example, the perception that internal divisions lead to inside access of some in the media or markets does not help the Fed's struggle to retain its political independence.

My negative view of the welfare effects of leaks contrasts with the literature on the freedom of the press and the benefits of advocacy. Gentzkow and Shapiro (2008) review this work and cite a key Supreme Court decision: "[The First] Amendment rests on the assumption that the [...] dissemination of information from diverse and antagonistic sources is essential to the welfare of the public." The Fed's use of informal communication is different because public knowledge of internal confidential information is not helpful if it leads to reduced policy flexibility as well as damage to the Fed's reputation and deliberative process. This information is made confidential for good reason.

In the last section of the paper, I discuss what can be done to improve the situation. I argue that the loss in policy flexibility from disclosure of information stems from a lack of understanding by the public of the Fed's policy reaction function. If the public fully understood how the Fed thinks, the Fed would not look less competent if it had to deviate from prior policy projections due to incoming news. One issue that makes it difficult for the public to learn the Fed's reaction function is that there is no single Fed decision-maker. Given the rotation of voting among Reserve Bank presidents, there is not even a stable set of Fed decision-makers. I speculate that reducing the number of policymakers and eliminating the rotation schedule may simplify communication and improve the public's understanding of the Fed's reaction function. This would involve having a subset of the current Reserve Bank presidents vote at all FOMC meetings. In practice, one could envision combining the 12 current Reserve Bank districts into a smaller set of "Super Reserve Banks" who always voted.

1. Evidence on the Importance of Informal Communication

1.1 Review of Work in Asset Pricing

An important paper in the literature on the impact of the Fed on asset prices is Lucca and Moench (2015). The paper documents an average return on the S&P500 of about 50 basis points (bps) in the 24 hours before scheduled FOMC announcements over the period from 1994–2011. They argue that this return is puzzling because no news appears to arrive during this period. They argue against a leak-based explanation because the monetary-policy news coming out would have to be systematically positive and because leaks are "unrealistic from an institutional viewpoint".

Cieslak, Morse and Vissing-Jorgensen (2019) (CMVJ) study the return of the stock market over the full period between FOMC meetings. They document that over the "FOMC cycle", average 5-day stock returns are large not only in the week around the announcement (as Lucca and Moench showed) but also in weeks 2, 4, and 6 after the announcements. They argue based on a series of evidence that the high even-week returns are in fact driven by monetary-policy news, which over the post-1994 period has been positive for the stock market on average and has reached markets via informal communications channels. First, they show that changes to the Fed funds target (rare post 1994 but common before that) tend to take place in even weeks in FOMC-cycle time, which implies that Fed debate and decision-making appears to take place disproportionately at these times. Second, they document that rates on Fed funds futures on average declined in even weeks, consistent with unexpectedly accommodating monetary-policy news. Third, they show that about half of the even-week returns arise due to even-week mean-reversion in the stock market following market declines. This pattern fits a "Fed put" interpretation, where the Fed provides accommodation (or promises accommodation should things get worse) following market declines, with this Fed put being stronger than expected in the post-1994 sample.[2] Fourth, even-week

2. Cieslak and Vissing-Jorgensen (2019) use textual analysis of FOMC minutes and transcripts to understand the economics underlying the Fed put and its emergence in the mid-1990s. They find that the Fed starts to focus more on the stock market in the mid-1990s and that the stock market is viewed as an important driver of consumption and, to a lesser extent, investment.

stock returns are higher following board meetings of the Board of Governors (with even-week meetings more important likely due to the Board having a full fresh set of policy recommendations from the Reserve Banks), consistent with even-week returns being driven by information created and disseminated from the Fed. Finally, CMVJ find that the high even-week returns are robust to controlling for macroeconomic news releases, corporate earnings announcements, and reserve maintenance periods. Their findings imply that unexpectedly accommodating monetary policy has been a central driver of the realized U.S. equity premium over the post-1994 period. In terms of information transmissions channels, CMVJ do not find evidence that Fed information releases or speeches by Fed officials line up systematically with even weeks. They argue instead that information reaches markets via informal communication. While they provide some examples of leaks, by their nature, leaks are difficult to document.

Morse and Vissing-Jorgensen (2019) study detailed calendars of a subset of Federal Reserve governors (including chairs and some vice-chairs). For the period February 2007 to November 2018, the available calendars contain about 29,000 items, with one item reflecting one appointment such as "Meeting with staff" or "Call with FR Bank president". Morse and Vissing-Jorgensen hypothesize that informal communication results from the interaction of policymakers, as will be at the heart of the argument and model below. Over the period studied, the Board of Governors has tended to act as a group, with no dissents by governors. Morse and Vissing-Jorgensen therefore conjecture that interactions between governors and Federal Reserve Bank presidents play an important role in information transmission.[3] They classify calendar items into a set of categories based on the types of individuals and organizations with whom Fed policymakers interact. To assess which types of interactions are perceived as most important by policymakers themselves, Morse and Vissing-Jorgensen regress daily calendar item dummies on the value of VIX on the prior day. If important meetings are scheduled or not canceled in times of market stress, this approach identifies categories of items that are important and flexible in terms of scheduling. Both interactions between governors and Federal Reserve Bank presidents and FOMC

3. Disagreement between Reserve Bank presidents may also matter but is harder to study. Since the Reserve Banks are not government agencies, they are not subject to Freedom of Information Act law. Only the New York Fed has published the calendar of its president.

interactions emerge as important based on this approach. In return analysis, stock returns in even weeks in FOMC-cycle time are shown to be significantly higher on even-week days with governor-president interactions, FOMC interactions, or Fed conference interactions. These three categories account for most of the even-week effect, with the former two categories more important in economic terms. Governor-president interactions are associated with particularly high even-week returns on days that follow Board of Governors' board meetings, further supporting the idea that information is created and disseminated around times of policymaker interactions. Analysis of hourly data documents high even-week returns following the start of calendar items of the three types mentioned, consistent with a causal interpretation and counter to a story of endogenous scheduling of meeting following high intra-day returns. Furthermore, high even-week day returns on days with governor-president interactions or FOMC interactions are not driven by speeches by policymakers, consistent with a central role for informal communication.

1.2 Leak Discussions in FOMC Documents, 1948–2013

Table 1 provides a list of leak discussions in FOMC documents. I constructed the list by searching the Board of Governors' website[4] for the words "leak", "Washington Post", "Wall Street Journal", and "New York Times" in the "FOMC information" category and reading the relevant documents. I dropped leak discussions not related to monetary policy (e.g., leaks about fiscal policy). It is apparent from the table that leaks are a repeated issue of concern for the FOMC itself, with 114 FOMC documents containing discussion of leaks. In most cases, each FOMC document corresponds to one FOMC meeting or conference call (exceptions include leak mentions in the Greenbook or in memos).

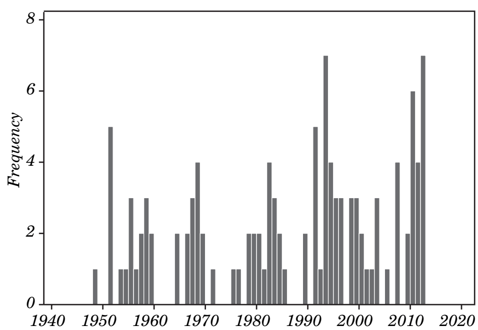
Figure 1 graphs the number of FOMC documents per year with leak discussions. The average number is 1.7 documents per year, with a slight upward trend. Leak discussions take various forms. Sixty-four of the documents discuss one or more recent leaks or possible leaks. Forty-four discuss the risk of leaks (including 8 warnings not to leak), 4 are about congressional hearings into leaks, and a few are

4. https://www.federalreserve.gov.

jokes/comments about leaks or lack of leaks.[5] The list is unlikely to be comprehensive, since FOMC participants may have used other words to discuss leaks. More importantly, to the extent that informal communication is a regular part of Fed business, only the more egregious leaks may be discussed at FOMC meetings.

A repeated theme in the FOMC documents is the difficulty of detecting leakers, with efforts presumably hampered by the large number of policymakers. To my knowledge, the only case in which a leak led to the resignation of a policymaker is the 2017 resignation of Richmond Fed President Lacker following admission of his involvement in the leak of confidential FOMC information to Medley Global Advisors in 2012. Medley Global Advisors, which was founded in 1995, was also involved in another major leak discussed in the June 1999 transcripts. Leaks to Macroeconomic Advisers, another policy intelligence firm like Medley Global Advisors, are also discussed in the FOMC transcripts.

Figure 1. Number of FOMC Documents with Leak Mentions, 1948-2013



Source: Annual Report on Exchange Arrangements and Exchange Restrictions.

5. The most recent document is perhaps the most interesting one. In the December 2013 transcript, Chairman Bernanke mentions a memo he has sent to the Conference of Presidents (consisting of the 12 Reserve Bank presidents) regarding information security at the Reserve Banks. The Fed has declined my FOIA request for this memo and the associated Fed analysis of the issue.

Table 1. FOMC Documents with Leak Mentions

Date	*FOMC document*	*Category*	*Topic*
17–18/Dec/2013	Meeting transcript	Risk of leaks	FOMC information security at the Reserve Banks.
19–20/Mar/2013	Meeting transcript	Recent leaks	Lack of results from investigation of prior leaks. Governor Tarullo concerned about risk of divided loyalty of board staff serving multiple governors
29–30/Jan/2013	Meeting transcript	Recent leaks	Leaks to New York Times and Medley Global Advisors
11–12/Dec/2012	Meeting transcript	Recent leaks	Investigation into leaks to New York Times and Medley Global Advisors
23–24/Oct/2012	Meeting transcript	Recent leaks	Investigation into leaks to New York Times and Medley Global Advisors. Separately, concern about leaks if SEP forecasts by name are circulated internally within the Fed
31/Jul–1/Aug/2012	Meeting transcript	Risk of leaks	Risk of leaks if Summary of Economic Projections includes names
20/Jun/2012	Meeting transcript	Possible leak	Possible leaks about plans for the maturity extension program (MEP)
13/Dec/2011	Meeting transcript	Recent leaks	Leaks of the FOMC agenda ahead of the meeting
28/Nov/2011	Conf. call transcript	Recent leak	WSJ article on leak to newsletter writer
20–21/Sep/2011	Meeting transcript	Risk of leaks	Fisher pushing back against more information sharing with Reserve Banks due to risk of leaks
25–26/Jan/2011	Meeting transcript	Recent leaks	Long discussion to formulate policy to prevent leaks from FOMC participants
3/Nov/2010	Meeting transcript	Recent leaks	Recent leaks to the press

Table 1. FOMC Documents with Leak Mentions (continued)

Date	*FOMC document*	*Category*	*Topic*
15/Oct/2010	Conf. call transcript	Recent leaks	Chairman disappointed with recent leaks of FOMC information
21/Sep/2010	Meeting transcript	Recent leaks	Leaks from August 10, 2010 FOMC meeting
24/Aug/2010	Memo	Recent leaks	Recent leaks of FOMC information to the press
9/May/2010	Conf. call transcript	Risk of leaks	Risk of leaks via Congress
26–27/Jan/ 2010	Meeting transcript	Risk of leaks	Leaking to Larry Meyer of Macroeconomic Advisers
28–29/Apr/2009	Meeting transcript	Recent leak	Leaked stress-test results
7/Feb/2009	Conf. call transcript	Warning not to leak	Chairman reminder to avoid leaks
31/Oct/2007	Meeting transcript	Possible leak	WSJ obtaining confidential information
16/Aug/2007	Conf. call transcript	Risk of leaks	Need for fast action to avoid leaks. Geithner leak to Bank of America
20–21/Mar/2007	Meeting transcript	Risk of leaks	Preference for transparency to not look non- transparent if information leaks
30–31/Jan/2007	Conf. call transcript	Risk of leaks	Concern about someone talking to New York Times Leak of FOMC agenda
1–2/Feb/2005	Meeting transcript	Recent leak	Several recent leaks. Need to announce shortly after the decision
9/Dec/2003	Meeting transcript	Recent leak	Washington Post and WSJ articles moving market expectations
15/Sep/2003	Meeting transcript	Recent leaks	Several recent leaks. Need to announce shortly after the decision

Table 1. FOMC Documents with Leak Mentions (continued)

Date	FOMC document	Category	Topic
25/Jun/2003	Meeting transcript	Recent leaks	Washington Post and WSJ articles moving market expectations
6/Nov/2002	Meeting presentation materials	Recent leak	Washington Post article moving market expectations
3/Jan/2001	Meeting transcript	Recent leak	WSJ leak before last meeting
19/Dec/2000	Meeting transcript	Recent leak	Recent leak to WSJ
3/Oct/2000	Meeting transcript	Possible leak	Possible front-running of FX intervention Announcement to avoid leak
18/May/1999	Meeting transcript	Risk of leaks	Announcement to avoid leak
30/Mar/1999	Meeting transcript	Recent leak	Leak of March 1998 directive
2–3/Feb/1999	Meeting transcript	Recent leaks	Discussion of various policies regarding confidentiality in context of leak over prior years
30/Jun–1/Jul/1998	Meeting transcript	Risk of leaks	Discussion of disclosure of tilt in directive to avoid leaks. Separately, Greenspan concerned about leak of internal working paper on the zero lower bound
19/May/1998	Meeting transcript	Recent leak	Impact of recent leak of policy bias on emerging markets
19/May/1998	Meeting transcript	Recent leak	WSJ article with leaked directive
24/Sep/1996	Greenbook	Recent leak	Leak of discount rate proposals moving market
24/Sep/1996	Meeting presentation materials	Recent leak	WSJ article moving market expectations
2–3/Jul/1996	Meeting transcript	Recent leaks	Recent leaks

Table 1. FOMC Documents with Leak Mentions (continued)

Date	*FOMC document*	*Category*	*Topic*
5–6/Jul/1995	Meeting transcript	Warning not to leak	Importance of avoiding leaks of discussion of downside risks
28/Mar/1995	Meeting transcript	Risk of leaks	Mention of risk of leak of directive
31/Jan–1/Feb/1995	Meeting transcript	Risk of leaks	Earlier period of leaks to WSJ
30/Dec/1994	Conf. call transcript	Risk of leaks	Risk of leak of swap facility with Mexico
22/Mar/1994	Meeting transcript	Risk of leaks	Immediate announcement to avoid perception of leaks
28/Feb/1994	Conf. call transcript	Risk of leaks	Risk of leak if policy action is delayed
4/Feb/1994	Meeting transcript	Risk of leaks	Need for statement due to risk of leak
16/Nov/1993	Meeting transcript	Congressional	Risk of leak from giving information to Congress
15/Oct/1993	Conf. call transcript	Congressional hearings on leaks	Further discussion of what to say in response to Congressional push for more disclosure in response to leaks
5/Oct/1993	Conf. call transcript	Congressional hearings on leaks	Leaks undercut Fed argument to delay release of information about policy
6–7/Jul/1993	Meeting transcript	Recent leak	Leak leading to lost flexibility in policymaking
1/Mar/1993	Conf. call transcript	Recent leak	John Berry story in Washington Post (leaked GDP revision)
2–3/Feb/1993	Meeting transcript	Risk of leaks	Immediate announcement to avoid leaks
6/Jan/1993	Meeting presentation materials	Congressional hearings on leaks	Letter from Congressman Gonzalez to the Fed about leaks
30/Jun–1/Jul/1992	Meeting transcript	Recent leak	WSJ article moving market expectations massively

Table 1. FOMC Documents with Leak Mentions (continued)

Date	*FOMC document*	*Category*	*Topic*
5/Nov/1991	Meeting transcript	Risk of leaks	Risk of leak from decision made but not disclosed to market
31/Oct/1991	Conf. call transcript	Joke about leaks	Joke about using leaks to affect Reserve Bank presidents voting
1/May/1991	Conf. call transcript	Recent leak	Chairman warning not to leak following leak to WSJ
5–6/Feb/1991	Meeting transcript	Recent leaks	Greenspan shutting down efforts to reduce leaks
9/Jan/1991	Conf. call transcript	Recent leaks	WSJ, NYT writing about policy change before it was known to some policymakers
18–19/Dec/1989	Meeting transcript	Recent leaks	Recent leaks and negative effect on Fed reputation and deliberations
16/Oct/1989	Conf. call transcript	Recent leaks	Recent leak to Washington Post. Leak reducing flexibility
21/May/1985	Meeting transcript	Recent leaks	Risk of leaks from sharing information with Council of Economic Advisers
26–27/Mar/1984	Meeting transcript	Recent leak	Recent leak, possibly via providing Greenbook to Treasury/CEA/OMB. Reducing number of staff at FOMC meetings to cut back on leaks
30–31/Jan/1984	Meeting transcript	Recent leak	GAO report on leak of Monetary Policy Report
22/Aug/1983	Discussion transcript	Recent leaks	Recent leaks of directive
12–13/Jul/1983	Meeting transcript	Recent leaks	Recent leaks leading Volcker to restrict attendance at policy session of FOMC meeting
8–9/Feb/1983	Meeting transcript	Warning not to leak	Chairman warning not to leak
16/Nov/1982	Meeting transcript	Recent leaks	Recent leaks. Arguments for immediate release of directive to stop leaks. Volcker arguing it reduces flexibility

Table 1. FOMC Documents with Leak Mentions (continued)

Date	*FOMC document*	*Category*	*Topic*
5/Oct/1982	Meeting transcript	Lack of leaks!	Chairman commending FOMC for not leaking since last meeting
30/Jun–1/Jul/1982	Meeting transcript	Recent leaks	Recent leaks. Reduction in attendance to prevent leaks
1–2/Feb/1982	Meeting transcript	Risk of leaks	Avoiding making final decisions to prevent leak
17/Jul/1981	Conf. call transcript	Recent leak	Leak of last week's policy decision to the Washington Post
19/Dec/1980	Meeting transcript	Recent leak	Recent possible leak. Effect on Fed credibility
12/Aug/1980	Meeting transcript	Recent leak	Recent leak. Reduction in attendance to prevent leaks or know better who leaked
11/Jul/1979	Meeting transcript	Risk of leaks	Leaks each month
27/Jun/1979	Conf. call transcript	Recent leak	Leak of GNP figure
19/Sep/1978	Meeting transcript	Recent leak	Leak of economic forecast
15/Aug/1978	Meeting transcript	Possible leak	Recent leaks
16/Nov/1976	Meeting transcript	Risk of leaks	FOMC phone system not secure. Risk of leak lead to no call
19/Feb/1975	Memorandum of discussion	Risk of leaks	Risk of leaks from Reserve Bank directors
16/Nov/1971	Memorandum of discussion	Risk of leaks	Risk of leaks from conversations with the British about swap line. Resulted in no conversations held
9/Sep/1969	Memorandum of discussion	Risk of leaks	Risk of leaks of postponement of British loan payments
14/Jan/1969	Memorandum of discussion	Recent leak	Investigation into leak of information on Treasury financing
17/Dec/1968	Memorandum of discussion	Recent leak	Leak of information on Treasury financing

Table 1. FOMC Documents with Leak Mentions (continued)

Date	*FOMC document*	*Category*	*Topic*
16/Jul/1968	Memorandum of discussion	Warning not to leak	Importance of avoiding leaks of negotiations about gold price
30/Apr/1968	Memorandum of discussion	Recent leak	Leak of information on Treasury financing
9/Jan/1968	Memorandum of discussion	Risk of leaks	Risk of leaks from the French
12/Dec/1967	Memorandum of discussion	Recent leaks	Leaks of international negotiations
27/Nov/1967	Memorandum of discussion	Recent leaks	Leaks reducing British policy flexibility
14/Nov/1967	Memorandum of discussion	Risk of leaks	Risk of leaks at meeting in Paris
23/Aug/1966	Meeting minutes	Risk of leaks	Risk of leaks of swap line plans
22/Mar/1966	Meeting minutes	Recent leak	Leaks of IMF proposal
5/May/1964	Meeting minutes	Recent leaks	Avoid paper documents to prevent leaks
28/Jan/1964	Meeting minutes	Recent leaks	Recent leaks about policy preferences
3/Mar/1959	Meeting minutes	Recent leaks	Reducing number of staff at FOMC meetings to cut back on leaks or know better who leaked
10/Feb/1959	Meeting minutes	Risk of leaks	Risk of leaks if discussing future policy
30/Jul/1958	Meeting minutes	Possible leak	Concern about policy move different from New York Times article
15/Apr/1958	Meeting minutes	Warning not to leak	Chairman reminder to avoid leaks
7/Jan/1958	Meeting minutes	Risk of leaks	Chairman concern about leaks
12/Nov/1957	Meeting minutes	Possible leak	Concern about someone talking to New York Times
9/Jul/1957	Meeting minutes	Risk of leaks	Risk of leak of discount rate requests

Table 1. FOMC Documents with Leak Mentions (continued)

Date	*FOMC document*	*Category*	*Topic*
6/Mar/1956	Meeting minutes	Risk of leaks	Whether increased access to FOMC information at Reserve Banks would lead to leaks
2/Aug/1955	Meeting minutes	Recent leak	Recent leak to newsletter
22/Jun/1955	Meeting minutes	Risk of leaks	Risk of leaks with more attendees
11/Jan1955	Meeting minutes	Recent leak	Recent leak of directive
7/Dec/1954	Meeting transcript	Warning not to leak	Chairman asking members who leak to make sure recepients don't cite leak as source
13/May/1953	Exec. committee meeting minutes	Risk of leaks	Reluctance to give specific instructions to New York Desk about weekly purchases for fear of number being leaked
27/Aug/1951	Meeting minutes	Warning not to leak	Warning by chairman to avoid leaks
7/May/1951	Exec. committee meeting minutes	Risk of leaks	Chairman comments regarding Treasury concern about leaks of Fed refunding recommendations
3/Mar/1951	Exec. committee meeting minutes	Warning not to leak	Warning by Chairman to avoid leaks. Suggestion to adopt rules about FOMC members talking to market newsletters
2/Mar/1951	Meeting minutes	Risk of leaks	Need to avoid leaks
6–8/Feb/1951	Meeting minutes	Recent leak	Leaks of content of first day of FOMC meeting
11/Nov/1948	Meeting minutes	Risk of leaks	Chairman citing Treasury secretary for suggesting immediate disclosure of a decision to prevent leaks

Source: https://www.federalreserve.gov.

1.3 Steps Taken to Reduce Leaks

As evidence of the importance of Fed leaks, it is helpful to document steps taken to try to avoid them.

FOMC statements: As discussed in CMVJ (2019), the decision by the Fed to release FOMC statements emerged after pressure from Congress in the early 1990s following a series of leaks. The idea that announcements of policy decisions may help reduce leaks is a recurring theme in FOMC leak discussions.

Press conferences: Leaks may have also contributed to the introduction of press conferences after FOMC meetings. The first press conference was in April 2011, just two meetings after the most extensive discussion of leaks at FOMC meetings, according to the available transcripts. This discussion led to the FOMC's first "Policy on External Communications of Committee Participants".[6] The first principle of the policy refers to press conferences:

> *Committee participants will endeavor to enhance the public's understanding of monetary policy. They are free to explain their individual views but are expected to do so in a spirit of collegiality and to refrain from characterizing the views of other individuals on the Committee. In explaining the rationale for announced Committee decisions, participants will draw on Committee communications and the Chairman's press conference remarks as appropriate.*

Initially the press conference started at 2:15 p.m., following the release of the FOMC meeting statement at 12:30 p.m. In March 2013, the statement release was moved to 2 p.m. with the press conference starting at 2:30 p.m. Bloomberg attributed this shift to leaks by FOMC participants in the period before the press conference (which is part of the blackout period), with Bernanke reducing the time between the statement and the press conference to take control of the message:

> ***Bernanke Tightens Hold on Fed Message Against Hawks.*** *Ben S. Bernanke is tightening his control of Federal Reserve communications to ensure investors hear his pro-stimulus message over the cacophony of more hawkish views from regional bank presidents. The Fed chairman, starting tomorrow, will cut the time between the release of post-meeting statements by the Federal Open*

6. The policy is available at https://www.federalreserve.gov/monetarypolicy/files/FOMC_ExtCommunicationParticipants.pdf.

Market Committee and his news briefings, giving investors less opportunity to misperceive the Fed's intent.[7]

Withholding information from other policymakers: CMVJ argue that discount rate requests from the twelve Reserve Banks play a central role in policymaking by providing information about how policy preferences evolve. Discount rate requests are submitted by the Reserve Banks to the Board of Governors. A 1996 Washington Post article about a leak clarifies how the Board withholds the identity of which Reserve Bank made a given request from the other Reserve Banks:

> *After the Fed Board meets each week (normally on Monday morning), the dozen reserve bank presidents are notified whether any change in the discount rate was approved. Coyne said the presidents are told how many banks sought a change and its size, but the recommendations of individual banks are not identified. Thus, the naming of the San Francisco, Minneapolis and Richmond banks as those seeking a half percentage point increase suggests that the leak must have come directly or indirectly from someone with access to information normally known only to the Fed Board and a handful of senior board staff.*[8]

Related, the members of the Board of Governors (by the nature of their position) do not make discount rate requests and can thus more easily keep their policy preferences private if they so desire. The absence of a formal mechanism for the Reserve Banks to obtain information about the preferences of other Reserve Banks and of the Board may explain why Morse and Vissing-Jorgensen (2019) find such an important role for calls/meetings between the governors and the Reserve Bank presidents.

Limiting attendance: A standard response to leaks is to limit attendance or avoid written documentation. In a survey by Linsky (1986) of around 500 current or former Federal government officials, 74 percent report being concerned about leaks. Of these, 77 percent report that their concern about leaks led them to limit the number of people involved in decision-making, and 75 percent report that they reduced the amount of information they put in writing. These standard

7. https://www.bloomberg.com/news/articles/2013-03-19/bernanke-tightens-hold-on-fed-message-against-hawks.

8. https://www.washingtonpost.com/archive/politics/1996/09/18/apparent-leak-of-advice-on-rates-shocks-the-fed/295fc4cd-2be8-4883-8ccf-50a538176988/?utm_term=.5fa386d5296d.

responses to leaks also appear in FOMC documents. After years of leaks, in July 1983 Chairman Volcker was so upset with recent leaks that he limited the policymaking discussion at FOMC meetings to the committee members. Perhaps in recognition that reducing attendance would not solve the problem if leaks were made by committee members, he noted in the June 1982 meeting:

> *Chairman Volcker: "There's only one recourse, which is obvious, if we have some sense of lack of confidentiality. There are a lot of people in this room and we could make it quite a few*

2. The Mechanics of Informal Communication

To understand the basics of how informal communication works, this section draws on the FOMC leak discussions as well as work in political science. I argue that leaks are often motivated by policymakers seeking to affect policy outcomes by changing public expectations. I also review the costs of leaks. FOMC documents show repeated concern about how leaks imply lost flexibility in policymaking, are detrimental to the Fed's reputation, and are harmful to the Fed's deliberative process.

2.1 Tactical Advantage from Changing Public Expectations

The political science literature distinguishes between several types of leaks. Drawing on earlier work by Hess, Pozen (2013) lists the following types:

- *Policy leak:* Intended to help, hurt, or alter a plan or policy. Subtypes of the policy leak include the *internecine leak*, "through which competing agencies or factions within the executive branch strive to strengthen their relative positions", and the *counter-leak* (or record-correction leak), "intended to neutralize or dispute prior disclosures";
- *Trial-balloon leak:* Used to test the response of key constituencies, members of Congress, or the general public;
- *Whistleblower leak:* Meant to reveal a perceived abuse;
- *Ego leak:* Used to satisfy the leaker's sense of self-importance;
- *Goodwill leak:* Meant to curry favor with a reporter;
- *Animus leak:* Meant to settle grudges or embarrass others; and
- *Inadvertent or lazy leak:* Happens by accident or ignorance with no particular instrumental aim in mind.

In the above-mentioned survey of government officials by Linsky, 42 percent answered yes to the question "Did you ever feel it appropriate to leak information to the press?". The most commonly cited reasons for leaking were "to counter false or misleading information" (78 percent) and "to gain attention for an issue or policy option" (73 percent). This implies a central role for internecine leaks and counter-leaks in U.S. government policymaking. Linsky's survey is also informative about how leaks may succeed in serving the interest of the leaker: The third most common reason for leaking was "to consolidate support from the public or a constituency outside government" (64 percent).

I next provide evidence from FOMC documents to argue that similar issues are relevant in the Fed context in that (a) internecine leaks and counter-leaks are important, and (b) they matter because they affect public perceptions, not in the sense that some in the public will come to the support of a particular policymaker's view, but in the sense that, once public perceptions are formed, the Fed is reluctant to not deliver on those expectations.

2.1.2 Bernanke's Frustration with Leaks for Tactical Advantage

Appendix A contains a memo sent by Chairman Bernanke to the Federal Open Market Committee in August 2010 regarding recent stories in the press. The memo suggests that Bernanke views these stories as policy leaks (internecine leaks) motivated by disagreement within the FOMC:

> *Chairman Bernanke: "[...] it damages the reputation and credibility of the institution if the outside world perceives us as using leaks and other back channels to signal to markets, to disseminate points of view, or to advance particular agendas"*

> *Chairman Bernanke: "[...] It is my hope that FOMC participants or observers are not intentionally or tactically conveying confidential information to the public."*

The memo also indicates what type of leaks are most valuable for those leaking:

> *Chairman Bernanke: "It is particularly important not to characterize the views of another participant at the meeting."*

Chairman Volcker more colorfully expresses the same sentiment of internecine leaks driven by policy disagreement in the November 1982 transcript:

Chairman Volcker: "I think there is a tendency on the part of any organization, for people to say 'Damn it! If somebody else is leaking, I'm going to talk to a reporter, too, and get my story out.' Unless this is stopped, it's just going to cut us up."

2.1.3 Leaks Affect Policy by Driving Market Expectations

Supporting the idea that Federal Reserve policymakers care about market expectations of policy, the Fed surveys both primary dealers (in the Survey of Primary Dealers) and a set of institutional investors (in the Survey of Market Participants) about their expectations for policy prior to each FOMC meeting. Attesting to the impact of these market expectations on policy, in 2017 a private company (Macropolicy Perspectives) launched what they refer to as the *Shadow Survey of Market Participants* in order to "collect information about consensus expectations that the FOMC uses as an input into its policy decisions" and release this information to interested buyers prior to the FOMC meeting.[9]

Examples from FOMC documents also provide evidence of the importance of market expectations for policy. Richard Fisher, president of the Federal Reserve Bank of Dallas expresses his concern about informal communication driving market expectations and thereby reducing policy flexibility at the June 2012 FOMC meeting:

Mr. Tarullo: "You accused somebody here of leaking. You didn't identify who it was, but you said there was a leak."

*Mr. Fisher: "What I'm saying is, I think we should work extremely hard to preserve every option that is debated at this table, and I have just noticed that this has been more intensely covered than I have seen in my seven years of sitting at this table. Everybody in this room is a decent person. I'm not casting any aspersions against anybody in this room. I'm just saying that if we can—in every way possible, however we do it—**we should try to preserve the options to be debated at this table, and then not use the argument that markets expect us to do X or Y. What is leading the markets to expect that? I haven't seen this broad-based discussion that we are having in the speeches."***

Chairman Bernanke states, at the December 2011 FOMC meeting, in response to recent leaks:

9. https://www.newyorkfed.org/medialibrary/media/research/conference/2019/quantitative_tools/Post_Rosner_NYATLFed.

> Chairman Bernanke: *"I also wanted, though, to mention today some press reports on the timing of our communications initiatives. It appears that at least one report had information about the agenda, in particular, that we would be discussing those matters today and providing public information in January. The substance of our discussions today on interest rate projections and on principles, inflation targets, and those sorts of issues, are well known. They were in the minutes, and they were discussed by a number of people in speeches, and so on, but* ***it does complicate the work of the subcommittee and of this Committee if the expectations of the public are for delivery of certain outcomes at certain dates."***

Chairman Greenspan and Vice-Chairman Corrigan state at the October 1989 FOMC meeting in response to recent leaks:

> Chairman Greenspan: *"[...] Secondly, let me just indicate to those to whom I haven't spoken that those articles in The Washington Post and The New York Times yesterday were not authorized releases. They were not done by myself nor anyone I'm aware of. I'm not sure at this stage particularly what damage was done, but* ***it clearly has very severely restricted our options, or it could.*** *I hope that during this period everyone will endeavor to stay away from the press."*

> *Vice-Chairman Corrigan: "Mr. Chairman, if I could, I'd like to add a point on those unfortunate press articles.* ***It is clear to me that they have already done some damage in terms of reducing [our] flexibility*** *and undermining discipline in the marketplace. It is absolutely essential, regardless of what the motivation for those particular articles may have been, that there is only one person who speaks for the Federal Reserve in these circumstances and that is you."*

In terms of reducing flexibility, Federal Reserve officials appear to think of formal and informal disclosure similarly (but with formal disclosure more committal than informal disclosure). Chairman Greenspan has argued that public disclosure ties the hands of policymakers going forward:

> *Chairman Greenspan: "Earlier release of the Directive would [...] force the Committee itself to focus on the market impact of the announcement as well as on the ultimate economic impact of its actions. To avoid premature market reaction to mere contingencies,* ***FOMC decisions could well lose their conditional character****. Given the uncertainties in economic forecasts and in the links between monetary-policy actions and economic outcomes,* ***such an impairment of flexibility in the evolution of policy would be undesirable."*** *[1991, cited in CMVJ].*

Similarly, Vice-Chairman Kohn wrote in the minutes from the July 1993 FOMC meeting:

> *Vice-Chairman Kohn: "In its discussion, the Committee reaffirmed its long-standing rules governing the confidentiality of FOMC information, including the schedule that calls for releasing the minutes of a Committee meeting, along with an explanation of the Committee's decisions, a few days after the next meeting.* ***These rules are designed to safeguard the Committee's flexibility to make needed adjustments to policy*** *and also to provide adequate time to prepare a full report of the context and rationale for its decisions."*

I interpret these quotes as saying that, once the Fed has publicly disclosed information about its preferred policy, it is difficult later to adjust policy in light of new information. Importantly, notice that, in Greenspan's thinking, what reduces the flexibility of policymakers going forward is what has been disclosed by the Fed about policy (as opposed to market expectations in general). A natural interpretation is that it is difficult to explain the state-contingent nature of optimal policy. This leads the Fed to look less competent (flip-flopping) if it does not deliver a policy consistent with what it had earlier led the market to believe would be its preferred policy. To capture this formally, in my model below, policymakers incur a loss if the chosen policy rate differs from market expectations of policymakers' average preferred policy rate, but only if policymakers have made prior disclosures about policy preferences. Stein and Sunderam (2018) argue that the Fed behaves as if it is averse to bond market volatility. This leads to an incentive to avoid policy choices that differ from market expectations, regardless of how those market expectations were formed. Stein and Sunderam show how this can explain gradualism in monetary policy.[10] My formulation of the problem emphasizes the idea that market expectations carry more weight in policymaking when they are based on Fed disclosure about policy and policy preferences, and I focus on the efforts of competing policymakers to selectively disclose information about policy preferences in order to drive the subsequent policy outcome.

10. In their model, the Fed seeks to reveal information about changes to its long-run policy target gradually in order to avoid large market surprises. However, the market foresees this and reacts strongly to a given policy change. Moving gradually thus has limited effectiveness in reducing bond market volatility but causes the policy rate to deviate further from its long-run target.

Direct evidence that disclosure reduces policy flexibility comes from comparing policymaking before and after the Fed started issuing statements following changes to the policy rate in February 1994. (Initially statements were issued only if the policy rate was changed; in January 2000 the Fed started issuing statements after all FOMC meetings.) Before 1994 the federal-funds target was frequently adjusted between meetings. CMVJ report that from 1982 to 1993, 62 of 93 target changes (two thirds) took place between scheduled meetings. This dropped to 7 of 62 changes (11 percent) over the 1994–2016 period. This suggests that from 1994 on, the Fed has generally waited to the next meeting to react to news arriving between meetings, presumably because intermeeting changes and the associated disclosures is viewed as constraining policy at the next meeting.

2.2 Advocacy with Disclosure of Confidential Information

If policymakers disagree and market expectations matter for the policy outcome, policymakers will each have an incentive to reveal information that supports their preferred policy. This is similar to advocacy in a courtroom, in which the defense and the prosecution each reveal only the information that supports their case. For example, a hawk may want to disclose that the Fed's internal growth forecast is quite high or that a previously dovish policymaker has been making more hawkish statements in internal debate. Importantly, if advocacy relies on the disclosure of internal confidential information then it cannot be done publicly (e.g., via speeches) and must instead be done via informal communication. This is a theme in several papers in the political science literature that focus on the U.S. administration. Kielbowicz (2006) emphasizes the selective reporting of facts via leaks: *"Because most promotional leaks spring from institutions' upper echelons, one veteran Washington reporter famously observed that the ship of state is the only vessel that leaks mainly at the top. President Kennedy's press secretary concurred, noting that a leak 'generally occurs when Presidents and governments wish to advance a certain viewpoint and pass to newspaper men documents or information of a confidential nature which would advance this point of view'."*[11] Similarly, Pozen (2013) argues that *"plants must be watered by leaks"*, i.e., that

11. "Promotional leak" is another term used for policy leaks.

policymakers often plant stories in the press but that these must be supported by leaks of confidential information to have an impact. Pozen provides an informative cite from Abel (1987): *"In the jaundiced but not unfounded view of some veteran reporters, '[t]he guiding principle, then and now, is that when it suits an administration's purpose to leak secret information to the press, it simply ignores or temporarily overrides a document's classification'."*

In the economics literature, Milgrom and Roberts (1986) study a persuasion game where two interested parties compete in providing information to a decision-maker. In equilibrium the truth comes out as long as, in any state of the world, there is one party who prefers the full-information decision. This will not necessarily be the case in the Federal Reserve context. First, the Fed faces costs from disclosure as discussed above (and elaborated on below). Second, in the Fed context, public expectations play the role of Milgrom and Roberts' decision-maker but not fully in that the interested parties (hawks and doves) determine policy based on both public expectations and their policy preferences. To the extent that the confidential information affects policy even without disclosure, the incentive to reveal information prior to decision-making is reduced. My model is designed to help understand when disclosure will occur and when it is welfare-reducing.[12]

2.3 The Costs of Leaks

2.3.1 Reduced Policy Flexibility

As discussed above, the incentive to leak stems from an impact of market expectations on the policy outcome. A potential leaker will balance any tactical advantage from leaking against the reduced ability of the Fed to react to new information that may arrive before the following FOMC meeting.

2.3.2 Damage to the Central Bank's Reputation

The first quote from Bernanke's August 2010 memo clearly expresses his concern with the impact of leaks on the Fed's reputation

12. In the classification of Gentzkow and Shapiro (2008) of bias in the market for news, advocacy by Fed hawks and doves would fit into the category of supply-driven bias (but with the bias generated by sources as opposed to news outlets).

and credibility. Chairman Greenspan expressed similar concerns at the July 1993 FOMC meeting:

> *Chairman Greenspan: "[...] Jerry Corrigan, as you may recall, said at the luncheon that we gave him on his farewell immediately following the last meeting of the FOMC that the one thing that could do this institution in is the leak question and the whole issue of the credibility of our operations. And I must tell you that Jerry is almost surely right on this."*[13]

One specific channel through which leaks affect the Fed's reputation is via a (correct) perception that some members of the private sector or the press have access to confidential information from the Fed. The January 2011 FOMC meeting again had leaks on the agenda and the transcripts contain a lengthy discussion on the issue (p.5–10 and 197–230).[14] The discussion was part of the process for formulating a policy to prevent leaking by the FOMC itself. President Yellen chaired a subcommittee on the issue and stated:

> *Vice Chair Yellen: "[...] As you may recall, the Chairman gave our subcommittee a three-part charge. He asked us first to assure appropriate treatment of confidential FOMC information, including our contacts with the press; second, we were to develop policies to avoid the perception that individuals outside of the Federal Reserve System are able to gain inappropriate access to FOMC information that could be valuable in forecasting monetary policy; and, third, we were to develop policies to ensure that the public communications of FOMC participants do not undermine the Committee's decision-making process or the effectiveness of monetary policy."*

> *Vice Chair Yellen: "[...] We're concerned about potential leaks of documents or their contents that are discussed in an FOMC meeting as well as leaks about the substance of discussions, such as who said what."*

In the discussion, several policymakers express concerns about the Fed giving away confidential information to connected parties in the financial sector or the press. Governor Tarullo states:

> *Mr Tarullo: "[...] The most disturbing thing right now is the phenomenon of someone who comes in, talks to most or all members*

13. Jerry Corrigan was the 7th president of the Federal Reserve Bank of New York and vice-chair of the FOMC.

14. The transcript is at https://www.federalreserve.gov/monetarypolicy/files/FOMC20110126meeting.pdf.

of the FOMC and then to a group of paying clients, essentially advertising that fact and suggesting that there's a special kind of information. This is not limited to one person, and this is not just Macroeconomic Advisers, although they have been mentioned. [...] I think this problem is more serious than most of the people around the table think it is, and I have believed since I've been here that there was a real problem waiting to explode."

Several policymakers express skepticism that any policy will be hard to enforce. President Plosser states:

Mr Plosser: "[...] I think enforcement is going to be really, really difficult, and, again, I think we just can't legislate good judgment."

The problem did in fact explode; it was not just Macroeconomic Advisers, and the policy was hard to enforce. As mentioned above, following involvement in a leak to Medley Global Advisors in 2012, President Lacker resigned in 2017. The New York Times wrote:

"Jeffrey M. Lacker, the president of the Federal Reserve Bank of Richmond in Virginia, resigned abruptly on Tuesday, saying that he had broken the Fed's rules in 2012 by speaking with a financial analyst about confidential deliberations. Mr. Lacker said he also failed to disclose the details of the conversation even when he was questioned directly in an internal investigation."[15] [16]

2.3.3 Damage to the Central Bank's Decision-Making Process

Consecutive chairs have worried about the impact of leaks on the quality of policy deliberations within the Fed. Bernanke's 2010 memo states:

Chairman Bernanke: "[...] And such leaks threaten the free give-and-take of ideas and collegiality of the FOMC as we grapple with the difficult issues we face."

Chairman Greenspan states at the December 1989 FOMC meeting:

Chairman Greenspan: "Before we resume our regular business, I would like to raise again a problem that continues to confront this organization with continuous damaging and corrosive effects, and that is the issue of leaks out of this Committee. We have had

15. https://www.nytimes.com/2017/04/04/business/lacker-leak-fed.html.
16. The memo is available at https://assets.documentcloud.org/documents/1372212/fed-dec-bound.pdf.

two extraordinary leaks, and perhaps more, in recent days [...] I'm getting a little concerned about the free discussions that go on in this group—and yesterday afternoon is a very good example of this. ***If [our discussions] start to be subject to selective leaks on content, I think we're all going to start to shut down.*** *Frankly, I wouldn't blame anyone in the least. We wouldn't talk about very sensitive subjects.* ***If we cannot be free and forward with our colleagues, then I think the effectiveness of this organization begins to deteriorate*** *to a point where we will not have the ability to do what is required of us to do."*

At the August 1980 FOMC meeting, Chairman Volcker states:

Chairman Volcker: "[...] I would like to mention and emphasize a matter on which I sent you a note. We had a leak about the aggregates [targets] for the year after our telephone consultation, which disturbed me. [...] Wherever it came from, ***there is nothing more corroding of the confidence with which we sit around the table or in a telephone conference and discuss [policy] than the fear that somehow there is going to be a leak of what is discussed.*** *I just cannot operate in that way. [...] If you haven't already done so, I would urge you to take whatever [measures necessary to convey] the message in your own way within your own institutions to give us the best assurance we can have that this doesn't happen again. We are going to end up not talking very freely if it does. Enough of that."*

3. The Game Theory of the Quiet Cacophony

This section provides a simple model of the interaction between two policymakers who each have an incentive to drive market expectations to gain an advantage in policymaking. The objective is to lay out a framework in which to think about the issue in order to understand the impact of leaks on policy and welfare in equilibrium.

3.1 Policy Preferences

Suppose two policymakers D and H have to decide on the interest rate at each policy meeting. They disagree on what the appropriate policy rate is, given economic conditions. Policymakers' views of the appropriate interest rate given economic conditions evolve as follows:

Date 0	*Date 1*	*Date 2*
Last policy meeting	Intermediate date	Current policy meeting
r_0^D	$r_1^D = r_0^D + e_1^D$	$r_2^D = r_0^D + e_2^D$
r_0^H	$r_1^H = r_0^H + e_1^H$	$r_2^H = r_0^H + e_2^H$

where the *e*'s are shocks to policy preferences and

$$e_2^D = e_1^D + v_2^D$$

$$e_2^H = e_1^H + v_2^H$$

$$\mathrm{cov}(e_1^D, v_2^D) = \mathrm{cov}(e_1^H, v_2^H) = 0$$

$$\mathrm{cov}(e_1^D, e_1^H) = \mathrm{cov}(v_2^D, v_2^H) = \mathrm{cov}(e_1^D, v_2^H) = \mathrm{cov}(v_2^D, e_1^H) = 0$$

The policy rate *r* is set at date 2 just after the realization of e_2^D and e_2^H.[17]

Assume that r_0^D and r_0^H are observable by policymakers and markets at date 0 after the last policy meeting. Policymakers observe e_1^D, e_1^H at time 1 and e_2^D, e_2^H at time 2 (via internal communication). They have a choice of whether to reveal information about e_1^D or e_1^H to markets at date 1. If information about e_1^D or e_1^H is disclosed, this reduces policy flexibility at date 2 in that policymakers incur a loss if the chosen policy rate *r* differs from the market's perception of average policy preferences as of date 1. As discussed above, this loss stems from the difficulty of conveying the nuance of why policymakers' preferred policy rate is changing, thus implying that the central bank is viewed as flip-flopping if it appears to have changing preferences.

Accordingly, assume that policymakers' loss functions as functions of the policy outcome, *r*, are:

$$L^D = \alpha\left(r - r_2^D\right)^2 + I^{disc}\beta\left(r - E_1^{market}\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right)\right)^2$$

$$L^H = \alpha\left(r - r_2^H\right)^2 + I^{disc}\beta\left(r - E_1^{market}\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right)\right)^2$$

17. The setup can be augmented to allow for observable news about e_1^D and e_1^H arriving between date 0 and 1. I ignore this for simplicity, since my focus is on understanding the disclosure of internally known information about e_1^D and e_1^H.

where $\alpha > 0$, $\beta > 0.1^{disc}$ is a dummy equal to one if D or H has made a date 1 disclosure about average policy preferences. $E_1^{market}\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right)$ is the market's expectation of the average preferred policy rate given all disclosure. These loss functions capture the idea that both policymakers look equally bad if the Fed appears to be flip-flopping.[18]

As noted earlier, the model focuses on the role of lost flexibility from leaks because this is what induces the temptation to leak. The costs from loss of Fed credibility and harm to its decision-making process could be added to the loss function. However, given that these costs are likely to be a function of sustained leaking as opposed to substantial costs incurred for one incremental leak, incorporating them would have only a small effect in terms of reducing the incentive to leak. For simplicity, I therefore omit them from the model. However, it is important to emphasize that these costs could materially add to the welfare loss from leaks even if they have only a minor effect on the range of parameter values for which a given equilibrium outcome emerges.

Assume that the policy outcome r at date 2 is chosen to minimize the total policymaker loss, given date 1 disclosure:

$$\min_r L\left(r \mid r_2^D, r_2^H, I^{disc}, E_1^{market}\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right)\right)$$

$$= L^D + L^H$$

$$= \alpha\left(r - r_2^D\right)^2 + \alpha\left(r - r_2^H\right)^2 + 2I^{disc}\beta\left(r - E_1^{market}\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right)\right)^2.$$

In this setup, disclosure reduces the flexibility of policymakers to react to news arriving between date 1 and 2. Disclosure thus has a flavor of what has been called Odyssean forward guidance in the recent literature on unconventional monetary policy.[19] However, my model works at a different frequency. It is about the pros and cons of

18. An alternative would be to make the loss from disclosure a function of $r - E_1(r \mid disclosure)$. This can lead to multiple equilibria, which may be of independent interest but is not pursued here.

19. See Campbell and others (2012).

disclosure between policy meetings, not about statements about what policy will be several meetings down the road.[20]

3.2 Advocacy (Spin)

Conditional on knowing e_1^D and e_1^H (news about the evolution of policy preferences between date 0 and 1),

$$E_1\left(\frac{1}{2}\left(r_2^D+r_2^H\right) \mid e_1^D, e_1^H\right)=\frac{1}{2}\left(r_0^D+r_0^H\right)+\frac{1}{2}\left(e_1^D+e_1^H\right).$$

Assumption (spin). Policymakers are able to selectively reveal information about average policy preferences:

(a) For a given value of $E_1\left(\frac{1}{2}\left(r_2^D+r_2^H\right) \mid e_1^D, e_1^H\right)$ a policymaker could, being the only one disclosing, make the market expect any value for the average policy preference within S^* of the truth:

$$E_1\left(\frac{1}{2}\left(r_2^D+r_2^H\right) \mid e_1^D, e_1^H\right)-S^*$$
$$\leq E_1^{market}\left(\frac{1}{2}\left(r_2^D+r_2^H\right) \mid \text{disclosure by one policymaker}\right)$$
$$\leq E_1\left(\frac{1}{2}\left(r_2^D+r_2^H\right) \mid e_1^D, e_1^H\right)+S^*.$$

(b) If competing policymakers each advocate in opposite directions, then market expectations are the truth plus the sum of the spin:

$$E_1^{market}\left(\frac{1}{2}\left(r_2^D+r_2^H\right) \mid \text{disclosure by both}\right)$$
$$=E_1\left(\frac{1}{2}\left(r_2^D+r_2^H\right) \mid e_1^D, e_1^H\right)+S^D+S^H.$$

My spin assumption is a shortcut for explicit modeling of what information is disclosed. It is intended to capture the idea that there are many pieces of information known internally to Fed policymakers, and policymakers each have a choice of what, if anything, to disclose. Since there are only so many dovish or hawkish pieces of information,

20. In the context of forward guidance, disclosure that generates an element of commitment may be a welfare-maximizing choice in cases where the beneficial impact on medium-term rates outweighs the cost of lost flexibility.

spin is limited between $-S^*$ and $+S^*$. While I do not provide micro foundations for policymakers' ability to spin, this is an interesting direction for future work both in the Fed context and in policy contexts more generally. One possibility is that markets cannot infer from non-disclosure whether a policymaker does not have a given piece of information or is strategically not disclosing it.[21]

3.3 Defining Strategies and Nash Equilibrium

A disclosure strategy for any given policymaker consists of a decision of whether to disclose and, if yes, what value of spin to use. A Nash equilibrium consists of:

1. A disclosure strategy for D that is optimal given the disclosure strategy of H and market expectations, and

2. A disclosure strategy for H that is optimal given the disclosure strategy of D and market expectations.

If neither D or H make a disclosure at date 1, $I^{disc} = 0$ and the policy outcome at date 2 solves

$$\min_r \ \alpha\left(r - r_2^D\right)^2 + \alpha\left(r - r_2^H\right)^2.$$

If either D or H make a disclosure at date 1, $I^{disc} = 1$ and the policy outcome at date 2 solves

$$\min_r \ \alpha\left(r - r_2^D\right)^2 + \alpha\left(r - r_2^H\right)^2 + 2\beta\left(r - E_1^{market}\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right)\right)^2$$

with $E_1^{market}\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right)$ based on disclosure by one or both policymakers.

3.4 Policy Outcome Given Disclosure

The policy outcome at date 2 is as follows.

Lemma 1 (Policy outcome given disclosure). The policy outcome without disclosure is

$$r = \frac{1}{2}\left(r_2^D + r_2^H\right)$$

and the policy outcome with disclosure is

21. See Milgrom (1981) for an early contribution to the literature on information unraveling.

$$r = \frac{\alpha}{\alpha+\beta}\frac{1}{2}\left(r_2^D + r_2^H\right) + \frac{\beta}{\alpha+\beta}E_1^{market}\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right).$$

Proof: See appendix B for all proofs.

Note that Lemma 1 implies that if advocacy (spin) was not feasible, neither policymaker would have an incentive to disclose. For example, even if $\frac{1}{2}\left(e_1^D + e_1^H\right)$ is positive, and $E_1\left(r_2^H \mid e_1^D, e_1^H\right) > E_1\left(r_2^D \mid e_1^D, e_1^H\right)$, it is not the case that H would benefit from disclosing the true value of $\frac{1}{2}\left(e_1^D + e_1^H\right)$. The reason is that with true disclosure, the full value of $\frac{1}{2}\left(e_1^D + e_1^H\right)$ will (in expectation) be incorporated in policy even without disclosure, so disclosure would only serve to reduce policy flexibility, which is bad for both policymakers.

3.5 Disclosure Equilibrium

Theorem 1 (Prisoners' dilemma, for sufficient disagreement and feasible spin).

Let E_1 denote expectations at time 1, conditional on e_1^D, e_1^H. Consider the situation where $E_1\,(r_2^H - r_2^D) > 0$, i.e., H is hawkish relative to D. If

$$\sqrt{2}\sigma_v < \left|\frac{1}{2}E_1\left(r_2^H - r_2^D\right)\right| \le S^*$$

then:

(a) D prefers disclosure to non-disclosure regardless of H's choice (disclosure is a strictly dominant strategy for D). D's "spin reaction function" is as follows:

If H does not disclose, D's optimal spin (given disclosure) is negative. It is given by

$$S^D = -\frac{1}{2}E_1\left(r_2^H - r_2^D\right)$$

and implies

$$E_1(r) = E_1\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right) - \frac{\beta}{\alpha+\beta}\frac{1}{2}E_1\left(r_2^H - r_2^D\right) < E_1\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right).$$

If H discloses, and picks spin of S^H, D prefers a spin of $S^D = \max\left(-\frac{1}{2}E_1\left(r_2^H - r_2^D\right) - S^H, -S^*\right)$.

(b) H prefers disclosure to non-disclosure regardless of D's choice (disclosure is a strictly dominant strategy for H). H's "spin reaction function" is as follows:

If D does not disclose, H's optimal spin (given disclosure) is positive. It is given by

$$S^H = \frac{1}{2} E_1\left(r_2^H - r_2^D\right)$$

and implies

$$E_1(r) = E_1\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right) + \frac{\beta}{\alpha+\beta}\frac{1}{2} E_1\left(r_2^H - r_2^D\right) > E_1\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right).$$

If D discloses, and picks spin of S^D, H prefers a spin of $S^H = \min\left(\frac{1}{2} E_1\left(r_2^H - r_2^D\right) - S^D, S^*\right)$.

(c) Given (a)-(b), the unique Nash equilibrium outcome is that both disclose with $S^D = -S^*$ and $S^H = S^*$ Both policymakers are worse off in this equilibrium than if neither disclosed.

Discussion: Notice that if H does not disclose, D does not advocate so much that $E_1(r) = E_1(r_2^D)$ because advocacy has a cost in terms of lost flexibility. Similarly for H.

Figure 2. The Tug of War over Market Expectations in the Model: Spin Reaction Functions

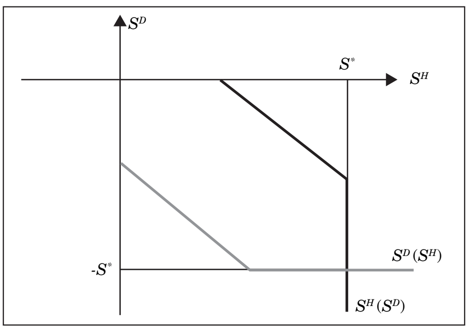


Figure 2 graphs the spin reaction function of H and D in S^D, S^H space to illustrate the tug of war over market expectations. If H discloses, D is trying to reach a total spin of $S^D + S^H = -\frac{1}{2}E_1\left(r_2^H - r_2^D\right)$ and thus sets $S^D = -\frac{1}{2}E_1\left(r_2^H - r_2^D\right) - S^H$ unless this is below the limit of $-S^*$. D's spin reaction function to spin by H is thus $S^D\left(S^H\right) = \max\left(-\frac{1}{2}E_1\left(r_2^H - r_2^D\right) - S^H, -S^*\right)$. Similarly, if D discloses, H is trying to reach a total spin of $S^D + S^H = \frac{1}{2}E_1\left(r_2^H - r_2^D\right)$ and thus sets $S^H = \frac{1}{2}E_1\left(r_2^H - r_2^D\right) - S^D$ unless this is above the limit of S^*. H's spin reaction function to spin by D is thus $S^H\left(S^D\right) = \min\left(\frac{1}{2}E_1\left(r_2^H - r_2^D\right) - S^D, S^*\right)$.

The spin reaction functions intersect at $S^D = -S^*$, $S^H = S^*$. Economically, this says that the outcome of the tug of war over market expectations is that each side discloses all the information that supports their case, resulting in the market learning all information (in the case with sufficient disagreement and sufficient feasible spin described in Theorem 1).

A potentially interesting observation in terms of the conditions of Theorem 1 is that, if date 1 was close to date 2, σ_v would be small (making the Theorem 1 outcome applicable), as there would be less information to learn about the economy and policymaker preferences. This could provide a theory for the pre-FOMC effect in stock returns.

Theorem 2 lays out the outcome of the game when the conditions in Theorem 1 do not hold, i.e., with low disagreement or in cases where it is difficult to spin.

Theorem 2 (If disagreement is low, or not much spin is feasible, then non-disclosure is possible). Consider the situation where $E_1(r_2^H - r_2^D) > 0$ i.e., H is hawkish relative to D.

Condition 1: $\sqrt{2}\sigma_v \geq \left|\frac{1}{2}E_1\left(r_2^H - r_2^D\right)\right|$.

Condition 2: S^* is sufficiently small.

If either of the above two conditions holds, then:

(a) D's spin reaction function is:

If H does not disclose, disclosure is not worthwhile for D.

If H discloses, and picks spin of S^H, D prefers a spin of $S^D = \max\left(-\frac{1}{2}E_1\left(r_2^H - r_2^D\right) - S^H, -S^*\right)$.

(b) H's spin reaction function is:

If D does not disclose, disclosure is not worthwhile for H.

If D discloses, and picks spin of S^D, H prefers a spin of $S^H = \min\left(\frac{1}{2}E_1\left(r_2^H - r_2^D\right) - S^D, S^*\right)$.

(c) Given (a)-(b), there are two Nash equilibria. In one equilibrium neither discloses. In the other equilibrium both disclose with $S^D = -S^*$ and $S^H = -S^*$. Both D and H prefer the non-disclosure equilibrium. It seems natural that in this case policymakers will coordinate on the non-disclosure equilibrium.

3.6 Can Leaking Ever Work in Equilibrium?

A central assumption of my model setup is that spin by each side cancels each other out, thus leading the truth to come out if both policymakers use informal communication. This implies that, in the equilibrium of Theorem 1, no one gains from leaking (just like the prisoners in the prisoners dilemma do not gain from confessing in equilibrium because they both confess). It would be interesting to consider variations of the model in which leaking could benefit a leaker in equilibrium. Several possibilities come to mind for further study.

First, one side may be better informed or better at spinning than the other. In that case the less informed party would not be able to fully counter the effects of leaks by the more informed party on market expectations (think of Reserve Banks having to make discount rate requests to the Board of Governors, but governors not having to disclose their policy preferences to Reserve Banks unless they so choose).

Second, perhaps record corrections do not work fully in that once markets have been influenced by the first leaker, it is difficult to fully undo this (recall how Bernanke moved up his press conference in 2013 in order to *"ensure investors hear his pro-stimulus message over the cacophony of more hawkish views from regional bank presidents"*, in Bloomberg's words). If this is the case, the market expectation of the average preferred policy rate after leaks by both parties may be biased toward the preferred rate of the first leaker. This induces an incentive to leak fast and may provide a mechanism for leaking to benefit the first leaker in equilibrium.

Third, some policymakers may be more willing to break the rules by leaking. This could lead to distorted policy choices that are driven disproportionately by those leaking.[22]

22. I thank Jeremy Stein for suggesting this possibility.

4. What Can Be Done?

Despite repeated attempts to stop them, leaks from the Fed continue. My model suggests a possible answer for this—it is hard to get out of a unique Nash equilibrium (the equilibrium in Theorem 1, which applies in times of sufficient disagreement).

There are obvious but unattractive solutions: One could avoid disagreement by appointing similar-thinking policymakers, but this would run counter to why we have group decision-making in the first place. Or one could publicly disclose policy preferences in real time so there is less to leak. However this would likely lead to even more loss in policy flexibility than the current framework. Think of no disclosure as retaining full flexibility, informal disclosure as generating some loss of flexibility, and public disclosure as generating the least flexibility.

Below I instead lay out an argument that links β (the parameter capturing the loss from deviating from market expectations in my model) to the public's understanding of the Fed's policy rule. I then discuss approaches to improve this understanding in order to lower β, arguing that reducing the number of policymakers and avoiding rotation of policymakers in FOMC voting may help.

4.1 Parallels to the Time-Inconsistency Literature

The quiet cacophony is in some ways similar to other time-inconsistency problems in monetary policy. Policymakers would prefer no disclosure at the intermediate date if this could be enforced, but are unable to commit to non-disclosure. In response to time-consistency problems, several papers recommend appointing a central banker with different preferences. Rogoff (1985) argues for appointing a central banker with a "too large" weight on inflation relative to employment, in order to overcome the standard time-inconsistency problem of policymakers creating surprise inflation to increase employment. Similarly, to avoid excessive gradualism in monetary policy, Stein and Sunderam (2018) argue that society would be better off with a central banker who cared less about market volatility. In the current context, what is needed is central bankers who care "too little" about delivering on policy expectations driven by Fed disclosure, relative to the representative household. Finding such central bankers seems difficult—why would potential candidates inherently have different β preferences? Incentivizing them to act as if they have low β also seems challenging, as this would reward what looks like erratic policymaking.

Improving the current state of affairs involves a better understanding of what drives the magnitude of β. In my view, β is not a fundamental preference parameter but is instead shaped by the public's lack of understanding of the Fed's decision rule. If the public fully understood how the Fed would optimally react to each type of incoming data, then markets would update expectations day by day as news came out about non-farm payroll, consumer confidence, and so on. Policy surprises (e.g., Kuttner surprises or stock returns on announcement days) would be small, yet the Fed would be unbound by prior policy statements as the public would agree that the optimal policy rate turned out different than what was expected at an intermediate date. Large policy surprises are thus a failure of communication, and this leaves the Fed reluctant to not deliver on what the market expects based on prior Fed disclosures. In other words, to the extent that markets do not understand the Fed's decision rule, any deviation of policy from expectations will be interpreted partly as a "Taylor rule residual", and thus make the Fed look erratic and less competent. This problem leads β to be positive, which in turn drives the use of informal communication.

4.2 Fewer Policymakers and No Rotation: Would This Help Lower β?

The issue thus comes down to how to help the Fed communicate its thinking better, i.e., teach the public the quite complicated economic model the Fed has in mind when setting policy. Undoubtedly, (post Greenspan) policymakers are trying hard to explain their thinking. However, the market's inference problem is incredibly difficult. The market needs to understand not one economic model but nineteen: the model of each of the seven members of the Board of Governors (or fewer if some governor seats are unfilled) and that of the twelve Reserve Bank presidents.[23] Furthermore, the market needs to understand the internal power dynamics of the Fed. This is a very difficult inference problem.

23. The FOMC consists of twelve voting members. The seven members of the Board, the president of the New York Fed and four of the remaining eleven Reserve Bank presidents who serve one-year terms on a rotation schedule. Non-voting Reserve Bank presidents attend and participate in FOMC meetings.

A 2016 Brookings survey of private-sector Fed watchers and academics gave poor grades to the Fed for its communications efforts.[24] Only 34 percent state that they have a very clear or mostly clear understanding of the Fed's policy reaction function. The most popular forms of communication are the meeting statements, chair speeches, and post-meeting press conferences, which over half of respondents find useful/extremely useful. By contrast, only 24 percent find speeches by Reserve Bank presidents useful/extremely useful. Sixty-four percent want the presidents to speak less. Instead, 51 percent want the chair to speak more. The message seems clear: Have the chair take more charge of communications. The 2019 change to have eight rather than four press conferences per year is a step in the right direction. The chair should understand the 19people's thinking and the power structure better than anyone. A central part of the chair's job should be to communicate the Fed's policy reaction function to the world in a way that the public understands, in order to retain policy flexibility. One problem in doing so is the large number of policymakers and the rotation of Reserve Bank presidents on the FOMC. With four presidents rotating out and four new ones rotating in each year, the FOMC does not have a stable policy reaction function. This makes the chair's job of trying to convey the FOMC's overall policy reaction function even harder.

A somewhat radical approach would be to reduce the number of Federal Reserve districts and avoid FOMC rotation. This would mean having only X of the Reserve Banks vote, but the same ones all the time. X could be chosen to maintain the balance of power between the Board and the Reserve Banks. Specifically:

• Eliminating the rotation schedule would reduce the number of policymakers that markets have to understand and would improve the stability of the FOMC's policy reaction function. In turn, β would fall and policy flexibility increase as the public understood the policy reaction function better, and this would lead the Fed to be less bound by prior statements and disclosures (either public or informal).

• Having X "Super Reserve Banks" would likely also indirectly strengthen Fed research and policymaking. By concentrating reserve-bank research at the Super Reserve Banks, these would each be able to have a larger research staff and, equally important, the staff would be serving a president who would always be a voting member of the

24. https://www.brookings.edu/wp-content/uploads/2016/11/fed-communications-survey-results.pdf.

FOMC. This would increase the profile of researchers at the Super Reserve Banks, which would help attract even more top talent. In turn, higher research quality would facilitate better group decision-making, with each voting member having an excellent team behind them.

• Any functions of the Reserve Banks that require local presence could be kept as is.

5. Conclusion

The paper seeks to shine light on the use of informal communication in monetary policy, focusing on the U.S. Federal Reserve. Recent evidence from asset pricing suggests that information flows from the Fed to markets via informal channels. Prevalent use of informal communication is consistent with the repeated discussions of leaks in FOMC documents going back to 1948. A reading of the historical documents suggests that leaks are motivated by a tug of war over market expectations because the Fed is reluctant to choose a policy that differs from prior policymaker guidance. I provide a model of the game theory of the quiet cacophony to understand the equilibrium outcome. If disclosure ties the hand of policymakers and policymakers can spin information about policy preferences via selective disclosure, the unique Nash equilibrium is that both policymakers leak when disagreement is sufficiently large relative to the remaining uncertainty to be resolved before the next policy meeting.

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Appendix A

Memo from Chairman Bernanke to the FOMC, August 2010*

BOARD OF GOVERNORS OF THE FEDERAL RESERVE SYSTEM

Date: August 24, 2010
To: Federal Open Market Committee
From: Chairman Bernanke
Subject: Recent Stories in the Press

As you are aware, there have been several recent stories in the press that have contained considerable information about policy options presented to the Federal Open Market Committee and the discussion within FOMC meetings. Needless to say, it damages the reputation and credibility of the institution if the outside world perceives us as using leaks and other back channels to signal to markets, to disseminate points of view, or to advance particular agendas. And such leaks threaten the free give and take of ideas and collegiality of the FOMC as we grapple with the difficult issues we face.

It is my hope that FOMC participants or observers are not intentionally or tactically conveying confidential information to the public. At times, many of us find ourselves in an unsettling situation where a reporter purports to have specific information from other sources and then presses for a confirmation or denial. Although no one individual provides all the information sought, by piecing together many discussions the reporter is able to get a detailed picture of developments within the Committee.

Let me ask everyone to be especially mindful going forward about providing details to the press or others outside the Federal Reserve about FOMC meetings or restricted materials. After the statement itself, the minutes should offer the clearest view of the Committee's deliberations. It is particularly important not to characterize the views of another participant at the meeting. Of course, if you want to make public your own views, there are many forums to do so, including speeches and interviews for attribution. We have a long history of considering difficult decisions in uncertain environments with collegiality and respect. Maintaining the confidentiality of our internal discussions is one important way we do so.

Thank you for your attention to these concerns. The reputation of the Federal Reserve and the quality of our discussions are public goods that we have a strong collective interest in preserving.

* Downloaded from:
https://www.federalreserve.gov/monetarypolicy/files/FOMC20100824memo01.pdf

Appendix B

Proofs

Lemma 1 (Policy outcome with continuous policy).
Proof:

$$\frac{\partial L\left(r \mid r_2^D, r_2^H, I^{disc}, E_1^{market}\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right)\right)}{\partial r}$$

$$= 2\alpha\left(r - r_2^D\right) + 2\alpha\left(r - r_2^H\right) + 4I^{disc}\beta\left(r - E_1^{market}\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right)\right) = 0$$

which implies

$$r = \frac{\alpha}{\alpha + I^{disc}\beta}\frac{1}{2}\left(r_2^D + r_2^H\right) + \frac{I^{disc}\beta}{\alpha + I^{disc}\beta}E_1^{market}\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right).$$

Theorem 1 (Prisoners' dilemma, for sufficient disagreement and feasible spin)
Proof: (a) **If *H* does not disclose:**
Non-disclosure by D leads to

$$r = \frac{1}{2}\left(r_2^D + r_2^H\right)$$

whereas disclosure by D results in

$$r = \frac{\alpha}{\alpha + \beta}\frac{1}{2}\left(r_2^D + r_2^H\right) + \frac{\beta}{\alpha + \beta}\left(E_1\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right) + S^D\right).$$

Therefore, D's expected losses are, with non-disclosure by

$$E_1\left(L^D\right) = \alpha E_1\left(\frac{1}{2}\left(r_2^D + r_2^H\right) - r_2^D\right)^2$$

$$= \alpha E_1\left(\frac{1}{2}E_1\left(r_2^H - r_2^D\right) + \frac{1}{2}\left(v_2^H - v_2^D\right)\right)^2$$

$$= \alpha\frac{1}{4}\left[E_1\left(r_2^H - r_2^D\right)\right]^2 + \alpha\frac{1}{4}E_1\left[\left(v_2^H - v_2^D\right)^2\right]$$

$$= \alpha\frac{1}{4}\left[E_1\left(r_2^H - r_2^D\right)\right]^2 + \alpha\frac{1}{2}\sigma_v^2$$

and with disclosure by D

$$E_1\left(L^D\right) = \alpha E_1\left(\frac{\alpha}{\alpha+\beta}\frac{1}{2}\left(r_2^D + r_2^H\right) + \frac{\beta}{\alpha+\beta}\left(E_1\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right) + S^D\right) - r_2^D\right)^2$$

$$+\beta E_1\left(\frac{\alpha}{\alpha+\beta}\frac{1}{2}\left(r_2^D + r_2^H\right) + \frac{\beta}{\alpha+\beta}\left(E_1\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right) + S^D\right)\right.$$

$$\left.-\left(E_1\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right) + S^D\right)\right)^2$$

$$= \alpha E_1\left(\frac{\alpha}{\alpha+\beta}\left[E_1\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right) + \frac{1}{2}\left(v_2^D + v_2^H\right)\right]\right.$$

$$\left.+\frac{\beta}{\alpha+\beta}\left(E_1\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right) + S^D\right) - r_2^D\right)^2$$

$$+\beta E_1\left(\frac{\alpha}{\alpha+\beta}\left[E_1\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right) + \frac{1}{2}\left(v_2^D + v_2^H\right)\right]\right.$$

$$\left.-\frac{\alpha}{\alpha+\beta}\left(E_1\left(\frac{1}{2}\left(r_2^D + r_2^H\right)\right) + S^D\right)\right)^2$$

$$= \alpha E_1\left(E_1\left(\frac{1}{2}\left(r_2^H + r_2^D\right)\right) + \frac{\alpha}{\alpha+\beta}\frac{1}{2}\left(v_2^D + v_2^H\right) + \frac{\beta}{\alpha+\beta}S^D - r_2^D\right)^2$$

$$+\beta E_1\left(\frac{\alpha}{\alpha+\beta}\frac{1}{2}\left(v_2^D + v_2^H\right) - \frac{\alpha}{\alpha+\beta}S^D\right)^2$$

$$= \alpha E_1\left(E_1\left(\frac{1}{2}\left(r_2^H - r_2^D\right)\right) + \frac{\beta}{\alpha+\beta}S^D + \frac{\alpha}{\alpha+\beta}\frac{1}{2}v_2^H + \left(\frac{\alpha}{\alpha+\beta}\frac{1}{2} - 1\right)v_2^D\right)^2$$

$$+\beta E_1\left(\frac{\alpha}{\alpha+\beta}\frac{1}{2}\left(v_2^D + v_2^H\right) - \frac{\alpha}{\alpha+\beta}S\right)^2$$

$$= \alpha\left[E_1\left(\frac{1}{2}\left(r_2^H - r_2^D\right)\right) + \frac{\beta}{\alpha+\beta}S^D\right]^2$$

$$+\left[\alpha\left(\frac{\alpha}{\alpha+\beta}\frac{1}{2}\right)^2 + \alpha\left(\frac{\alpha}{\alpha+\beta}\frac{1}{2} - 1\right)^2 + \beta\left(\frac{\alpha}{\alpha+\beta}\right)^2\frac{1}{2}\right]\sigma_v^2 + \beta\left(\frac{\alpha}{\alpha+\beta}S^D\right)^2$$

$$= \alpha\left[E_1\left(\frac{1}{2}\left(r_2^H - r_2^D\right)\right) + \frac{\beta}{\alpha+\beta}S^D\right]^2 + \frac{\alpha}{\alpha+\beta}\left[\alpha\frac{1}{2} + \beta\right]\sigma_v^2 + \beta\left(\frac{\alpha}{\alpha+\beta}S^D\right)^2$$

where the last equality follows from

$$\left[\alpha\left(\frac{\alpha}{\alpha+\beta}\frac{1}{2}\right)^2+\alpha\left(\frac{\alpha}{\alpha+\beta}\frac{1}{2}-1\right)^2+\beta\left(\frac{\alpha}{\alpha+\beta}\right)^2\frac{1}{2}\right]$$

$$=\left[\alpha\frac{\alpha^2}{(\alpha+\beta)^2}\frac{1}{2}+\alpha\left(\frac{\beta}{\alpha+\beta}\right)+\beta\frac{\alpha^2}{(\alpha+\beta)^2}\frac{1}{2}\right]=\frac{\alpha}{\alpha+\beta}\left[\alpha\frac{1}{2}+\beta\right].$$

Conditional on disclosure, the FOC for D's choice of spin is:

$$0=2\alpha\frac{\beta}{\alpha+\beta}\left[E_1\left(\frac{1}{2}\left(r_2^H-r_2^D\right)\right)+\frac{\beta}{\alpha+\beta}S^D\right]+2\beta\left(\frac{\alpha}{\alpha+\beta}\right)^2S^D$$

$$0=\left[E_1\left(\frac{1}{2}\left(r_2^H-r_2^D\right)\right)+\frac{\beta}{\alpha+\beta}S^D\right]+\frac{\alpha}{\alpha+\beta}S^D\Rightarrow S^D=-\frac{1}{2}E_1\left(r_2^H-r_2^D\right).$$

Under the condition $\left|\frac{1}{2}E_1\left(r_2^H-r_2^D\right)\right|\le S^*$, S^D is not constrained by S^*.

Substituting $S^D=-\frac{1}{2}E_1\left(r_2^H-r_2^D\right)$ into D's expected loss:

$$E_1\left(L^D\right)=\alpha\left[E_1\left(\frac{1}{2}\left(r_2^H-r_2^D\right)\right)-\frac{\beta}{\alpha+\beta}\frac{1}{2}E_1\left(r_2^H-r_2^D\right)\right]^2$$

$$+\frac{\alpha}{\alpha+\beta}\left[\alpha\frac{1}{2}+\beta\right]\sigma_v^2+\beta\left(\frac{\alpha}{\alpha+\beta}\frac{1}{2}E_1\left(r_2^H-r_2^D\right)\right)^2$$

$$=\frac{1}{4}\left(E_1\left(r_2^H-r_2^D\right)\right)^2\left[\alpha\left(\frac{\alpha}{\alpha+\beta}\right)^2+\beta\left(\frac{\alpha}{\alpha+\beta}\right)^2\right]+\frac{\alpha}{\alpha+\beta}\left[\alpha\frac{1}{2}+\beta\right]\sigma_v^2$$

$$=\alpha\frac{1}{4}\left(E_1\left(r_2^H-r_2^D\right)\right)^2\left[\frac{\alpha}{\alpha+\beta}\right]+\frac{\alpha}{\alpha+\beta}\left[\alpha\frac{1}{2}+\beta\right]\sigma_v^2.$$

Thus, D's expected loss given disclosure is smaller than D's expected loss given non-disclosure if

$$\frac{1}{4}\left(E_1\left(r_2^H-r_2^D\right)\right)^2\left[\frac{\alpha}{\alpha+\beta}\right]+\frac{\alpha}{\alpha+\beta}\left[\alpha\frac{1}{2}+\beta\right]\sigma_v^2<\alpha\frac{1}{4}\left[E_1\left(r_2^H-r_2^D\right)\right]^2$$

$$+\alpha\frac{1}{2}\sigma_v^2\Leftrightarrow$$

$$\frac{1}{\alpha+\beta}\left[\alpha\frac{1}{2}+\beta-\frac{1}{2}(\alpha+\beta)\right]\sigma_v^2<\frac{1}{4}\left[E_1\left(r_2^H-r_2^D\right)\right]^2\left(\frac{\beta}{\alpha+\beta}\right)\Leftrightarrow$$

$$\frac{1}{2}\sigma_v^2<\frac{1}{4}\left[E_1\left(r_2^H-r_2^D\right)\right]^2\Leftrightarrow$$

$$\sqrt{2}\sigma_v<\left|E_1\left(r_2^H-r_2^D\right)\right|.$$

If H does **disclose:** The policy outcome is

$$r=\frac{\alpha}{\alpha+\beta}\frac{1}{2}\left(r_2^D+r_2^H\right)+\frac{\beta}{\alpha+\beta}\left[E_1\left(\frac{1}{2}\left(r_2^D+r_2^H\right)\right)+S^D+S^H\right]$$

and D picks S^D to minimize:

$$E_1\left(L^D\right)=\alpha\left[E_1\left(\frac{1}{2}\left(r_2^H-r_2^D\right)\right)+\frac{\beta}{\alpha+\beta}\left[S^D+S^H\right]\right]^2$$

$$+\frac{\alpha}{\alpha+\beta}\left[\alpha\frac{1}{2}+\beta\right]\sigma_v^2+\beta\left(\frac{\alpha}{\alpha+\beta}\left[S^D+S^H\right]\right)^2$$

which results in a reaction function of $S^D=\max\left(-\frac{1}{2}E_1\left(r_2^H-r_2^D\right)-S^H,-S^*\right)$.

(b) The proof is similar to that for (a).
(c) With no disclosure

$$r=\frac{1}{2}\left(r_2^D+r_2^H\right)$$

$$E_1\left(L^D\right)=\alpha\frac{1}{4}\left[E_1\left(r_2^H-r_2^D\right)\right]^2+\alpha\frac{1}{2}\sigma_v^2\ .$$

With both disclosing $S^D=-S^*$ and $S^H=S^*$

$$r=\frac{\alpha}{\alpha+\beta}\frac{1}{2}\left(r_2^D+r_2^H\right)+\frac{\beta}{\alpha+\beta}E_1\left(\frac{1}{2}\left(r_2^D+r_2^H\right)\right)$$

$$E_1\left(L^D\right)=\alpha\frac{1}{4}\left[E_1\left(r_2^H-r_2^D\right)\right]^2+\frac{\alpha}{\alpha+\beta}\left[\alpha\frac{1}{2}+\beta\right]\sigma_v^2.$$

D is thus worse off with both disclosing than neither disclosing since

$$\frac{\alpha}{\alpha+\beta}\left[\alpha\frac{1}{2}+\beta\right]>\alpha\frac{1}{2}\Leftrightarrow\left[\alpha\frac{1}{2}+\beta\right]>(\alpha+\beta)\frac{1}{2}\Leftrightarrow\beta>\beta\frac{1}{2}$$

which is true for any $\beta > 0$. Similarly, disclosure by both is worse for H relative to no disclosure.

Theorem 2 (If disagreement is low, or not much spin is feasible, then non-disclosure is possible)

Proof: **Suppose condition 1 holds,** $\sqrt{2}\sigma_v \geq \left|\frac{1}{2}E_1\left(r_2^H - r_2^D\right)\right|$

(a) If H does not disclose: Using the arguments from the proof of Theorem 1 (a), D's expected loss given disclosure is now equal to or larger than D's expected loss given non-disclosure, even if spin is unconstrained, $\left|\frac{1}{2}E_1\left(r_2^H - r_2^D\right)\right| \leq S^*$ and thus also if spin is constrained. If H does disclose, D's thinking is as in Theorem 1 leading to the same reaction function.

(b) The proof is similar to that for (a).

(c) follows directly from (a) and (b). The fact that both prefer the non-disclosure equilibrium follows from the argument used in the proof of Theorem 1 (c).

Suppose condition 2 holds, S^* sufficiently small.

(a) If H does not disclose: D's expected loss is, with non-disclosure by D

$$E_1\left(L^D\right)=\alpha\frac{1}{4}\left[E_1\left(r_2^H-r_2^D\right)\right]^2+\alpha\frac{1}{2}\sigma_v^2$$

and with disclosure by D

$$E_1\left(L^D\right)=\alpha\left[E_1\left(\frac{1}{2}\left(r_2^H-r_2^D\right)\right)-\frac{\beta}{\alpha+\beta}S^*\right]^2+\frac{\alpha}{\alpha+\beta}\left[\alpha\frac{1}{2}+\beta\right]\sigma_v^2+\beta\left(\frac{\alpha}{\alpha+\beta}S^*\right)^2$$

D thus prefers non-disclosure if:

$$\alpha\left(\frac{\beta}{\alpha+\beta}S^*\right)^2-2\alpha E_1\left(\frac{1}{2}\left(r_2^H-r_2^D\right)\right)\frac{\beta}{\alpha+\beta}S^*$$

$$+\frac{\alpha}{\alpha+\beta}\left[\alpha\frac{1}{2}+\beta\right]\sigma_v^2+\beta\left(\frac{\alpha}{\alpha+\beta}S^*\right)^2>\alpha\frac{1}{2}\sigma_v^2\Leftrightarrow$$

$$\frac{\alpha\beta}{\alpha+\beta}\left(S^*\right)^2-2\alpha E_1\left(\frac{1}{2}\left(r_2^H-r_2^D\right)\right)\frac{\beta}{\alpha+\beta}S^*+\frac{\alpha}{\alpha+\beta}\left[\alpha\frac{1}{2}+\beta\right]\sigma_v^2>\alpha\frac{1}{2}\sigma_v^2$$

which is the case for S^* sufficiently small since $\frac{\alpha}{\alpha+\beta}\left[\alpha\frac{1}{2}+\beta\right]>\alpha\frac{1}{2}$ (for any $\beta > 0$).

If H does disclose, D's thinking is as in Theorem 1 leading to the same reaction function.

(b) The proof is similar to that for (a).

(c) follows directly from (a) and (b). The fact that both prefer the non-disclosure equilibrium follows from the argument used in the proof of Theorem 1 (c).

The Three E's of Central-Bank Communication with the Public

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Central banks used to ask, "Shall we communicate this?" Now, as a rule, they ask, "Why wouldn't we communicate this?"[1] This first wave of the revolution in central-bank communication is giving rise to a second wave. The question increasingly is, "How should we communicate this in a way that engages a broader cross-section of society?" This addresses the challenge laid out by Blinder and others (2008) that "It may be time to pay some attention to communication with the general public."

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1. See Skingsley (2019).

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1. The Communications Revolution

These two waves of the communication revolution followed naturally from the growing understanding of the central role that management of expectations plays in economic management[2] and the potentially important role that central-bank communication has on expectations. But much remains to be understood, especially concerning the second wave.[3] In Haldane and McMahon (2018), we addressed issues of feasibility and desirability of communication with the general public. This paper explores, by using a simple theoretical framework and supporting empirical analysis, some of the concerns that have been raised about such broader communication and especially the potential that these efforts may do more harm than good. We set out a simple framework of complementary activities—the Three E's of Explanation, Engagement, and Education—that may help the central bank to avoid the potential pitfalls.

As we show in section 2, the evidence suggests that many households may never engage with central-bank communication because it is written in a way that they cannot understand. This contributes to a lack of trust in the central bank as an independent institution. These twin deficits (of understanding and trust) impinge on the efficacy of monetary policy and, potentially, limit the ability of operationally independent central banks to meet the terms of their social contract to serve the whole population as well as possible. It is this realisation that has sparked the second stage of the revolution: shifting from the traditional audience for central-bank communication (financial market participants and journalists) conveyed via complex, carefully crafted reports, speeches, and statements, toward directly communicating with a broader audience of the general public.

While acknowledging the evidence on twin deficits of understanding and trust, and that broader engagement is important for democratic and political economy reasons, some economists have expressed concerns about this new focus for communication. In particular, there is concern that the economy is complex and, as a result, monetary policy is not simple but, if communication is too simplified, then people may develop a false sense of certainty about the central banks' views

2. See Blinder (2009), and Woodford (2001).

3. Important papers in this literature on communicating with the wider public include Kryvtsov and Petersen (2013), Binder (2017), Braun (2018), Bholat and others (2018), and Coibion and others (2019).

about the economy. Delivering simple messages could ultimately lead the public to be disappointed if the central bank does not deliver on its communicated forecasts.

In order to explore this idea, we develop a framework in section 3 in the spirit of the rational-inattention literature but include three important dimensions: (1) A second form of communication that is easier to read but that comes with the cost that the household misses the uncertainty around those forecasts. This means that, when the world does not turn out exactly as the central bank predicted, households are surprised. (2) We change the structure of costs for different households reading the central-bank communication. Households will no longer add idiosyncratic noise to the signal but, because of too high costs, some will simply choose to be uninformed. (3) We introduce a reduced-form concept of trust into the model. We assume that this trust evolves dynamically in the model, rising when the central bank engages the public, but falling when the public are surprised by the outcomes in the economy. The cost of reading the central-bank material is linked to the household's level of trust.

While clearly designed to emphasise the potential concerns about simplified communication, the model has both an optimistic and a cautionary message. Simplified communication can increase the proportion of the population paying attention to central-bank messages which also builds trust and, as a result, increase welfare. However, this is a transitory state without further intervention. Trust ultimately falls when the household observes that reality did not exactly match the communicated signal. The net effect overall is that, in expectation, the trust of each household that pays attention to the simplified content for at least one period will be lower in the new steady state than in period 0, before the introduction of the new communication. Without intervention, welfare would be lowered in the kind of environment people have been concerned about.

While simplified communication alone is not enough, in such an environment central banks can take action to influence the speed of transition to the lower-welfare steady state and thereby can extend the time during which welfare is boosted. We explore such complementary activities in section 4 under a framework of the three E's of public communication: Explanation, Engagement, and Education. These three pillars are clearly linked—more education increases the chances of engagement and makes explanation easier. Central banks have made great strides in all three in addressing the twin deficits. Our work suggests that these related endeavours may not simply be "nice-to-haves". Rather, they may be "need-to-haves" if central banks are to reach the people currently by-passed by central-bank communication, maintain this reach, and build durable levels of trust.

Central-bank communication on monetary policy addresses both high-frequency issues (such as current economic conditions and monetary-policy decisions), as well as low-frequency ones (such as the framework for monetary policy). Adapting high frequency communication to be suitable for a wider audience is the most novel part of the recent push to communicate with the general public and will be the main focus of this paper. But as communication with a broader audience is at the heart of the inflation-targeting framework, given that the target is itself a low-frequency communication medium, we conclude the paper with a brief discussion of the overlap of the three E's regarding low-frequency communication. We highlight some of the current efforts and challenges around them (section 5).

Will existing efforts to central banks' outreach, engagement, and education be successful? Will the new approaches deliver significant penetration into previously unengaged parts of the population? The jury is still out. Blinder (2018) is pessimistic and believes that central banks are likely to continue to fail to land their messages with the general public. But given that this second wave of the central-banking communication revolution is unlikely to disappear anytime soon, further research into this issue is a must. This should include continued assessment of the outcomes of new approaches, as well as suggestions to improve results with novel approaches or refinements to existing attempts.

2. Central-Bank Communication and Trust

Does it make economic sense to have high-frequency communication with the general public? It does to the extent that expectations are important for economic dynamics—as in the New Keynesian model in Galí (2015)—and communication can aid expectations management—as in Blinder (2009) and Woodford (2001). In standard economic environments, therefore, central banks wishing to control inflation can benefit from using communication to share any private information and influence inflation expectations.

In Haldane and others (2019), we explore this question in a model in which agents do not become fully informed but rather are rationally inattentive. The main finding is that central banks should provide as much detail as possible even though some households will optimally pay little attention ("skim-read") to the signals.[4] This finding is, essentially, the approach taken by most inflation-targeting central banks. They regularly release a large amount of highly detailed information. Statements of policy decisions, inflation reports, minutes of meetings, speeches, forecast information, information on the models used, etc... are typically all available on central-bank websites for anyone to read.

But the issue is not that households skim-read the material. Rather, most households do not read it at all. For many, in fact, they cannot read it. As discussed in Haldane (2017), Coenen and others (2017), and Haldane and McMahon (2018), the main central-bank publications in many advanced economies including the U.K. and the U.S. had a reading grade level of between 14–18 according to the Flesch-Kincaid reading grade score. This is roughly equivalent to college-level and is, based on the population distribution of literacy across the population, inaccessible to about 90 percent of the general public. The majority of people presumably do not even attempt to engage with the material in, for example, an inflation report. (Speeches by politicians, by contrast, are much simpler—around grade 8 level—and thus accessible to up to half the population).

In such an environment, is it any surprise that many households have little understanding of monetary policy or the institutions that set policy? But it is not just a deficit of understanding that has concerned central banks recently. It is the fact that this deficit of understanding typically goes hand in hand with a deficit of trust in the institution, as in Haldane (2017).[5] This twin deficit is evident in responses to the Bank of England's Inflation Attitudes Survey, which is a survey of around 2,000 individuals conducted since 2001.[6] To construct an index of monetary-policy knowledge among the general public (hereafter called the "knowledge index"), we use responses to three questions about the institutional structure of monetary policy from the survey:

4. Since households in this framework choose optimally how much attention to pay to signals about the shocks, and the central bank can vary the precision of its signals (more precise signals are more costly to process), the central bank optimally chooses how precisely to communicate in order to minimise welfare losses. Making the signals easier to read involves making them less precise, but any such public noise is common to all households, and so households co-ordinate on it, thus leading to inefficient fluctuations in consumption. And so more central-bank precision is optimal.

5. See also Braun (2016) who also discusses the issue of trust in communication with the general public.

6. See also Jost (2017) and Rockall (2018).

- Q11: Which group of people set Britain's basic interest rate level?
- Q12: Which of these groups do you think sets the interest rates?
- Q13: Which of these do you think best describes the Monetary Policy Committee?

For each question, respondents getting the correct answer adds +2 to the knowledge score, admitting they do not know yields +1 and getting it wrong yields 0. This index runs from a score of 6 ("perfect knowledge") through 3 ("admitted no knowledge") to 0 ("Gets every answer wrong").

The top panel of table 1 shows the mean overall knowledge score in the U.K. survey over the past 17 years. At best, this has flat-lined despite the increase in communication by the Bank of England (BoE) over the period, thus suggesting that the public's understanding of monetary-policy structures appears to have been largely immune to central banks' communication revolution. But the aggregate evolution masks significant stratification in knowledge scores by age, education, and social class (as well as by income), with the young, less well-educated, and poor being materially less knowledgeable. For example, those in social class AB (upper-middle and middle class) have an index score 36 percentage points higher than those in grade DE (working and non-working class). This suggests that central banks' current communications initiatives are by-passing large cohorts of society. The communications revolution has been selective.[7]

By using the survey answer to Q14, which asks "Overall, how satisfied or dissatisfied are you with the way the Bank of England is doing its job to set interest rates to control inflation?", we construct a measure of satisfaction with central banks' actions. This serves as a proxy for trust and runs from 5 (most satisfied / highest trust) to 1 (unsatisfied / lowest trust). The lower panel in table 1 shows the mean of satisfaction/trust proxy score. As with other trust measures from other surveys, this declined during and following the financial crisis and has yet to fully recover. This pattern in satisfaction/trust scores in central banks' actions has been broadly based across demographic groups and across countries.

Of course, one concern is that the measure of satisfaction is not a good proxy for trust. We check this by using the survey for 2017, when there was also a question about credibility—the first part of Q27 asks respondents to what extent they agree that the Bank of England is credible. In 2017, when we have both concepts measured, there is a statistically significant positive correlation (0.46) between the credibility score and the trust proxy. Column (1) of table 2 shows

7. See Haldane and McMahon (2018).

that this correlation survives the inclusion of numerous demographic controls. Column (2) adds the institutional knowledge and economic knowledge scores too; the former is also an important correlate. Columns (3)–(5) instead focus on the correlates driving the trust proxy, with (3) showing the reversed regression from (2). Column (4) shows that even excluding the Credibility measure, institutional knowledge is a significant correlate in 2017, and (5) shows that this relationship in 2017 is very similar to the relationship across the whole sample (for which the credibility score is not available).

As argued in Haldane and McMahon (2018), one of the reasons why a central bank may want to communicate more directly with the general public is to try to build public understanding as a means of establishing trust and credibility about central banks and their policies. But why, apart from professional pride, should a central bank care whether people trust it? Shouldn't it simply get on with its job of setting the best interest rate which will, sometimes, involve difficult decisions? Mainly, this is important for reasons of political accountability, ensuring that operationally independent central banks are meeting the terms of their social contract with wider society.

Another reason to try to build trust is that trust helps manage expectations. The data in the U.K. is consistent with trust being an important driver of expected inflation.[8] There is growing evidence that inflation expectations affect economic choices made by households. This evidence includes effects on major purchase decisions and financial choices. Bachmann and others (2015) show that higher expected inflation slightly increases U.S. consumers' readiness to spend on durables in normal times. In turn, Duca and others (2018) find a similar effect for euro-area consumers, but the increase in the likelihood of making a make a major purchase is particularly strong at the effective lower bound (ELB). Malmendier and Nagel (2016) show that household's inflation expectations explain their financial decisions such as whether to have a fixed- or floating-rate mortgage. Armantier and others (2015) show that consumer inflation expectations are correlated with their experiment-based investment choices, but also that those participants whose behaviour is not consistent with economic theory have lower education and economic literacy. Vellekoop and Wiederholt (2018) show that higher inflation expectations lead households to accumulate less net worth driven by both lower asset holdings (such as savings account, bonds, and stocks) and also lower liabilities.

8. See the analysis below which expands on the analysis in Haldane and McMahon (2018), and Rockall (2018).

Table 1. Knowledge of and Satisfaction with the Central Bank

	2001	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
Knowledge Score Mean	4.2	4.2	4.2	4.2	4.3	4.1	4.2	4.2	4.1	4.2	4.2	4.1	4.0	4.0	4.0	3.9	4.1	4.0	4.0
AB Class	5.0	4.9	5.0	4.9	5.0	4.9	4.9	4.8	4.8	4.8	4.9	4.7	4.7	4.7	4.7	4.6	4.7	4.7	4.6
DE Class	3.6	3.6	3.6	3.8	3.7	3.5	3.6	3.6	3.6	3.6	3.6	3.6	3.4	3.4	3.3	3.3	3.5	3.5	3.4
University Degree	4.8	4.8	4.8	4.8	4.9	4.7	4.6	4.7	4.7	4.8	4.8	4.5	4.6	4.5	4.5	4.4	4.6	4.5	4.4
No Formal Education	4.0	4.1	4.0	4.2	4.1	4.0	4.1	3.7	3.7	3.8	3.7	3.7	3.5	3.4	3.5	3.4	3.6	3.5	3.6
Age: 15–24	3.2	3.4	3.4	3.3	3.3	3.2	3.2	3.4	3.3	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.2	3.1	3.3
Age: 55–64	4.6	4.5	4.6	4.7	4.7	4.7	4.8	4.6	4.5	4.7	4.6	4.6	4.4	4.5	4.3	4.4	4.5	4.6	4.6
Trust Proxy Mean	3.5	3.7	3.6	3.6	3.6	3.6	3.5	3.4	3.0	3.3	3.1	3.2	3.1	3.3	3.4	3.4	3.4	3.4	3.3
AB Class	3.8	3.9	3.7	3.7	3.8	3.8	3.7	3.6	3.2	3.5	3.4	3.5	3.4	3.5	3.6	3.5	3.6	3.6	3.5
DE Class	3.4	3.5	3.4	3.4	3.5	3.5	3.3	3.2	2.9	3.1	2.9	3.0	2.9	3.1	3.3	3.2	3.2	3.2	3.1
University Degree	3.8	3.9	3.7	3.7	3.7	3.7	3.6	3.6	3.2	3.5	3.4	3.4	3.3	3.5	3.6	3.4	3.5	3.5	3.4
No Formal Education	3.5	3.7	3.6	3.5	3.6	3.6	3.4	3.3	2.8	3.2	3.0	3.0	2.9	3.2	3.4	3.3	3.3	3.3	3.2
Age: 15–24	3.3	3.4	3.4	3.2	3.4	3.4	3.2	3.2	3.0	3.1	3.0	3.0	3.1	3.2	3.3	3.2	3.3	3.2	3.2
Age: 55–64	3.7	3.8	3.7	3.7	3.7	3.7	3.6	3.5	2.9	3.4	3.2	3.2	3.2	3.4	3.5	3.5	3.5	3.5	3.4

Sources: Bank of England Inflation Attituted Survey and authors' calculations.
Notes: Bank of England Attitudes to Inflation Survey. The knowledge score (upper panel) is between 0 and 6, where 6 indicates perfect knowledge of the institutions of monetary policy. The trust proxy score (lower panel) is between 5 (most satisfied / highest trust) and 1 (unsatisfied / lowest trust).

Table 2. Regression Analysis of Inflation Attitudes Survey

	(1) Credibility	*(2) Credibility*	*(3) Trust Proxy*	*(4) Trust Proxy*	*(5) Trust Proxy*
Trust Proxy	0.39***	0.37***			
	[0.00]	[0.00]			
Knowledge		0.052***	0.062***	0.10***	0.12***
		[0.00]	[0.00]	[0.00]	[0.00]
Econ Knowledge		−0.025	0.020	0.011	0.0070
		[0.18]	[0.33]	[0.62]	[0.15]
Credibility			0.49***		
			[0.00]		
Constant	2.19***	2.10***	1.20***	2.72***	2.77***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Observations	3,382	3,382	3,382	3,597	65,905
R-squared	0.272	0.280	0.266	0.102	0.087
Estimation	OLS	OLS	OLS	OLS	OLS
Demographic Controls	Yes	Yes	Yes	Yes	Yes
Year-Fixed Effects	No	No	No	No	No
Sample	2017	2017	2017	2017	2001–2019

Sources: Bank of England Inflation Attituted Survey and authors' estimations.
Notes: *Trust Proxy* measures respondent satisfaction with how the Bank is carrying out monetary policy to control inflation, *Knowledge* is their score in terms of understanding the institutions setting monetary policy, and *Econ Knowledge* is their score in terms of understanding of how monetary policy affects the economy. P-values constructed using robust standard errors are reported in brackets below the coefficient estimates. Demographic controls for gender, age, income, class, working status, housing tenure, education, and region are included.

Table 3 shows the relationship between our trust proxy and absolute values of deviations of household inflation expectations from the inflation target. There are two columns each for 1-year-ahead (columns (1)–(2)), 2-year-ahead (columns (3)–(4)), and 5-year-ahead inflation expectations (columns (5)–(6)). In these regressions, we control for the measures of both institutional knowledge and knowledge of the transmission mechanism, as well as time-fixed effects and various demographic factors (gender, age, income, class, working status, housing tenure, education, and region). Lower trust is associated with inflation expectations that are further from the inflation target. Moreover, including quadratic terms suggests that these deviations grow as trust falls. This suggests that the gains to building trust, as measured by the degree of anchoring of inflation expectation, will be largest if the central bank targets those with the lowest starting levels of trust.

Table 3. Effect of Trust on Inflation Expectations

	(1)	(2)	(3)	(4)	(5)	(6)
	$\left\|E_t[\pi_{t+1}] - \pi^*\right\|$	$\left\|E_t[\pi_{t+1}] - \pi^*\right\|$	$\left\|E_t[\pi_{t+2}] - \pi^*\right\|$	$\left\|E_t[\pi_{t+2}] - \pi^*\right\|$	$\left\|E_t[\pi_{t+5}] - \pi^*\right\|$	$\left\|E_t[\pi_{t+5}] - \pi^*\right\|$
Trust Proxy	-0.17***	-0.79***	-0.23***	-0.95***	-0.23***	-0.98***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Knowledge	-0.034***	-0.041*	-0.065***	-0.097***	-0.064***	-0.055
	[0.00]	[0.08]	[0.00]	[0.01]	[0.00]	[0.19]
Econ Knowledge		0.011		0.012		0.054
		[0.67]		[0.80]		[0.32]
Trust Proxy2		0.10***		0.12***		0.13***
		[0.00]		[0.00]		[0.00]
Knowledge2		0.00076		0.0042		-0.0014
		[0.80]		[0.36]		[0.79]
Econ Knowledge2		-0.0084		-0.013		-0.019
		[0-14]		[0.19]		[0.11]
Constant	1.97***	2.80***	2.97***	3.88***	3.26***	4.13***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Observations	58,150	58,150	29,139	29,139	25,870	25,870
R-squared	0.093	0.098	0.064	0.070	0.041	0.046
Estimation	OLS	OLS	OLS	OLS	OLS	OLS
Demographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year-Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Sample	2001–2019	2001–2019	2009–2019	2009–2019	2009–2019	2009–2019

Sources: Bank of England Inflation Attitudes Survey and authors' estimations.

Notes: *Trust Proxy* measures respondent satisfaction with how the Bank is carrying out monetary policy to control inflation, *Knowledge* is their score in terms of understanding the institutions setting monetary policy, *Econ Knowledge* is their score in terms of understanding of how monetary policy affects the economy, π_t. Perception measures their perception of current inflation, and $E_t\,[h]$ is the respondent's expectation for h-years ahead inflation where h = 1, 2&5. P-values constructed using robust standard errors are reported in brackets below the coefficient estimates. Demographic controls for gender, age, income, class, working status, housing tenure, education, and region are included.

3. A Model of Simple Communication and Trust

The previous section might make the use of simplified communication by central banks seem obvious. By communicating in a way that a broader cross-section of society can understand, the central bank might be able to better anchor inflation expectations as well as, potentially, build trust.

But some economists have expressed concern that simplified communication might be too simple. The worry is that, rather than boost trust and engagement, households will fail to understand the complex and stochastic nature of the environment which policymakers operate in. Over time, central banks might simply disappoint these newly engaged households when they miss a target or have a large forecast error. The effect on household trust and engagement may not be so desirable over time.

To explore this, we build on the empirical evidence of the last section and try to develop a framework that incorporates a role for engagement and trust. But we also want to take seriously the concerns that have been raised. The framework, which assumes that some of the concerns will play out, enables us to ask to what extent, or under which circumstances, introducing more accessible communication could help address the twin deficits.

Of course, there are reasons that the concerns may not be correct. For instance, we will assume that simplicity of the message reduces its communicated uncertainty. It is not clear whether this is true or not. The model will also only allow engagement with central-bank communication to increase trust whereas, in reality, there may be many different ways of building trust. And households may get their information on the central bank from other sources. We return to some of these issues in section 4.

3.1 Our Model Environment

The basic model environment is the simple, three-equation New Keynesian model. In order to have a role in communication with the public, we alter the informational assumptions. Specifically, we assume that, as in the textbook model, firms observe current shock realisations but, unlike the textbook model, households observe shocks only after a one-period lag. This can be thought of as the firms being "close to the ground" and so seeing shocks to technology and costs first-hand, but households having to hear about the shocks after they have hit.

Households can, however, learn about contemporaneous shocks from reading central-bank communications.[9] In the equations below, $E_t^F x$ is the expectation of x held by a fully informed agent (who observes current shock realisations) in period t, and $E_t^H x$ is the expectation of x held by households in period t.

Define c_t^* as the consumption that would be chosen by a household who observed the current realisations of all exogenous shocks. The Euler equation of a fully informed household is:

$$c_t^* = E_t^F c_{t+1}^* - \frac{1}{\sigma}\left(i_t - E_t^F \pi_{t+1}\right). \tag{1}$$

Uninformed households maximise their expected utility by setting consumption at the level they expect a fully informed household would choose, $c_t = E_t^H c_t^*$. If, as in the standard model, households do observe the current realisations of exogenous shocks, then $c_t = c_t^*$, and this model collapses to the textbook three-equation model. However, without real-time observation of shocks, this is no longer the case.

In order to ensure that our model is comparable to much of the existing literature, we want to confirm that it admits the same New Keynesian Phillips curve as in Galí (2015). The derivation of this requires that households are be always on their product-demand and labour-supply curves, and so we have to assume that households directly observe relative prices and the real wage when making their consumption and labour decisions. This comes at the cost of assuming that agents cannot back out the shocks from these observations. To this end, we simplify by assuming that households observe wages and relative prices in the current period, but they only observe the nominal interest rate with a lag, and they are unable to infer from wages and relative prices what the shocks and interest rate must be. This simplification keeps the analytic model tractable as it allows us to focus on i.i.d. shocks. [10]

$$\pi_t = E_t^F \pi_{t+1} + \kappa \tilde{y}_t + v_t, \tag{2}$$

9. Different households will receive idiosyncratic signals in our model. While the link from heterogeneous information to heterogeneous wealth is potentially interesting, it is beyond the scope of this paper. We therefore simplify by assuming that all households belong to a large family, which redistributes wealth among households at the end of each period.

10. With i.i.d. shocks, the nominal interest rate is the only way shocks can affect consumption in the household Euler equation. If households could observe the interest rate, they would therefore have no need of further information about the shocks, and central-bank communication would be irrelevant.

The central bank follows a Taylor rule:

$$i_t = \phi_\pi \pi_t. \tag{3}$$

To complete the model, there is a market-clearing condition relating the output gap to aggregate consumption c_t.

$$\tilde{y}_t = c_t - y_t^n = E_t^H c_t^* - \frac{1+\varphi}{\sigma+\varphi} a_t. \tag{4}$$

There are two exogenous shocks: a technology shock a_t and a cost-push shock v_t.

Both are assumed to be drawn from i.i.d. normal distributions:

$$a_t \sim N\left(0, \sigma_a^2\right), v_t \sim N\left(0, \sigma_v^2\right). \tag{5}$$

3.2 Expectations, Central-Bank Signals and Attention

As in Sims (2003), and in the rest of the rational-inattention (RI) literature, households form their expectations about the consumption they should be choosing, $E_t^H c_t^*$, by paying attention to signals about shocks. In this paper, we examine the role of central-bank communication as the source of these signals. From the signals that they extract from the communication, the households will form expectations about current shock realisations, which they will then map to expected fully informed consumption c_t^*.

As described above, in Haldane and others (2019), by using an information environment that is similar to the typical RI environment, we show that, when the central bank provides independent signals about the two shocks, welfare losses from the volatility of inflation and the output gap are minimised when the central bank communicates as much information as possible (which means that their signals contain as little noise as possible). This is because, being common to all households, any noise introduced by the central-bank communication causes households to coordinate on this central-bank noise, thus leading to inefficient fluctuations in consumption. The fact that the noise is common across households is key. When households choose to pay less attention to signals, household-specific noise is introduced into expectations but, unlike the central-bank noise, it cancels out in aggregate.

In this paper, to allow us to consider the effects of the twin deficits of trust and understanding, as well as being more explicit in analysing the effects of introducing an alternative medium of communication, we make three changes to the communication and information setup:

1. Households face a household-specific fixed cost of processing central-bank communication (μ_h).
2. There is a medium-specific cost of reading information which reflects the complexity of the medium (F_{medium}). This allows us to explore the effects of having a second form of central-bank communication that is easier to read (lower processing cost).
3. We introduce, in a very reduced-form manner, the concept of trust, $\mathcal{T}_{ht}$, into the model and link this to the cost of reading the central-bank material.

The overall household- and medium-specific cost of reading a communication combines the three aspects introduced:

$$C_{IR,h,t} = F_{IR} \frac{\mu_h}{\mathcal{T}_{ht}}. \tag{6}$$

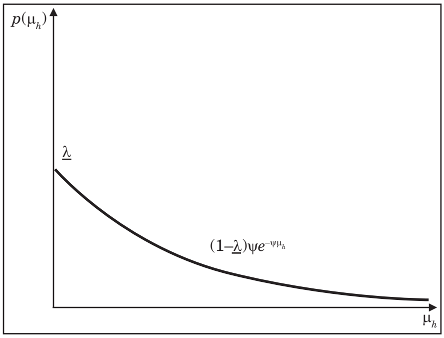
We will now discuss each element in turn.

3.2.1 Household-Specific Processing Cost

The household-specific cost of processing the central-bank communication, which could be thought of as their ability to process information, or the particular importance of information to them compared with other households, is modelled as follows. A fraction $\underline{\lambda}$ of households are endowed with a cost of information $\mu_h = 0$, while the remaining $1-\underline{\lambda}$ have μ_h, which is drawn (before period 0) from an exponential distribution $\mu_h \sim exp(\psi)$.[11] This means that the proportion of households with zero cost of processing the Inflation Report is the $\underline{\lambda}$ and also those drawn from the exponential distribution to have zero cost ($f(\mu_h = 0) = \psi$). Thus, the population probability that the household has no cost, $p(\mu_h = 0)$, is given by the combination of these two: $p(\mu_h = 0) = \underline{\lambda} + (1-\underline{\lambda})\psi$. The $\mu_h = 0$ distribution, $p(\mu_h = 0) = \underline{\lambda}$, is depicted in figure 1.

11. The probability density function (pdf) of an exponential distribution is defined over non-negative support as $f(x;\psi) = \psi e^{-\psi x}$.

Figure 1. Distribution of Household Processing Costs μ_h



Source: Authors' model assumption.
Notes: A fraction A of households are endowed with a cost of information $\mu_h = 0$. The remaining $1-\underline{\lambda}$ are drawn from an exponential distribution $\mu_h \sim exp(\psi)$.

3.2.2 Traditional and Simplified Central-Bank Communication

We will compare the effects of the central bank introducing a second form of communication that is easier to read. We will call these communications "Inflation Report" and "layered content" for consistency with the recent innovations of the Bank of England, as discussed in Haldane and McMahon (2018) and below. We will assume the central bank always provides the Inflation Report and the decision is whether to introduce the second medium of communication.

Both forms of communication are costly to read. The layered content is easier to read because it contains less detail, which we model by setting $F_L < F_{IR}$. In line with the concerns discussed above, we impose that the layered content does not communicate fully the complex stochastic nature of the outlook. In other words, the easier-to-read content communicates the mean of the shocks at lower cost to the household but at the cost that the household underestimates the uncertainty around those forecasts.

Specifically, the layered content gives households the same expectations of all shocks as the full Inflation Report,[12] but it does

12. As in Haldane and others (2019), we assume that the Inflation Report contains signals about each shock x_t given by $s_t^x = x_t + \in_t^x$ where $\in_t^x$ is an i.i.d. public noise shock. Households choosing to read the Inflation Report observe these signals and update their expectations about each fundamental shock x_t, and each noise shock $\in_t^x$, accordingly. Details of the resulting expectations can be found in Haldane and others (2019).

not say anything about the uncertainty around those expectations. Households misinterpret this to mean that there is no uncertainty.[13] This is clearly an extreme assumption. Household utility is unaffected by the uncertainty in the Inflation Report because this is a linearised model. However, the perceived certainty will lead households to be surprised by realisations that differ from their perceptions. These surprises, described formally below, reduce households' trust in the central bank.

3.2.3 Trust

We define a variable $\mathcal{T}_{ht} \in [0,1]$ to be the degree of trust household h has in the central bank. When a household trusts the central bank more, they will be more likely to pay attention to its communications, which we model by including trust in the overall cost for a household when processing central-bank signals. Trust evolves depending on the experiences of the household. We assume that trust in the central bank increases when the central bank communicates with a household. If, however, the communication leads the household to be surprised by the outcome, then trust will decline.

All households begin with $\mathcal{T}_h = 0.5$ and trust then evolves according to:

$$\mathcal{T}_{ht} = \begin{cases} 0 & \text{if } \hat{\mathcal{T}}_{ht} \leq 0 \\ \hat{\mathcal{T}}_{ht} & \text{if } \hat{\mathcal{T}}_{ht} \in (0,1) \\ 1 & \text{if } \hat{\mathcal{T}}_{ht} \geq 1 \end{cases} \tag{7}$$

Where:

$$\hat{\mathcal{T}}_{ht} = \mathcal{T}_{ht-1} + \delta_c 1_{\text{engage}} + \delta_s 1_{\text{surprise}} S\left(a_{t-1}, v_{t-1}, \epsilon^a_{t-1}, \epsilon^v_{t-1}\right), \delta_c > 0, \delta_s < 0. \tag{8}$$

13. Strictly speaking, we are departing from Rational Inattention (RI) in the style of Sims (2003) here. Sims' information cost is proportional to the uncertainty reduction from processing the signal (measured by the expected entropy reduction between prior and posterior beliefs). Our simple signal reduces uncertainty to zero and would so carry an infinite cost if we used this measure, which would not capture the intuitive notion that a point expectation is easier to communicate than the uncertainty around that expectation. This is why we specify the cost of processing signals in terms of the reduced-form constants F_{IR} and F_L.

The indicator 1_{engage} equals 1 when the household has processed some information from the central bank in period t. δc measures the responsiveness of trust to engagement. Some households will, in equilibrium, choose optimally to not read *any* communication.

In period t, the household observes the realisations of the shocks from period $t-1$. The indicator variable 1_{surprise} equals 1 in period t if the realised shocks in the last period were outside the support of the household's expectations. In standard rational-inattention models, communication induces beliefs with an infinite support, so these surprises never happen. This will, however, occur when we move to the simpler, 'layered content' for the reasons described above. The function $S(\cdot)$ measures how surprised the household is—how far realised shocks deviate from the edge of their beliefs—and it is defined formally below. δs measures the responsiveness of trust to surprises.

3.3 Welfare and Information Processing

The key to the model is the fact that information is costly to process, but less-informed households suffer a welfare loss by making sub-optimal decisions. In this case, the household will decide whether or not to read central-bank communication and, in doing so, will become somewhat informed. Households who optimally choose not to be informed will have no signals.

We follow a guess-and-verify approach:

1. We start with a guess for how shocks influence inflation and the consumption of a fully informed household. We assume that each is a linear function of current shocks and public noise and refer to these as the policy functions.

The policy function for fully informed consumption is $c_t^* = \beta_0 a_t + \beta_1 v_t + \beta_2 \in_t^a + \beta_3 \in_t^v$.

2. Given these relationships, we then find the consumption of inattentive households and the output gap implied by these linear rules. These choices of the inattentive households feed back into the model equations and determine the coefficients of the policy functions.

3. All of these policy-function coefficients are dependent on the amount of attention households pay to central-bank communication. The expected utility loss from being less than fully informed about shocks, to a quadratic approximation of the utility function,[14] is proportional to the variance of $(c_t^* - c_t)$ - the gap between the

14. We prove this finding in appendix A.

consumption of a fully informed household and actual consumption. We then solve for the household's decision to pay attention, which depends on its time- and household-specific processing cost.

4. Only a fraction of households processes the central-bank communication in period t. Define this fraction Λ_t, which is given by the following expression:

$$\Lambda_t = \underline{\lambda} + (1 - \underline{\lambda})\lambda_t \tag{9}$$

where Λ_t is the fraction of households with positive information costs who process the communication. This variable will feed back into the behaviour of the economy.

5. Once we have the optimal household choices and the implied behaviour of the economy, we can explore the effects of introducing an alternative form of communication.

This guess-and-verify approach is necessary because of the role of higher-order beliefs in equilibrium. For a household to translate their expectations of each shock into a consumption choice, they must form a belief about how the interest rate responds to shocks. To do this they need to form beliefs about how other households respond to the shocks, and so each household must form beliefs about the (average) shock expectations of other households, and also about the beliefs of those other households about all other households, and so on. This is not an issue in full information models, where all households have the same expectations, and those expectations are common knowledge. The guess-and-verify approach finds an equilibrium for the higher-order belief problem and is common in the rational-inattention literature.[15]

3.4 To Read, or not to Read the Inflation Report?

We start by considering an environment in which there is only the Inflation Report, as in the baseline model. The key result from this section can be summarised as:

Result 1

When there is *only the Inflation Report from the central bank, the equilibrium will be a steady state in which all households with zero idiosyncratic processing costs* ($\mu_h = 0$) *and some households with positive processing costs* ($\mu_h > 0$) *will read it.*

15. See Mackowiak and Wiederholt (2009).

Trust is constant in the steady state with all readers of the communication having full trust. Those who do not read anything remain with trust at its starting value because they never engage but never form precise expectations, so are also never surprised.

The decision is whether a household will read the Inflation Report or not read anything. Households processing the Inflation Report are not fully informed: they observe noisy signals s_t and set $c_{IR,t} = E_t^H(c_t^* | s_t)$. Households not processing any communication get no information and so set $c_{N,t} = 0$.

If more households pay attention (i.e. if Λ_t rises), inflation is less volatile conditional on fundamental shocks a_t and v_t, because aggregate consumption is more responsive to these shocks. Conversely, aggregate consumption is also more responsive to noise in the Inflation Report when Λ_t rises, which increases the volatility of inflation. The overall effect of an increase in the proportion of households who are attentive is that the variance of inflation falls, which means that the consumption of a fully informed household is less volatile, and this reduces the incentive for other households to pay attention.[16]

As noted above, the utility loss from lack of information is a constant multiple of the variance of the gap between actual consumption and the optimal consumption of a fully informed household.[17] The utility loss from choosing no information rather than reading the Inflation Report is therefore a constant multiplied by the difference between these two variances. This simplifies to:

$$\mathrm{Var}\left(c_t^* - c_{N,t}\right) - \mathrm{Var}\left(c_t^* - c_{IR,t}\right) = \tag{10}$$

$$\left(\frac{\kappa\phi_\pi(1+\varphi)}{(\sigma+\kappa\phi_\pi\Lambda_t)(\sigma+\varphi)}\right)^2 \tau_a\sigma_a^2 + \left(\frac{\phi_\pi}{\sigma+\kappa\phi_\pi\Lambda_t}\right)^2 \tau_v\sigma_v^2$$

where τ_a and τ_v are the signal to noise ratios of the Inflation Report signals about the technology shock and the cost-push shock, respectively.

16. This is why we model a continuum of household information costs: with two types of households (low μ and high μ) there will not necessarily be an equilibrium where households play pure strategies of either paying attention or not.

17. In order for this to be the relevant loss function, here we assume that households do not take into account how the parameters in the optimal decision rule will change over time. That is, they assume that the current share of households processing information Λ_t will persist forever, though in fact with layered content it will not.

We normalise the constant in front of this variance in the utility loss to 1 without loss of generality, as it just requires a rescaling of the complexity of information parameter FIR. Households therefore choose to pay attention to the Inflation Report if:

$$\left(\frac{\kappa\phi_\pi(1+\varphi)}{(\sigma+\kappa\phi_\pi\Lambda_t)(\sigma+\varphi)}\right)^2\tau_a\sigma_a^2+\left(\frac{\phi_\pi}{\sigma+\kappa\phi_\pi\Lambda_t}\right)^2\tau_v\sigma_v^2>F_{IR}\frac{\mu_h}{\mathcal{T}_{ht}}. \tag{11}$$

In the initial period when all households have trust equal to 0.5, all $\underline{\lambda}$ households with ($\mu_h = 0$) pay attention to the Inflation Report. In addition, a fraction A_0 of households with ($\mu_h > 0$) pay attention, that is, all households with a $\mu_h < \mu^*(\lambda_0)$, where:

$$\begin{aligned}&\left(\frac{\kappa\phi_\pi(1+\varphi)}{\left(\sigma+\kappa\phi_\pi\left(\underline{\lambda}+(1-\underline{\lambda})\lambda_0\right)\right)(\sigma+\varphi)}\right)^2\tau_a\sigma_a^2\\&+\left(\frac{\phi_\pi}{\sigma+\kappa\phi_\pi\left(\underline{\lambda}+(1-\underline{\lambda})\lambda_0\right)}\right)^2\tau_v\sigma_v^2=F_{IR}\frac{\mu^*(\lambda_0)}{0.5+\delta_c}\end{aligned} \tag{12}$$

The exponential distribution of μ_h means that λ_0 is given by:[18]

$$-\frac{F_{IR}\ln(1-\lambda_0)(\sigma+\kappa\phi_\pi(\underline{\lambda}+(1-\underline{\lambda})\lambda_0))^2}{(0.5+\delta_c)\psi\phi_\pi^2}=\left(\frac{\kappa(1+\varphi)}{\sigma+\varphi}\right)^2\tau_a\sigma_a^2+\tau_v\sigma_v^2 \tag{13}$$

From this, $\frac{d\lambda_0}{dF_{IR}}<0$. That is, the more difficult the Inflation Report is to process, the fewer households process it.

After the initial period, all households with $\mu_h > \mu^*(\lambda_0)$ pay attention to the Inflation Report and see their trust rise until it reaches the maximum trust of 1. The steady state with the Inflation Report as the only possible communication from the central bank therefore has a share $\Lambda_0=\underline{\lambda}+(1-\underline{\lambda})\lambda_0$ of households processing any information about shocks, and an average trust of:

$$\bar{\mathcal{T}}_0=\Lambda_0+\frac{1-\Lambda_0}{2}=\frac{1+\Lambda_0}{2}. \tag{14}$$

18. The quantile function of the exponential distribution is, conveniently, given by: $\mu^*(\lambda)=-\frac{\ln(1-\lambda)}{\psi}$.

3.5 Introducing Simplified Communication

Now, instead, imagine that in period 1, the central bank introduces the new form of easier-to-process communication. The key result from this section can be summarised as:

Result 2

Simplified Communication initially increases trust as more households engage with the central bank.

But when a large shock arrives, households are surprised, lose trust, and stop engaging. Not reading the simplified communication is an absorbing state, as there is no way for trust to increase once a household has stopped reading the communication.

If trust starts out lower before the introduction of simplified communication, the initial gain in trust is larger, but the decay in engagement occurs more quickly.

In terms of the decision when there is a choice of media, we can distinguish the reaction of different types of household—those who were reading the Inflation Report and stay reading it, those who switch to reading the layered content, those who did not read the Inflation Report but start reading layered content, and those who never engage with either medium.

Since household utility is unaffected by the uncertainty in the Inflation Report, households with $\mu_h = 0$ are indifferent between the Inflation Report and the simplified communication. We assume that all households with $\mu_h = 0$ continue to read the Inflation Report.[19]

Households with $\mu_h > 0$, however, strictly prefer the simplified communication: it gives the same expected utility loss and is cheaper to process. All households with $\mu_h \in (0,\mu^*(\lambda_0)]$ therefore switch from processing the Inflation Report to paying attention to the simplified communication.

In addition, many households who were previously processing no information from the central bank will now read the simplified communication. This is true for households with $\mu_h \in (\mu^*(\lambda_0), (\mu^*(\lambda_1)]$, where:

$$-\frac{F_L \ln(1-\lambda_1)(\sigma+\kappa\phi_\pi(\underline{\lambda}+(1-\underline{\lambda})\lambda_1))^2}{(0.5+\delta_c)\psi\phi_\pi^2} = (\frac{\kappa(1+\varphi)}{\sigma+\varphi})^2 \tau_a \sigma_a^2 + \tau_v \sigma_v^2. \tag{15}$$

19. This is necessary because all households who switch to simplified communication will eventually lose trust and switch to not processing any information. If all households did this, aggregate consumption would be completely unresponsive to the interest rate and the model solution would be indeterminate.

Note that $F_L < F_{IR}$ implies that $\lambda_1 > \lambda_0$, so we can be sure that some households switch from processing no information to paying attention to simplified communication.

These forces have opposing effects on trust. Processing the simplified communication increases the trust of these households in the central bank. In periods after switching, however, the households who read the simplified communication are subject to being surprised, which reduces trust.[20]

The degree to which their trust falls is determined by $\delta_{s,}$ as well as how far the shocks are from the expectations given by the simplified communication, which is determined by the $S(\cdot)$ function:

$$S\left(a_t, v_t, \in_t^a, \in_t^v\right) = (a_t - E_t^L a_t)^2 + (v_t - E_t^L v_t)^2 + (\in_t^a - E_t^L \in_t^a)^2 + (\in_t^v - E_t^L \in_t^v)^2. \tag{16}$$

Here E_T^L is the expectation induced by the simplified communication. By assumption, the simplified communication implies the same expectations of each shock as the Inflation Report, so $E_t^L a_t = \tau_a\left(a_t + \in_t^a\right)$, $E_t^L v_t = \tau_v\left(v_t + \in_t^v\right)$, $E_t^L \in_t^a = \left(1-\tau_a\right)\left(a_t + \in_t^a\right)$, $E_t^L \in_t^v = \left(1-\tau_v\right)\left(v_t + \in_t^v\right)$. Substituting this into the definition of S we have:

$$S\left(a_t, v_t, \in_t^a, \in_t^v\right) = 2(a_t\left(1-\tau_a\right) - \tau_a \in_t^a)^2 + 2(v_t\left(1-\tau_v\right) - \tau_v \in_t^v)^2. \tag{17}$$

Note that the extent of surprise expected by the policymaker before shocks are realised is therefore:

$$E_{t-1} S\left(a_t, v_t, \in_t^a, \in_t^v\right) = 2\left(1-\tau_a\right)\sigma_a^2 + 2\left(1-\tau_v\right)\sigma_v^2. \tag{18}$$

There is also a dynamic effect from the evolution of trust. If there are a few periods with small shocks, then the surprises S_t will be low and trust will rise. Eventually, however, there will be large enough shocks that cause trust to fall and, when this happens, households will stop reading the simplified communication because the cost of processing it rises with falling trust. In the model, not reading

20. They observe the true realisations of the previous period fundamental shocks a_{t-1} and v_{t-1}, and the noise shocks $\in_{t-1}^a$ and $\in_{t-1}^v$. The values communicated in the simplified communication were combinations of fundamental and noise shocks, so the probability that these shocks exactly equal the values communicated in the simplified communication is zero. The shock realisations are therefore outside of the range households reading the simplified communication thought was possible, and so they lose trust.

the simplified communication is an absorbing state, as there is no way for trust to increase once a household has stopped reading the communication. This is an extreme assumption. This means that, eventually, there will be a series of sufficiently large shocks that the share of households processing simplified communication hits zero.[21] At that point, only the $\underline{\lambda}$ households with no information cost remain processing any information. We therefore eventually reach a new steady state with $\Lambda_t = \underline{\lambda}$. This is lower than the share of households processing information in period 0, before the introduction of the simplified communication.

The expected time path for λ_t, the share of households with positive information costs μ_h who process any information at all, is plotted in figure 2a for a quarterly calibration (discussed in appendix B). In this calibration, before the introduction of simplified communication, a fraction $\lambda_0 = 0.1$ of households with positive information costs read the Inflation Report. In period 1, all of these households switch to reading the simplified communication and a further 20 percent of the households with $\mu_h > 0$ switch from not processing any information to reading the simplified communication. The new communication therefore initially has the effect that more households pay attention to the communication. Over time, however, the trust of households processing the simplified communication is eroded, and so households start to switch to no information processing.

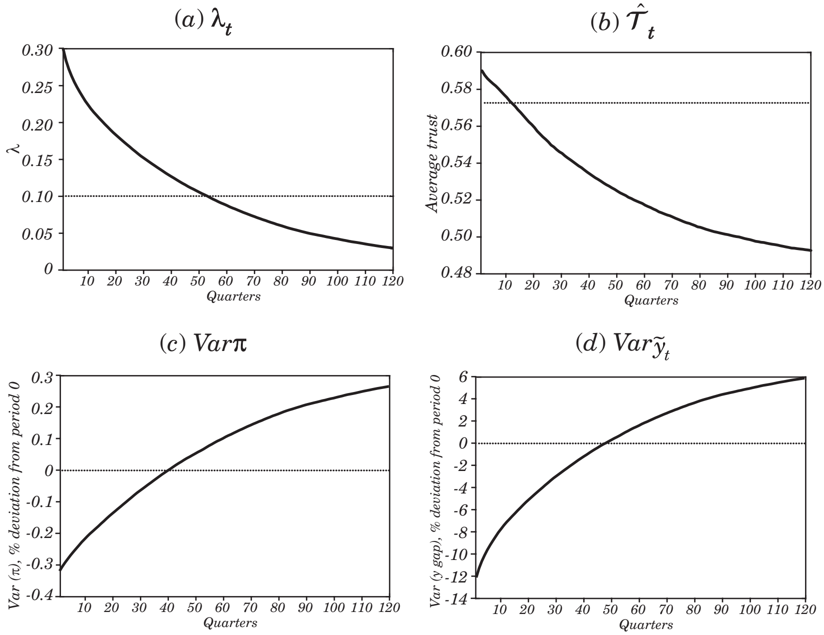
The average trust households have in the central bank is expected to evolve according to the path plotted in figure 2b. Initially, trust rises when the simplified communication is introduced, because many households who were not paying any attention to central-bank communication now read the simplified communication, and that contact with the central bank increases their trust. However, over time this boost is outweighed by the losses in trust when households see past realisations of shocks and realise that they were outside of the support of their beliefs, which they were given by the central bank through the simplified communication. Trust then falls. The rate at which it falls is decreasing over time (the time path is convex) because a household's trust only continues to fall for as long as they pay attention to the simplified communication. As time passes, fewer and fewer households are still paying attention to that communication,

21. Interestingly, the fact that not reading any information is an absorbing state means that even if $\delta_c + \delta_s ES \geq 0$ i.e. if trust would rise over time if surprises were of their expected magnitude, the model eventually ends up at the low-trust steady state.

and so the rate of decrease of average trust slows down. Eventually, no households are left paying attention to the simplified communication and average trust reaches a new lower steady state.

With this calibration, average trust is above its initial (pre-simplified communication) level for 11 quarters on average, and the share of households engaging with simplified communication remains above its initial level for 50 quarters. This continues to be higher than the initial level long after trust is below its initial value because the simplified communication has a lower processing cost than the Inflation Report. Trust and engagement reach their new lower steady state after approximately 250 quarters.

Figure 2. Time Path of λ_t, $\hat{\mathcal{T}}_t$, Var π and Var $\tilde{y}_t$ after the Introduction of Simplified Communication



Source: Authors' model.
Notes: The line is the expected path of either share of processing households or average trust. The horizontal line is the steady state where no simplified communication has ever existed.

The critical trust level at which a household with information cost μ_h stops processing the simplified communication is given by:

$$\mathcal{T}_h^* = \frac{F_L \mu_h (\sigma + \kappa\phi_\pi \left(\underline{\lambda} + (1-\underline{\lambda})\left(1 - e^{-\psi\mu_h}\right)\right))^2}{\phi_\pi^2 (\left(\dfrac{\kappa(1+\varphi)}{\sigma+\varphi}\right)^2 \tau_a \sigma_a^2 + \tau_v \sigma_v^2)}. \tag{19}$$

This critical trust is increasing in μ_h, so households who face higher information costs stop processing simplified communication earlier, when their trust has fallen only a small amount. Once a household has stopped processing the simplified communication, their trust from the next period onwards is $\mathcal{T}_h^* + \delta_s S\left(a_{t^*}, v_{t^*}, \in_{t^*}^a, \in_{t^*}^v\right)$, where t^* is the last period in which they processed the simplified communication.[22] This model has the implication, consistent with the U.K. data, that the households with the highest trust are also those with most engagement and understanding—the A households.

The effect of this on welfare is clear. When the fraction of households processing information about shocks increases, the unconditional variance of inflation and the output gap decrease, thus boosting welfare. This is because attentive households respond appropriately to changes in the interest rate, where inattentive households do not. A greater share of responsive households therefore has the same effect in the model as increasing the Taylor rule coefficient . However, inflation and the output gap are more volatile in the new steady state because fewer households ultimately process information about shocks. The time path for the volatility of inflation and the output gap is plotted in figures 2c and 2d.

This means that even if the policymaker does not care about trust for its own sake, introducing simplified communication can have negative long-run welfare effects. This is because it causes some households who were previously paying attention to the Inflation Report to switch to simplified communications and therefore lose trust in the central bank. This means that the long-run share of households processing information from the central bank falls, thus increasing the volatility of inflation.

22. The extra $\delta_s S$ comes from the surprise they receive in the period after they stop processing simplified communication, when they realise that the shocks in period t^* were not within the support of their expectations.

3.6 Factors Affecting the Balance Between the Two Effects

As described at the beginning of this section, this model is engineered to give a central role to the concern that simple communication does not communicate uncertainty appropriately, and this can lead households to become surprised. Given the result above, why would a central bank in our model environment adopt the simple-communication strategy? In this subsection we describe the key model parameters that alter the magnitude of, and speed of moving between, the positive and negative welfare effects. The framework also allows us to begin to explore the extent to which central banks introducing simplified communication may wish to also engage in other outreach activities to try to prevent this disengagement and reduction in welfare over time. In the next section, we relate these model parameters to more practical concepts in the real world and emphasise the three E's.

3.6.1 Myopia

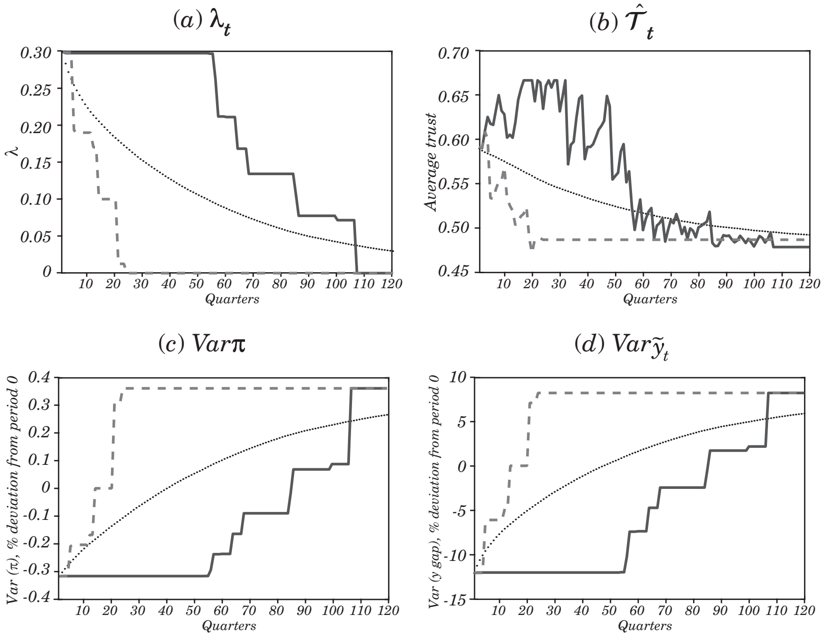
In assessing the decision to introduce the simple forms of communication, a central banker needs to weigh near-term welfare gains with longer-term losses. Since the potential costs come only over time, a more myopic central banker will be more likely to want to switch as the future welfare losses will be discounted toward zero.

3.6.2 Luck

If there are periods of shocks with smaller than average magnitudes, then average trust will rise and no households will switch away from reading the simplified communication. As soon as larger shocks come along, though, trust will fall. To see this, figures 3a and 3b plot the paths of λ_t and $\overline{\mathcal{T}}_t$ for two simulations of the model.

The effect of these different time paths of trust and engagement is reflected in markedly different welfare effects. Figure 3c (3d) shows that inflation (output gap) volatility decreases (decreases) when simplified communication is introduced, and if shocks are benign it stays low, as in the first 55 periods of the simulation drawn in the solid line. This makes the adoption of simplified communication much more beneficial in the solid-line simulation than in the dashed-line simulation, where large shocks early on after the introduction of simplified communication cause large falls in trust and engagement.

Figure 3. Time path of λ_t, $\hat{\mathcal{T}}_t$, Var π and Var $\tilde{y}_t$ after the Introduction of Simplified Communication: the Effect of Benign or Volatile Times



Source: Authors' calculations.
Notes: The dotted line is the expected path of the share of processing households, average trust, the variance of inflation, or the variance of the output gap. The dark gray (solid) and gray (dashed) lines are these variables for two simulations of the model.

3.6.3 Less Sensitivity to Surprises (or Greater Sensitivity to Communication)

Another obviously important aspect of the model, and one that may potentially be influenced be the central bank, is the speed at which the central bank gains or loses trust ($\delta_c > 0$ and $\delta_s < 0$). Interestingly, we reach the new lower-welfare steady state even in the case where the trust loss from the expected surprise is smaller than the trust gain from communication (i.e. $\delta_c + \delta_s ES > 0$). This is because not reading any communication is an absorbing state: once trust has fallen below the critical level for a household, it is assumed they stop reading any communication and there is no way for trust to rise again. (In reality, the central bank will have to adopt alternative engagement techniques to re-establish trust.) After many periods, there will eventually be enough large shocks to ensure that trust falls to the level needed to reach the new steady state. This is helped by the fact that trust is bounded above by 1, so many periods of reasonably accurate communication does not imply trust continually improving. Figure 4 plots the same expected time paths of model variables considered in figure 2, comparing the baseline results with the corresponding paths if penalty from surprises (δ_s) has been reduced so that the effect of communication on trust after an average-sized surprise is positive.

It takes much longer for households to stop reading the simplified communications in this setting, and so there are many more periods before engagement with central-bank communication is expected to fall below its initial level. The economy does still arrive at the new steady state in which no household with reads any central-bank communication eventually, however. In this calibration, this is expected to occur after approximately 100 years (400 quarters).

3.6.4 Starting Levels of Trust Matter

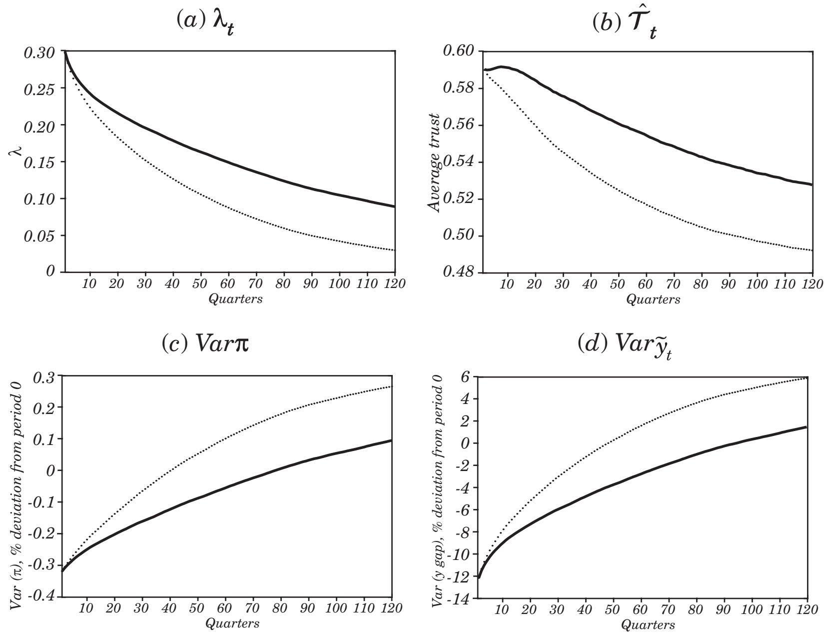
The introduction of simplified communication at the Bank of England did not take place in a vacuum. It was, in part, a response to a general fall in the trust households placed in the institution (and in public institutions in general) after the Great Recession, as highlighted above. Here we show that the effects of introducing simplified communication in this model differ depending on whether it is done in an era of high trust (i.e. pre-crisis) or after an external shock has reduced the trust of all households (post-crisis).

Figure 5 plots the expected paths of the share of households with positive information processing costs engaging with central-bank communications (λ_t), average trust, the volatility of inflation, and the output gap after the introduction of simplified communication for two starting points. For the first (drawn with a dotted line), trust is high for all households in period zero before the introduction of simplified communication, whereas in the second (solid line), initial trust is low for all households, even those who have been reading the Inflation Report for many periods.[23] In both cases, the expected paths of all

23. The initial trust before simplified communication of those not reading any communications and those reading the Inflation Report is 0.9 and 1 respectively in the high-trust case, and 0.1 and 0.2 respectively in the low-trust case.

variables are plotted as percentage deviations from the respective values of these variables in the period before the introduction of simplified communication.

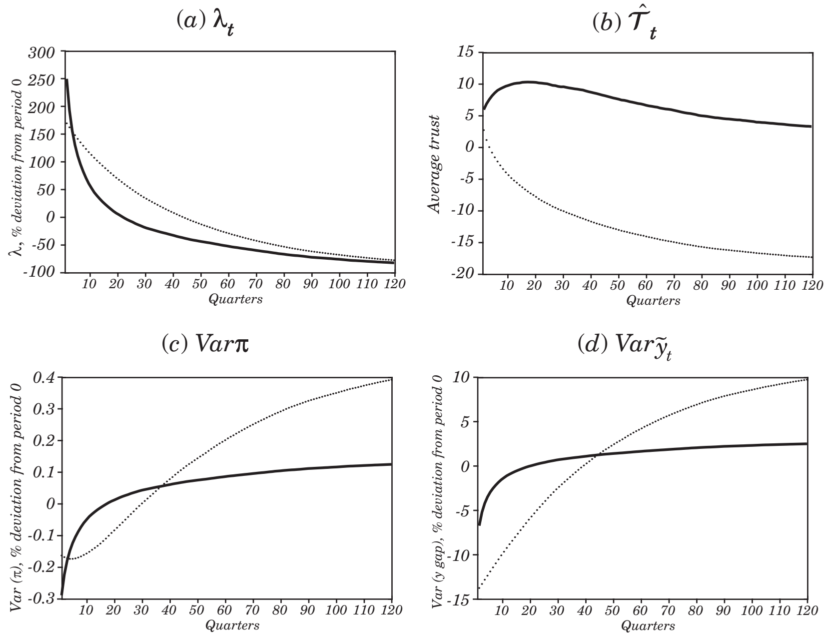
Figure 4. Time path of λ_t, $\hat{\mathcal{T}}_t$, Var π and Var $\tilde{y}_t$ after the Introduction of Simplified Communication: the Effect of Less Sensivity Via $\delta_c > 0$ and $\delta_s < 0$



Source: Authors' calculations.

Notes: The dotted line is the expected path of the share of processing households, average trust, the variance of inflation, or the output gap in the baseline model. The solid line is the same expected paths for a 10% smaller (less negative) value of δ_s.

Figure 5. Time path of λ_t, $\hat{\mathcal{T}}_t$, Var π and Var $\tilde{y}_t$ after the Introduction of Simplified Communication: the Effect of Different Starting Levels of Trust



Source: Authors' calculations.
Notes: The dotted line is the expected path of either share of processing households, average trust, the variance of inflation, or of the output gap relative to initial values with high initial trust. The solid line is the expected path relative to period 0 of the same variables in the case where initial trust is low.

The share of households engaging with central-bank communication λ_t increases when simplified communication is introduced for both initial levels of trust, but this increase is substantially larger when initial trust is low. However, low initial trust also leads to a more rapid decline in λ_t. This is because the total cost to a household of processing central-bank communications is the complexity of that information F multiplied by $\frac{\mu_h}{\mathcal{T}_h}$. The difference between the cost of processing the simplified communication and the Inflation Report is therefore higher when trust is low:

$$C_{L,h,t} - C_{IR,h,t} = \frac{(F_L - F_{IR})\mu_h}{\mathcal{T}_h}. \tag{20}$$

When trust is low, introducing simplified communication therefore makes a greater difference to the costs of processing central-bank communication, and so the initial rise in λ_t when simplified communication is introduced is greater when trust is low. The rate at which processing cost falls as trust rises is also greater when trust is low. This is why λ_t falls more quickly over time in the low initial trust case:

$$\frac{dC_{L,h,t}}{d\mathcal{T}_h} = -\frac{F_L \mu_h}{\mathcal{T}_h^2}. \tag{21}$$

These paths for λ_t imply that the fall in the volatility of inflation on the introduction of simplified communication is greater when initial trust is low, but that inflation volatility also rises more quickly in this case. The low-trust steady state that is reached after many periods of simplified communication and household surprises is the same irrespective of the initial levels of trust. As the variance of inflation before simplified communication is higher when trust is lower, the increase in inflation volatility from pre-simplified communication to the new steady state is smaller for lower initial trust.[24]

Interestingly, average trust may actually be higher in the new steady state after the introduction of simplified communication than it was with just the Inflation Report. This is because there is a large number of households who engage with the simplified communication and so see their trust rise. They stop engaging when they receive a surprise and their trust falls, but it is still above the level when the Inflation Report was the only way to engage with the central bank. This is not the case in our baseline with medium initial trust, or with high initial trust.

4. The Three E's of Public Communication

We now turn to consider the practical steps a central bank can take in conjunction with adopting simplified communication. If the concerns built into the model are correct, these are necessary steps to ensure the longest possible benefits in terms of welfare and trust. But even if not, these are likely to be desirable as part of central banks' commitment to being accountable to the whole economy.

24. Lower initial trust implies higher initial inflation volatility because with lower trust, fewer households are engaging with the Inflation Report and so fewer households are informed about shocks.

While most of the central-bank communication literature focuses on management of expectations, we adopt a focus on three E's that play an important role in such management:[25]

- Explanation
- Engagement
- Education

We shall discuss each in turn and relate the ideas to our model's predictions. We shall also discuss the Bank of England's activities under each heading.

4.1 Explanation

This is the core of communication in the effort to manage expectations. Explanation is about ensuring the people form their expectations with the best possible information. In the model, it is the sending of signals. In reality it is much harder. The economy is not summarised by two independent shocks but is, rather, a high dimensional and extremely complex system.

In the model, we embedded the complexity of the explanation in the common cost of the communication F_{IR} or F_L. The idea of the model is that clearer explanations that are easier to read (related to the earlier material on readability measures) build trust, but ultimately may lead to the household being unduly confident about the future outcome, such that they are surprised by actual developments.

Haldane and McMahon (2018) undertook an experiment using the communication from the Bank of England's November 2017 release of more-easily understood communication alongside the traditional quarterly Inflation Report (IR) and Monetary Policy Summary.[26] The new, broader-interest version of the IR became known as its layered content—different layers spoke to less-specialist audiences. In that paper, we presented the results of these experiments conducted immediately after the November 2017 Inflation Report launch. There were two groups surveyed: a survey of 285 members of the U.K. general public ("Public sample") and a sample of first-year graduate students in the Department of Economics at the University of Oxford ("MPhil sample"). Here we relate those results to the analysis in the paper, as well as update the discussion for more recent analyses of the issue.

25. There are numerous other "3 E's" in different fields such as the 3 E's of sustainability (Environmental, Economic, and Ethical) as in Goodland (1995).

26. Experiments in macroeconomics are more common than often considered to be the case. For example, see Petersen and others (2014) for a discussion.

The layered content achieved its aim of being easier to read. It had a Flesch-Kincaid grade level of 7.8 (eighth-grade level), which compares with the Monetary Policy Summary, which was released at the same time, with a Flesch-Kincaid grade level of 13.4.

We randomly assigned participants to read the new content or the traditional content and analysed the effect on their expectations for the U.K. economy at the time by using equation (22). The dummy variable, D(Layers), indicates those participants that read the new-style communication. We use a series of demographic controls, X_i, in the public sample, though these are not available in the MPhil sample.[27] As a proxy for knowledge, we use whether or not the person has studied economics D (Econ). One of the questions asks "To what extent do you have confidence in the Bank of England as a public institution to implement macroeconomic policy?"; we use this, Trust, as our proxy measure for existing trust in the Bank of England.

$$Y_i = \gamma_0 + \gamma_1 D(\text{Layers}) + \gamma_2 D(\text{Econ}) + \gamma_3 \text{Trust} + \Gamma' X_i + \zeta_i. \tag{22}$$

Here we replicate and expand on that earlier analysis to show how the responses depend on both knowledge of economics and the proxy for pre-existing trust in the institution. In order to emphasise the latter point, we also run a regression, equation (23), that includes an interaction between existing trust and exposure to the new content:

$$\begin{aligned} Y_i = {} & \gamma_0 + \gamma_1 D(\text{Layers}) + \gamma_2 D(\text{Econ}) + \gamma_3 \text{Trust} \\ & + \gamma_4 \text{Prior Trust} D(\text{Layers}) + \Gamma' X_i + \zeta_i. \end{aligned} \tag{23}$$

We assessed the effect of the new style on responses to three questions:

1. "To what extent are you able to understand the content and messages of the material you just read?" Participants selected from a five-point scale from which we created a numeric variable, *Understand*, which ranges from 1 ("None or nearly none of it") to 5 ("All or nearly all of it").

2. "How has reading the excerpt from the Inflation Report summary changed your views or expectations on the outlook for the U.K. economy, if at all?" From this question, along with knowledge of how participants differed from the IR forecasts, we define a dummy variable, D(*Adjust*),

27. Excluding controls does not significantly affect the results for the public sample.

which is 1 if the participant appropriately adjusts their expectations and 0 otherwise. [28]

3. "Learning that this is typical of the type of communication in the Bank of England's quarterly Inflation Report, how has the Inflation Report summary affected your perceptions of the Bank of England, if at all?" The five-point numeric scale, measuring Δ *Perception*, runs from "Worsened significantly (1)", through "Broadly unchanged (3)", to "Improved significantly (5)".

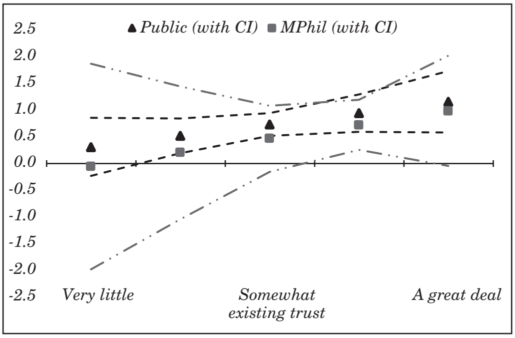
Table 4. Regression Analysis of Communication Experiment on Understanding

	(1) Understand	*(2) Understand*	*(3) Understand*	*(4) Understand*	*(5) Understand*
D(*Layers*)	0.71***	0.83***	0.73***	0.63***	0.46
	[0.00]	[0.00]	[0.00]	[0.00]	[0.14]
Trust x *D*(*Layers*)			0.21		0.26
			[0.11]		[0.47]
D(*Economics*)	0.54***		0.54***		
	[0.00]		[0.00]		
Trust	0.10	0.15**	0.016	0.16	-0.015
	[0.10]	[0.03]	[0.81]	[0.29]	[0.96]
Constant	2.68***	2.49***	2.68***	3.63***	3.74***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Observations	285	235	285	68	68
R-squared	0.226	0.247	0.235	0.140	0.150
Estimation	OLS	OLS	OLS	OLS	OLS
Demographic Controls	Yes	Yes	Yes	No	No
Sample	Public	Non-Econ	Public	MPhil	MPhil

Source: Authors' estimations.
Notes: *D*(*Layers*) is 1 if the participant was randomly assigned the new, layered content in the experiment. *D*(*Economics*) is a dummy variable which is 1 if the participant has studied economics as part of a university degree course. BoE Confidence is a numeric variable rating the participant's confidence in the Bank. Demographic controls, available only for the public survey, are separate dummy variables equal to 1 indicating the respondent is Female, English-speaking, British nationality, Student, or Fulltime Employed. P-values constructed using robust standard errors are reported in brackets below the coefficient estimates.

28. Participants provided their two-year expectations for CPI inflation, unemployment, and interest rates on a five-point scale from "Fall significantly (-2)", through "Broadly unchanged (0)", to "Increase significantly (2)". The November 2017 IR projections were also mapped to this scale. This allowed us to work out whether converging on the IR projections meant that the participant should become more pessimistic (higher inflation, unemployment and/or interest rates) or optimistic.

Figure 6. Marginal Effect of *D*(*Layers*) on *D*(*Understand*) by Trust



Source: Authors' estimations.
Notes: The triangles (squares) show the estimated coefficient from the Public (MPhil) sample of the effect of reading the Layered Content (*D*(*Layers*)) on reported understanding by different levels of Trust. The lines around the point estimates indicate the 95% confidence intervals.

Table 4 presents the results of regressions of *D*(*Layers*) on participant understanding from the two different samples. Columns (1)–(3) present the results for the public sample and (4)–(5) for the MPhil survey. The main result is that, for both samples, the new layered content is easier to read and understand, even for technically advanced MPhil students. This improvement in understanding was statistically significant for both samples, at the 1 percent level, and averaged 0.68 points across the two. To contextualise these benefits, the effect of the layered content on understanding is larger than the effect on understanding of studying economics as part of a university degree. The MPhil sample results suggest that even the traditional, technically trained audiences may benefit from clarifying and simplifying communication.

Columns (3) and (5) report the estimates of (23). The results of different levels of prior trust on the effect of *D*(*Layers*) is presented graphically for the two samples in figure 6. The sample estimates are very close across the two samples. In particular, those who have the highest existing trust find the new content to be an even bigger improvement.

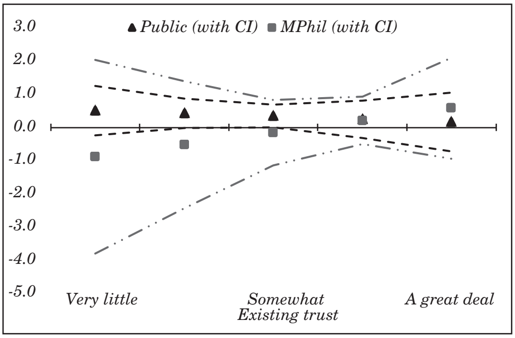
We now repeat the analysis using the *D*(*Layers*) dummy variable to see if participants brought their expectations into line with the Bank of England's forecast. As the dependent variable is a dummy variable, we use a probit model for equations (22) and (23). Table 5 and figure 6 present the results as before. The effect of the more readable communication on expectations differs between the two samples. In the case of the general public survey, layered communication boosts the chance that the participants update their beliefs to become more closely aligned with the Bank's forecasts. This effect is more significant for the less trusting, which is the bulk of the public sample. For MPhil students, the average coefficients are positive, but the results are not statistically significant (figure 7).

Table 5. Regression Analysis of Communication Experiment

	(1) *D(Adjust)*	(2) *D(Adjust)*	(3) *D(Adjust)*	(4) *D(Adjust)*	(5) *D(Adjust)*
D(*Layers*)	0.35**	0.43**	0.33*	0.090	-0.16
	[0.04]	[0.02]	[0.06]	[0.78]	[0.76]
Trust x *D*(*Layers*)			-0.089		0.37
			[0.64]		[0.50]
D(*Economics*)	-0.24		-0.24		
	[0.32]		[0.33]		
Trust	-0.11	-0.070	-0.065	0.28	0.044
	[0.28]	[0.51]	[0.63]	[0.26]	[0.91]
Constant	-0.21	0.036	-0.21	-0.81***	-0.66*
	[0.52]	[0.92]	[0.51]	[0.01]	[0.07]
Observations	285	235	285	68	68
Estimation	Probit	Probit	Probit	Probit	Probit
Demographic Controls	Yes	Yes	Yes	No	No
Sample	Public	Non-Econ	Public	MPhil	MPhil

Source: Authors' estimations.
Notes: *D*(*Layers*) is 1 if the participant was randomly assigned the new, layered content in the experiment. *D*(*Economics*) is a dummy variable which is 1 if the participant has studied economics as part of a university degree course. BoE Confidence is a numeric variable rating the participant's confidence in the Bank. Demographic controls, available only for the public survey, are separate dummy variables equal to 1 indicating the respondent is Female, English-speaking, British nationality, Student, or Fulltime Employed. P-values constructed using robust standard errors are reported in brackets below the coefficient estimates.

Figure 7. Marginal Effect of *D*(*Layers*) on *D*(*Adjust*) by Trust



Source: Authors' estimations.
Notes: The triangles (squares) show the estimated coefficient from the Public (MPhil) sample of the effect of reading the Layered Content (*D*(*Layers*)), by different levels of Trust, on whether the respondent adjusted their expectations in the direction of the Bank of England's forecast. The lines around the point estimates indicate the 95% confidence intervals.

Finally, table 6 and figure 8 examine whether participants reading the new content tended to develop an improved perception of (trust in) the institution. While the mean effect is not statistically significant in the public survey, it is highly significant in the MPhil sample. The inclusion of the interaction term, as with the regressions on understanding the content, shows the two samples are quite similar. The interaction term highlights that the layered content tends to significantly increase perceptions of those with existing high levels of trust. The different mean estimates seem to reflect the fact that the existing levels of trust are, on average, higher in the MPhil sample. There is, in addition, a difference whereby the technically trained MPhil respondents seem to appreciate more the efforts to "talk to the layperson". The takeaway from this is that on-going efforts may be needed to reach and convince those parts of the public most mistrustful of central banks, to begin with. This speaks to improved communication alongside improved economics education for this less-specialist audience (see below).

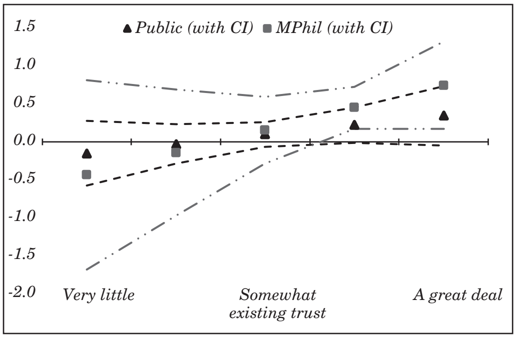
Since our original analysis, others have conducted similar work. Also focusing on the Bank of England's introduction of layered content, Bholat and others (2018) tested four different ways of communicating the February 2018 Inflation Report: (1) the traditional *Monetary Policy Summary*, (2) the layered content, (3) a reduced text summary, and (4) a relatable summary. The latter two were designed by the joint BIT/Bank of England team. The relatable summary aimed to make the material more relatable to the lives of the participants, and it expressed costs in absolute rather than relative or growth terms. This relatable summary was found to be most effective at increasing comprehension scores (+42 percent compared to the traditional *Monetary Policy Summary*), and it was also the most effective for applicable understanding. For example, readers of it were best able to predict what a basket of groceries costing £100 *should* cost the following year based on the information.

Table 6. Regression Analysis of Communication Experiment

	(1) Δ *perception*	(2) Δ *perception*	(3) Δ *perception*	(4) Δ *perception*	(5) Δ *perception*
D(*Layers*)	0.083	0.086	0.098	0.35**	0.16
	[0.33]	[0.36]	[0.23]	[0.01]	[0.49]
Trust x *D*(*Layers*)			0.12		0.30
			[0.19]		[0.18]
D(*Economics*)	-0.032		-0.033		
	[0.76]		[0.75]		
Trust	0.15***	0.16***	0.10*	-0.14	-0.31*
	[0.00]	[0.00]	[0.10]	[0.19]	[0.07]
Constant	3.19***	3.13***	3.20***	3.12***	3.23***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Observations	285	235	285	66	66
R-squared	0.055	0.065	0.062	0.111	0.138
Estimation	OLS	OLS	OLS	OLS	OLS
Demographic Controls	Yes	Yes	Yes	No	No
Sample	Public	Non-Econ	Public	MPhil	MPhil

Source: Authors' estimations.
Notes: *D*(*Layers*) is 1 if the participant was randomly assigned the new, layered content in the experiment. *D*(*Economics*) is a dummy variable which is 1 if the participant has studied economics as part of a university degree course. BoE Confidence is a numeric variable rating the participant's confidence in the Bank. Demographic controls, available only for the public survey, are separate dummy variables equal to 1 indicating the respondent is Female, English-speaking, British nationality, Student, or Fulltime Employed. P-values constructed using robust standard errors are reported in brackets below the coefficient estimates.

Figure 8. Marginal Effect of *D*(*Layers*) on Δ(*Perceptions*) by Trust



Source: Authors' estimations.
Notes: The triangles (squares) show the estimated coefficient from the Public (MPhil) sample of the effect of reading the Layered Content (*D*(*Layers*)) on reported perceptions about the institution by different levels of Trust. The lines around the point estimates indicate the 95% confidence intervals.

In the U.S. context, Coibion and others (2019) conduct a large (20,000 participants) randomized control trial examining eight different communication types about inflation. They find that reading the FOMC statement changes inflation expectations by the same as the latest inflation data. The effect is economically significant—households' average inflation forecast is reduced, from a high level, by around 1.2 percentage points. They also found that relying on news intermediaries, such as the media, gives rise to effects that are smaller and less persistent. This is particularly the case for some lower-income, lower-education participants when reading *USA Today*. As well as pointing to a need for further research on the role of the media in expectation formation, this also suggests a potentially potent role for direct communication rather than relying on message intermediaries.

Binder and Rodrigue (2018), also in the U.S. context, find that households' long-run inflation forecasts react to communication about the prevailing or recent inflation rate, or the inflation target. This suggests that, for some households, even a very simple message such as the inflation target could be very powerful in anchoring expectations, but only if those households can be reached.

4.2 Engagement

Clearly explained communication may count for nothing if people do not engage with this communication in the first place. The effects that we find in our experiment come about *after* participants were incentivised to engage. But how likely is it that people do engage? To give a sense of the challenge facing central banks if they stick with their traditional medium of explanation, we asked the sample participants in our survey of the public in November 2017 about their familiarity with the IR. Most participants (66 percent) claimed to have heard of the IR, although less than 6 percent had ever read it (and only 1 participant who claimed to read it regularly). The remaining 34 percent had never heard of it.

For these reasons, engagement is, like explanation, core to the objectives of the central bank when improving its policy effectiveness. And, as with explanation, engagement is easier in theory than in practice. Moreover, a key message of our trust model is that simple communication on its own might not be enough. To build and maintain trust, it might require extra action. Engagement in itself might contribute to building and, in particular, maintaining that trust. Or, put differently, trust is less likely to depreciate (or evaporate) the greater the degree of engagement.

One aspect of our model to consider is what happens to trust (and therefore the potential for future engagement) if a household does not read any of the information. In the model we make the assumption that unengaged households are never surprised and so their trust does not change. It is also assumed that, once engaged but surprised, trust is lost and gone forever. Both are likely to be far too strong. There may be a risk that, if the central bank is not communicating with individuals, then their trust might fall anyway. This is especially true in an era of social media engagements targeted at previously unengaged areas of the population.

An alternative formulation would be to acknowledge that, if the central bank is not talking to people, someone else will fill the void with possibly noisier messages. A way to model this would be to follow the application of Bernoulli's model of infectious diseases to social dynamics as in Burnside and others (2016).[29] While they apply it to the housing market, the idea in terms of central-bank communication is that of being the narrative entrepreneur who can help people to make sense of the economy and form reasonable expectations. The central bank, by engaging and educating people, can help households to form better expectations. If a household has no engagement with

29. Bailey and others (2018) also discuss the role of social contagion in driving housing-market behaviour.

the central bank, then they do not receive the best guidance and are more susceptible to believing other opinions about the outlook and the institution; in our model, these are noisier signals. This would admit a stronger role for engagement because absent engagement, the baseline could be progressively less well-informed opinions on central banks.

4.3 Media and the Narrative Channel

Shiller (2017) stresses the important role that "popular narratives" can play in determining behaviour in the macroeconomy. One advantage could be that simplified content enables greater coverage and penetration of the policy narrative. And this better understanding of the factors driving the decisions could help to reduce the incidence of such self-reinforcing expectational swings in sentiment and behaviour.

Communications may need to be simple, relevant, and story-based to become convincing and credible to a wider audience. Traditional central-bank communications tend to fail on all three fronts. Therefore, to be more engaging, central banks need to create a context. They need to create stories. The availability of simplified central-bank messaging may also help traditional information intermediaries, such as the mainstream media, which further facilitates the process of message transmission to a wider audience.

A risk, related to concerns in Morris and Shin (2002), is that such simple messages create an incentive for people to stop investing in their own information collection. This is a problem because, if it is common to all households, then any noise in it leads to inefficient variation in consumption.

4.3.1 Social Media: Opportunity and Challenges

New media channels, especially but not exclusively social media, provide new opportunities and new challenges.[30] The obvious benefit is that it is likely easier to target the uninformed because many of the uninformed view large amounts of news material on Facebook, Twitter, Instagram, YouTube, and other social media every day. The challenge is that, in a saturated market for news and stories, how can the central bank compete with cat videos?

30. See also Binder (2017) on the implications of new media.

Most central banks are now on social media platforms. McMahon and others (2018) report followers' data from a number of major central banks. While some have large followers, none have more than 0.5 percent of their national population. To put this in context, the U.S. Federal Reserve has around 0.5 million followers, while U.S. President Donald Trump has over 88 million followers or nearly 20 percent of the U.S. population.[31] The most followed accounts, in December 2020, include Barack Obama (127m followers), Justin Bieber (113m followers), Katy Perry (109m followers), Rihanna (99m followers), and Christiano Ronaldo (89m followers).

Nonetheless, easier-to-understand communication should improve the reach of the central bank's communication. To examine this, we compare reach for the November 2017 Inflation Report (which had the layered content but also the U.K.'s first rate rise for a decade) with two counter-factual events:

1. August 2017 (previous) IR—this is without layered content but also without any major monetary news.

2. August 2016 IR—this also had no layered content but is associated with significant monetary news (a 25bps rate reduction and an additional QE package).

Table 7. Analysis of IR Reach

	August 2016 IR	*August 2017 IR*	*November 2017 IR*
Website hits	16,600	12,460	30,900
o/w Layer 2	n/a	n/a	16,200
Tweets	1,745	320	1,566
o/w Layer 1	n/a	n/a	845

Source: Bank of England.
Notes: Tweet numbers represent the total number of retweets of, quotes of, and replies to all BoE tweets relating to the Inflation Report and Bank rate announcement in the time period up to 24 hours after each period's announcements. Tweets about the Inflation Report from Twitter accounts other than the Bank's which are not retweets of, quotes of, or replies to BoE tweets are not included. Layer 1 refers to just a tweet of the basic announcement that Bank Rate went up by 25bps. Layer 2 is the *Inflation Report Visual Summary* webpage content on www.inflationreport.co.uk.

31. Of course, in both cases some followers will be international.

Table 7 summarises the website and Twitter activity associated with the three events over the subsequent 24 hours. There was a large increase in direct website traffic associated with the November 2017 IR. Even relative to August 2016, website hits almost doubled. Moreover, almost all of this increase was associated with hits on the new, simplified content, with hits on the existing technical material largely unaffected. This is consistent with the new communications having achieved a somewhat broader reach with a somewhat different audience.[32]

An analysis of social media engagement, measured by Twitter traffic, suggests a more nuanced picture. Numbers of tweets and retweets associated with the IR were at their highest in August 2016. Nonetheless, Twitter traffic was 4.9 times higher in November 2017 than in August, and the Bank itself issued more than twice as many tweets in August 2016 than in November 2017.

An alternative window on social window engagement is provided by examining at the Twitter networks associated with the monetary policy and IR events. The August 2016 and November 2017 Twitter networks are similar in their reach and penetration. By contrast, the August 2016 network involves significantly fewer tweets in total and the network was simpler and sparser. There is also evidence of far less media engagement. Overall, this preliminary analysis is a nuanced good news message.

It is clear, however, that monetary-policy news itself, rather than the means by which it is communicated, is the largest single factor determining the reach of central-bank communications. This makes it problematic to detect the marginal impact of changes to communications strategy by using traffic data alone.

Looking at the time-series data on both website hits and Twitter retweets in figure 9, two points stand out. First, hits on the *Visual Summary* have remained about constant in each IR (November 2018 is an exception). This is very positive given the additional marketing effort that accompanied the first *Visual Summary*. Second, the data on Twitter retweets and the hits to the *Monetary Policy Summary* website make clear that it is interest rate changes that lead to the

32. Our data does not allow us to show that the extra hits on the website hosting the new layers (www.inflationreport.co.uk) were unique. However, the majority of hits to the new microsite came via paid search, which is unlikely to be relevant for the usual IR readers. Moreover, we can measure the clickthrough from the main IR page to the new microsite (and vice versa) and it is a very small percentage of the total hits on each; this suggests the users are different.

greatest engagement. Even the May 2018 surprise decision not to increase rates did not lead to the same interest.

4.3.2 Direct Engagement: Business Contacts and Citizens Panels

Central banks can also engage people in a more direct way. Central banks regularly engage business contacts through established networks across the country. For example, the Bank of England has a network of 12 regional agencies across the U.K., with regular contact with almost 10,000 companies. These hundreds of engagements each month allow for a two-way flow of information. The information gathered is fed into the policy process and senior policymakers often join the agents on visits.

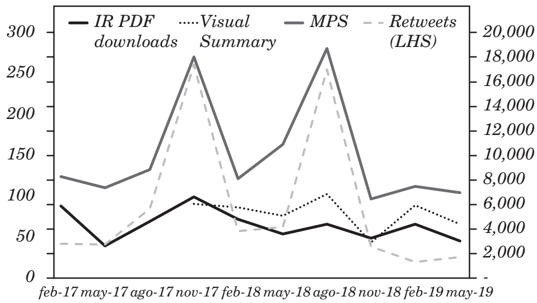
Policymakers now participate in a range of bespoke engagements, designed and delivered in partnership with organisations such as charities, social enterprises, and faith groups. These groups often represent some of the hardest-to-reach groups in society including, for example, those living in significant poverty, facing severe debt issues, refugees, the homeless, and even prisoners.

And the Bank has set up citizens' panels. The idea is to assemble, via a publicity campaign in local print and social media, a group of around 20–24 people in each of the 12 agency regions and to hold two meetings a year. The people, who are selected to be broadly representative of the local population, will have a regular chance to explain their worries and concerns, as well as to discuss current policy issues.

Other central banks are using social media for such attempts to generate direct engagement. For example, Stefan Ingves, Governor of the Riksbank, takes part in regular online Q&As, as does Minneapolis Fed President Neel Kashkari on Twitter with his "#AskNeel" sessions. The recent "Fed Listens conference" is another example.

Monetary-policy decisions are largely an exercise in information aggregation, as in Hansen and others (2014), and policymakers who bring a broader coverage of information likely become more influential, as in Hansen and others (2017). Is there any evidence that listening to a wider audience leads to a change in policy? Perhaps not directly, but such information can help to contextualise the more traditional data and highlight potential solutions to data puzzles. It may also help policymakers to ensure their communications are conveyed in a way that addresses peoples' concerns.

Figure 9. Website Hits and Twitter Retweets around the IR Launch



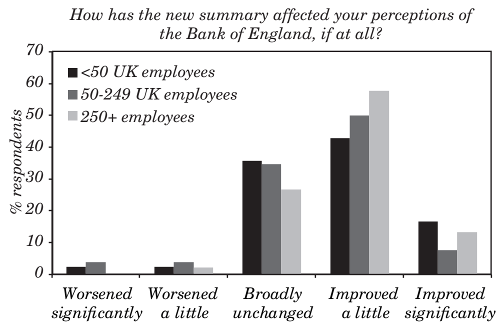
Source: Bank of England data.

In addition to information, these engagements should help build trust. In the model, we show that a stronger positive reaction to engagements could help central banks improve welfare. Figure 10 shows two examples of this from the Bank of England's direct engagements. Figure 10a shows the results of a survey of their business contacts carried out by the Bank of England's regional agents immediately following the release of the November 2017 IR. The survey asked specifically about the new layered content. Overall, more than 70 percent of respondents felt the new layered summary helped them to better understand the messages of the IR. Moreover, as figure 10a shows (with results broken down by company size) around 60 percent of respondents felt the new communication improved either "somewhat" or "a lot" their perception of the Bank.

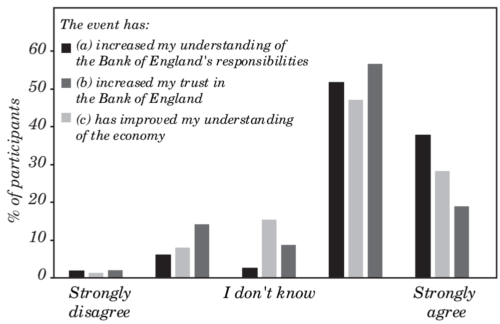
Figure 10b shows aggregated results of surveys carried out following a few of the Bank's Citizens' Panels. Respondents were asked to rate how the session (a) increased your knowledge of the Bank's responsibilities, (b) increased your trust in the Bank, and (c) improved your understanding of the economy. The evidence is that the events have helped on all counts: 90 percent either "somewhat agree" or "strongly agree" that the event increased their knowledge of the Bank's responsibilities and confidence; the proportion is 75 percent for increasing trust in the Bank; and 76 percent believe it improved their knowledge. Of course, such survey results should be interpreted carefully due to the possibility of self-selection by companies and likely self-selection by citizens' panels participants.

Figure 10. Effects of Direct Engagement and Simple Communication

(*a*) *Agents' Survey of Regional Contacts*



(*b*) *Citizens' Panels*



Source: Bank of England.
Notes: Survey of regional corporate contacts carried out by the Bank of England's regional agents in November 2017 and Bank of England 2019 Citizens' Panels.

Finally, these engagements could actually have further reach than is easy to measure, e.g. the Bank of England uses local media to promote its activity in the regions. As in the example of social dynamics discussed above, central banks need torchbearers to carry the story and narrative forward. Direct engagement may help to provide such torchbearers in the local economy.

4.4 Education

In the model, a key challenge arises from the fact that the households that are newly engaged by the simple communication fail to understand the complexity and stochastic nature of the economy. Better education may reduce the costs of engagement and reduce the reaction to surprises, and it may slow the depreciation rate of trust (as in 3.6.3 above). Also, the evidence has suggested that those with a better understanding have higher levels of trust which, in the model, would translate into better engagement and higher welfare.

The central bank has a primary role in educating the public on its framework, strategy, analysis, and policy decisions. This entails education on both the high-frequency and low-frequency aspects that the central bank communicates on. Better-informed agents may, at a higher frequency, form more appropriate expectations for inflation, output, and interest rates. But, equally, high levels of trust and understanding may help to sustain democratic legitimacy as an independent institution and improve the resilience of trust. In this section, we discuss attempts to educate existing economic decision-makers, leaving efforts to educate younger audiences to the next section.

Even engaged and technical audiences need regular educational briefing. This includes briefings with, notes for, and videos aimed at businesses and major banks explaining new ideas on the economy. This is especially necessary when the central bank sees fit to deploy new tools or to vary how it will operate the existing ones. Such decisions now always come with additional explanation and extra materials.

But there is a larger population of less-engaged and less-technical decision-makers. One example of how education influences the high-frequency nature of the central bank's communication strategy concerns understanding of economic concepts. Keywords such as "inflation" and "GDP", which are central to policy discussions, are understood by only small minorities of the general public.[33] Focus groups highlight, therefore, that the public rarely understands there may be a relationship between inflation and unemployment. This makes it clear that explanation is linked to the ability to engage, which in turn depends on the extent of successful past education.

One reaction by a number of central banks, as already discussed, is to adapt their communications strategies to improve their reach to the general public through more-accessible language and more-direct engagement. The other is the increasing provision of videos such as

33. See Haldane (2017).

those explaining the decisions made, or simply videos explaining recent issues or research in layman's terms. Other resources, aimed at educating on the lower-frequency dimensions of monetary policy, include guides to how the economy and monetary policy interact, and the mechanisms that are at play. Specific examples include the Federal Reserve Bank of St Louis' "In Plain English: Making Sense of the Federal Reserve" material, the Bank of England's "Knowledge Bank: The economy made simple" website, and the European Central Bank's "The ECB Explains".

Aimed at existing college students or graduates, the Fed also hosts videos of "Chairman Bernanke's College Lecture Series". These are four lectures delivered in March 2012 by Ben Bernanke (then Fed Chairman) about the Federal Reserve and the financial crisis that emerged in 2007.

As is the case with explanation, a big challenge in educating household and business decision-makers is engagement. This is particularly tricky when there is a large population of people who do not understand how the aggregate economy and monetary work, but they think that they do. At least this shows that people want to understand. But how do we feed their interest? Where is the monetary-policy equivalent of Sir David Attenborough (the nature-documentary maker) to succeed in creating widespread wonder in how central banks work? The Bank of England has recently been the subject of a two-part, behind-the-scenes documentary on national TV in the U.K. Below we also discuss the Bank of Jamaica's attempts at engagement by using reggae music videos.

5. Lower-Frequency Monetary Communication

While the focus of this paper has been on the decision of central banks to communicate at a relatively high frequency, the last section made clear that educational efforts do not have as clear a distinction between high and low frequency. And central banks must also communicate at a lower frequency. They must explain their framework and, where appropriate, their target, and they must engage and educate people to understand what they do and why. Here we briefly examine some of the ways in which low-frequency communication is also about the three E's and give some examples of the activities of central banks in each regard.

5.1 Explanation: Inflation Targets

The widespread adoption of inflation targeting since the Reserve Bank of New Zealand did it in 1990 can be viewed as a communication tool. The idea was that indirect targets such as monetary rules or exchange rate targets did not provide the majority of people with a sufficient nominal anchor. Inflation targets, it was hoped, would be easier to understand and this has largely turned out to be true. For example, Crowe (2010) provides cross-country evidence on the usefulness of an inflation target in anchoring inflation expectations. And in the case of the U.S., Binder (2017) shows that the Federal Reserve's adoption of a formal 2 percent inflation target contributed to better-anchored households' inflation expectations. This work also relates to issues of the twin deficits, as the analysis also shows that better-informed households' expectations were more affected (in terms of becoming better anchored) relative to less-informed households.

The importance of low-frequency communication cannot be overstated. Coibion and others (2019), discussed above, find that communicating the Fed's inflation target has the same statistically significant effect on households' inflation expectations as communicating the FOMC's inflation forecast or the FOMC statement.

One important issue that affects communication on low-frequency issues is how to communicate changes to existing frameworks. While the above analysis suggests that adopting an inflation target can aid the management of inflation expectations, it is less clear how easily established inflation-targeting regimes could be changed. This has come to be discussed because, in an era of low nominal rates, higher inflation targets are seen by some as low-hanging fruit to build a buffer away from hitting the effective lower bound again soon. This requires a credible change in target such that expectations move and become re-anchored at the new target.

One difficulty with this is that changing the regime may also signal that the regime *can* change. In the U.K., for example, the current inflation-targeting framework with an operationally independent central bank is over 20 years old. In that time there has been one variation in the framework—in December 2003, the inflation index used to calculate the measure of inflation in the target was changed from RPIX to CPI. In line with methodological differences in the two indices, the target changed from 2.5 percent RPIX to 2 percent CPI. It was emphasised that this was a non-change.

Such care with credible and established regimes is warranted. The U.S. Federal Reserve has recently announced a review of its monetary framework. However, Vice-Chair of the Federal Reserve Board and FOMC member Richard Clarida suggested that it will be "more likely to produce evolution, not a revolution" (April 2019 speech).

5.2 Engagement: Recent Novel Approaches

As with higher-frequency analysis, it is important for the impact of the communication that households and businesses engage with it. They need to read or see it, and they need to take the message on board. Reis (2011) examines a rational-inattention model in which a central bank must decide when to make public a low-frequency announcement such as a change in the monetary framework. His analysis emphasises that economic agents trade off between being more informed about today (and responding better to today's environment) and being better informed about the future (and so preparing better for the change). The central bank also needs to balance the clarity of the message it can send (which grows over time) with the risk that the public will inefficiently coordinate on its announcement.

In practice, new technology has provided a mechanism for direct engagement on these lower-frequency messages too. For example, the ECB has used popular YouTuber Simon Clark to explain what a central bank, and specifically the ECB, is.

The Bank of Jamaica's (BOJ) move from a focus on control of the exchange rate to "full-fledged inflation targeting (FFIT)" has been widely discussed for the innovative ways in which the BOJ has communicated the move to the public.[34]

The BOJ faced a public that was more familiar with a policy focus on the exchange rate. In order to speak the language of the public, they have released a series of videos including top reggae stars (such as Tarrus Riley) comparing inflation control to the "bassline" in reggae music. Through their "Low, Stable, Predictable Inflation" narrative, made available on TV, radio, and social media platforms such as YouTube[35] and Twitter, they hope to establish both support for and understanding of their new framework.

34. The Bank of Jamaica (Amendment) Bill, currently under review by a Joint Select Committee of Parliament, will amend The Bank of Jamaica Act to clarify its mandate as well as some other changes. This includes clarification that "The mandate of the Bank is the maintenance of price stability and financial system stability, with the primary objective being the maintenance of price stability."

35. Available at https://youtu.be/wtQAkWjyuDg

While this is a great example of an innovative engagement effort with a wider audience, the benefits are more difficult to measure. Businesses' perception of the authorities' control of inflation, calculated as 100 plus the number of satisfied survey respondents minus the number of dissatisfied respondents, decreased in April 2019 although it has generally been increasing since the move toward FFIT. But this also coincides with the underlying state of the economy. Further analysis will be warranted to see if this campaign yields longer-term benefits and trust in the FFIT framework.

5.3 Education: From Comics to Classrooms

As pointed out in subsection 4.4, the distinction between high- and low-frequency communication is less pertinent. Since most of the discussion above concerned both high- and low-frequency objectives toward people who need to learn now, here we discuss some of the efforts of central banks to be involved in educating younger audiences in a more gradual fashion before they become economic decision-makers. This can be justified by realising that children who understand the economy and the role of the central bank from an earlier age will be less susceptible to attempts to undermine central-bank independence.

Also, today's youths are tomorrow's politicians and decision-makers.

When we think of education of young people, it is not obvious that the central bank is the main entity with responsibility. Decisions such as how much to teach about interest rates in school rest, typically, with educational boards and the Ministry of Education.

But central banks have taken on the role of providing, in addition to the videos and other engagement mechanisms discussed above, free classroom materials. These range from resources about how the economy works, to what the central bank does. Many central banks split the resources into material for different target age groups. The Federal Reserve Bank of New York has even developed a series of comic books to describe the Fed, monetary policy, and how money works.

Many central banks also offer competitions for school and university students. These events raise awareness of the central bank and its objectives, as well as provide opportunities for personal development for the participants. The Bank of England has a number of efforts in this direction. For example, "'EconoME'" is a free education resource created jointly by educational experts and the Bank. It is designed to help young people aged 11 to 16 understand the economy better and provide them with the analytical skills to make informed decisions. The Bank also provides inflation and interest calculators to help households with financial planning. It previously ran a national monetary-policy competition across U.K. schools (Target 2.0).

All of these are potentially useful exercises to engage, explain, and educate. Of course, central banks are constrained by what resources they have available. Two activities will help focus on the allocation of resources in the future. First, listening to a wide array of stakeholders is one way to learn where to target educational efforts. Second, careful examination and appraisal of the successes and failures of different approaches should be undertaken.

6. Conclusion

The last decade has seen central banks respond to the challenges posed by the fallout of the financial crisis by engaging more and more with a broader audience about monetary policy. Providing clarity is likely important but this paper argues that explanation through simplified communication may, alone, be necessary but not sufficient. Central banks need complementary efforts in engagement and education.

There is much still to be done to understand the optimal design and use of communication with the general public. This includes further research and further practical experimentation in terms of communication with the public. Such experiments should be scrutinised for the lessons of what worked, what did not, and why. The Center for Economic and Policy Research (CEPR) has recently initiated a Research Policy Network, together with the European Central Bank and with membership of many central banks, academics, journalists, and professional economists. The objective is to encourage such research efforts and the dissemination of findings to both researchers, those involved in communication in central banks, journalists, and other interested stakeholders.

Moreover, most central banks now have remits that extend beyond monetary policy. The design of communication strategies is likely specific to each objective especially since the audiences are possibly different. For example, the communication about prudential policies may give rise to even tougher challenges. This is because the policies' aims might be harder to communicate and the tools available are more varied both within and across countries.

Central banks must remain steadfast in their efforts to reach a broader audience. Given the necessary degree of trial and error, there will be mistakes. But success should not be measured by the ability to reach everyone but rather by engaging even limited audiences beyond the current small core audience of technical specialists and information intermediaries.

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Appendices

Appendix A

Expected Utility Loss from Inattention

This derivation follows the steps of appendix D in Mackowiak and Wiederholt (2015). Define $\widetilde{U}$ as the log-quadratic approximation of the discounted household utility function $\widetilde{U}$, and let $\widetilde{U}^*$ be the equivalent for the fully informed household. The approximation is taken about the steady state. Note that since in steady state all shocks equal the household prior beliefs of zero, inattention plays no role in determining the steady state.

It can be shown that the expected utility loss from inattention is:

$$\widetilde{U}^* - \widetilde{U} = -E_0^H \sum_{t=0}^{\infty} \beta^t \Big[\frac{1}{2}\left(x_t - x_t^*\right) H_0 (x_t - x_t^*)' + \left(x_t - x_t^*\right) H_1 \left(x_{t+1} - x_{t+1}^*\right)'\Big] \quad (24)$$

where $x_t = [b_t\ n_t]$ and:

$$H_0 = \begin{bmatrix} U_{bb} & U_{bn} \\ U_{bn} & U_{nn} \end{bmatrix} \quad (25)$$

$$H_1 = \begin{bmatrix} U_{bb_1} & U_{bn_1} \\ U_{nb_1} & U_{nn_1} \end{bmatrix}. \quad (26)$$

U_{ij} is the second derivative of discounted utility U (before approximation) with respect to i and j, evaluated at the steady state. Note that lower case x_t is the log-deviation of x from steady state in period t. Furthermore, denote the steady state of x by the capital X, and let $\tilde{x}_t = x_t - x_t^*$. U_{ij1} is the second derivative with respect to $i_t\ j_{t+1}$.

In this particular model, substituting in for U_{ij} and substituting out for bonds using the budget constraint, we have:

$$\begin{aligned}\widetilde{U}^* - \widetilde{U} = -E_0^H \sum_{t=0}^{\infty} \beta^t [&-\frac{1}{2}\sigma B^2 C^{-\sigma-1}\left(1+\frac{1}{\beta}\right)\tilde{b}_t^2 + \sigma WNBC^{-\sigma-1}\tilde{b}_t \tilde{n}_t \\ &-\frac{\varphi}{2} N^{1+\varphi}\tilde{n}_t^2 - \frac{\sigma}{2} W^2 N^2 C^{-\sigma-1}\tilde{n}_t^2 + \sigma B^2 C^{-\sigma-1}\tilde{b}_t \tilde{b}_{t+1} \\ &-\sigma BWNC^{-\sigma-1}\tilde{b}_t \tilde{n}_{t+1}].\end{aligned} \quad (27)$$

Factorising:

$$\widetilde{U}^{*} - \widetilde{U} = E_0^H \sum\nolimits_{t=0}^{\infty} \beta^t [\frac{\varphi}{2} N^{1+\varphi} \tilde{n}_t^2 - C^{-\sigma-1}(-\frac{1}{2}\sigma B^2 \left(1+\frac{1}{\beta}\right)\tilde{b}_t^2 + \sigma WNB\tilde{b}_t\tilde{n}_t - \frac{\sigma}{2}W^2N^2\tilde{n}_t^2 + \sigma B^2\tilde{b}_t\tilde{b}_{t+1} - \sigma BWN\tilde{b}_t\tilde{n}_{t+1})]. \tag{28}$$

Now define three new variables:

$$\Delta_t = B\tilde{b}_t \tag{29}$$

$$\Delta_{c,t} = \frac{1}{\beta}\Delta_{c,t-1} - C\tilde{c}_t \tag{30}$$

$$\Delta_{n,t} = \frac{1}{\beta}\Delta_{n,t-1} - WN\tilde{n}_t \tag{31}$$

The log-linearised budget constraint implies:

$$C\tilde{c}_t + B\tilde{b}_t = \frac{1}{\beta}B\tilde{b}_{t-1} + WN\tilde{n}_t \tag{32}$$

From this, we obtain:

$$\Delta_t = \Delta_{c,t} + \Delta_{n,t} \tag{33}$$

Taking the term in round brackets in equation (28) we substitute out for $\tilde{b}$ and $\tilde{n}$ using these new variables to obtain:

$$-\frac{1}{2}\sigma\left(1+\frac{1}{\beta}\right)\left(\Delta_{c,t}+\Delta_{n,t}\right)^2 + \sigma\left(\Delta_{c,t}+\Delta_{n,t}\right)\left(\Delta_{n,t} - \frac{1}{\beta} + \Delta_{n,t-1}\right) - \frac{1}{2}\sigma\left(\Delta_{n,t} - \frac{1}{\beta}\Delta_{n,t-1}\right)^2 + \sigma\left(\Delta_{c,t}+\Delta_{n,t}\right)\left(\Delta_{c,t+1}+\Delta_{n,t+1}\right) - \sigma\left(\Delta_{c,t}+\Delta_{n,t}\right)\left(\Delta_{n,t+1} - \frac{1}{\beta}\Delta_{n,t}\right). \tag{34}$$

Expanding the brackets and cancelling terms, we obtain:

$$-\frac{1}{2}\sigma\left(1+\frac{1}{\beta}\right)\Delta_{c,t}^{2}+\sigma\Delta_{c,t}\Delta_{c,t+1}+\sigma\left(\Delta_{n,t}\Delta_{c,t+1}-\frac{1}{\beta}\Delta_{n,t-1}\Delta_{c,t}\right) \tag{35}$$
$$+\frac{1}{2\beta}\sigma\left(\Delta_{n,t}^{2}-\frac{1}{\beta}\Delta_{n,t-1}^{2}\right).$$

Now we take the first two terms of this expression and write them as:

$$-\frac{\sigma}{2}\Delta_{c,t}^{2}-\frac{\sigma}{2\beta}\Delta_{c,t}^{2}+\sigma\Delta_{c,t}\Delta_{c,t+1}. \tag{36}$$

Substitute out for in the first term of this and for in the third term, using equation 30, to obtain:

$$-\frac{\sigma}{2}\left(\frac{1}{\beta^{2}}\Delta_{c,t-1}^{2}-\frac{2C}{\beta}\tilde{c}_{t}\Delta_{c,t-1}+C^{2}\tilde{c}_{t}^{2}\right)-\frac{\sigma}{2\beta}\Delta_{c,t}^{2}+\frac{\sigma}{\beta}\Delta_{c,t}^{2}-\sigma C\tilde{c}_{t+1}\Delta_{c,t}. \tag{37}$$

Rearranging:

$$-\frac{\sigma C^{2}}{2}\tilde{c}_{t}^{2}+\frac{\sigma}{2\beta}\left(\Delta_{c,t}^{2}-\frac{1}{\beta}\Delta_{c,t-1}^{2}\right)-\sigma C\tilde{c}_{t+1}\Delta_{c,t}+\frac{\sigma C}{\beta}\tilde{c}_{t}\Delta_{c,t-1}. \tag{38}$$

Using these expressions, the utility loss from inattention becomes:

$$\tilde{U}^{*}-\tilde{U}=E_{0}^{H}\sum\nolimits_{t=0}^{\infty}\beta^{t}[\frac{\varphi}{2}N^{1+\varphi}\tilde{n}_{t}^{2}+\frac{\sigma C^{1-\sigma}}{2}\tilde{c}_{t}^{2} \tag{39}$$
$$-C^{-\sigma-1}(\frac{\sigma}{2\beta}\left(\Delta_{c,t}^{2}-\frac{1}{\beta}\Delta_{c,t-1}^{2}\right)-\sigma C\tilde{c}_{t+1}\Delta_{c,t}+\frac{\sigma C}{\beta}\tilde{c}_{t}\Delta_{c,t-1}+$$
$$\sigma\left(\Delta_{n,t}\Delta_{c,t+1}-\frac{1}{\beta}\Delta_{n,t-1}\Delta_{c,t}\right)+\frac{1}{2\beta}\sigma\left(\Delta_{n,t}^{2}-\frac{1}{\beta}\Delta_{n,t-1}^{2}\right))].$$

Notice that every term within the round brackets cancels with a corresponding term in another period. Using $\lim_{T\to\infty}\beta^{T}E_{0}\left[\Delta_{c,T}^{2}\right]=\lim_{T\to\infty}\beta^{T}E_{0}\left[\Delta_{n,T}^{2}\right]=\lim_{T\to\infty}\beta^{T}E_{0}\left[\Delta_{n,T}\Delta_{c,T+1}\right]=\lim_{T\to\infty}\beta^{T}E_{0}\left[\Delta_{c,T}\tilde{c}_{T+1}\right]=0$, we therefore have:

$$\tilde{U}^{*} - \tilde{U} = E_0^H \sum_{t=0}^{\infty} \beta^t \left[\frac{\varphi}{2} N^{1+\varphi} \tilde{n}_t^2 + \frac{\sigma C^{1-\sigma}}{2} \tilde{c}_t^2 \right]. \tag{40}$$

Finally, note that through the log-linearised labour supply condition, $\tilde{n}_t = -\frac{\sigma}{\varphi} \tilde{c}_t$, so:

$$\tilde{U}^{*} - \tilde{U} = \frac{\sigma}{2} E_0^H \sum_{t=0}^{\infty} \beta^t \left[C^{1-\sigma} + \frac{\sigma}{\varphi} N^{1+\varphi} \right] \tilde{c}_t^2. \tag{41}$$

Since the model is stationary, the expected loss from inattention is therefore proportional to the variance of $\tilde{c}_t = \left(c_t^{*} - c_t \right)$.

Appendix B

Calibration

In section 3 we use a standard quarterly calibration with values as in the table below.

Table B1. Calibration of the Main Model Parameters

Parameter	*Name*	*Value*
β	Discount factor	0.99
σ	Coefficient of risk aversion	1
φ	Disutility of labour	1
$\in$	Elasticity of substitution	9
κ	Phillips curve slope	0.34
ϕ_π	Taylor rule coefficient	1.5
σ_a^2	Variance of technology shocks	0.01
σ_v^2	Variance of cost-push shocks	0.01

Source: Authors' assumptions.
Notes: Calibration used in the simulations of the model in section 3.

We set the parameters of the attention decision as:

Table B2. Calibration of Attention Parameters

Parameter	*Name*	*Value*
F_{IR}	Complexity of the Inflation Report	1
F_L	Complexity of layered content	0.25
$\mathcal{T}_a$	Signal to noise in technology signal	0.9
$\mathcal{T}_v$	Signal to noise in cost signal	0.9
$\underline{\lambda}$	Proportion with no processing cost	0.05
δ_c	Trust improvement from engagement	0.1
δ_s	Trust change from surprise	$\frac{-0.105}{ES}$
ψ	Parameter in μ_h distribution	9

Source: Authors' assumptions.
Notes: Calibration used in the simulations of the model in section 3.

These parameters imply that before layered content, 14.5 percent of all households read the Inflation Report. In the first period of the layered content, 5 percent read the Inflation Report, and 28.5 percent read the layered content.

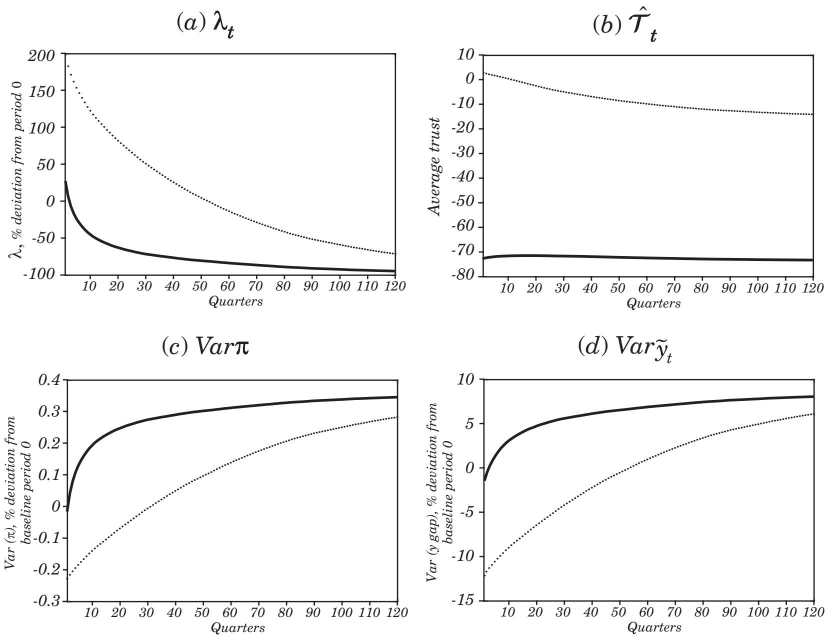
When we study changes in the initial level of trust, the high-trust case has those reading the Inflation Report with full trust, and those not reading with trust 0.9. The low-trust case has these households on trust 0.2 and 0.1, respectively. The higher δ_c we consider is 0.11, and the alternative δ_s we consider is $\frac{-0.095}{ES}$.

Appendix C

Effect of Starting Level of Trust Relative to Medium-Trust Baseline

Figure C1 plots the equivalent of figure 4 in the main text but in these figures the deviations are relative to the baseline starting level in the medium trust case.

Figure C1. Time path of λ_t, $\hat{\mathcal{T}}_t$, Var π and Var $\tilde{y}_t$ after the Introduction of Simplified Communication: the Effect of Starting with Higher or Lower Trust



Source: Authors' calculations.

Notes: The dotted line is the expected path of either the share of processing households, average trust, the variance of inflation, or of the output gap relative to initial values in the baseline (medium trust) case. The solid line is the expected path relative to the medium-trust period 0 baseline of the same variables in the case where initial trust is low.

Improving U.S. Monetary Policy Communications

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The job of central bankers is to use the monetary powers granted to them to promote price stability, sustainable growth, and a stable financial system. They do this in an environment fraught with unavoidable uncertainties. But, in conducting policy, there is one uncertainty that policymakers can and should reduce: the uncertainty they themselves create. Everyone agrees that monetary policymakers should do their best to minimize the noise that their actions add to the environment. When policy is transparent and effective, people in the economy and financial markets respond to the data, not to the policymakers.

During the past quarter-century, the evolution of an ever more detailed inflation-targeting framework facilitated a vast improvement

It is traditional to use the introductory footnote to thank colleagues who contributed comments and advice. In this case, there were dozens of people without whom we could not have written this paper. First, 24 former senior officials, academics and market economists responded orally or in writing to our open-ended survey; many have agreed to allow us to quote them in the text. Second, numerous people offered their guidance and answered our numerous questions. These include a number of current FOMC members, Lewis Alexander, Seamus Brown, Donald Kohn, Ellen Meade, Hiroshi Nakaso, Debarshi Nandy, Masaaki Shirakawa, and Paul Tucker. Third, our discussants, Jón Steinsson at the Federal Reserve's Conference on Monetary Policy Strategy, Tools, and Communication Practices (A Fed Listens Event) on June 4–5, 2019, and Petra Geraats at the XIII Annual Conference of the Central Bank of Chile on July 22–23, 2019, provided very useful comments, as did Conference attendees. Fourth, we thank Scott Davis and Mark Wynne for sharing their data. And fifth, but certainly not last, Jonathan Robidoux carefully and diligently transcribed the oral interviews

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in Federal Open Market Committee (FOMC) communication.[1] Over the same period, both the level and uncertainty of inflation have declined.[2] We infer that since the mid-1990s, the U.S. economy has been reaping the benefits of a credible commitment to price stability, including a communications framework that reinforces that commitment.

It is in this context that we take on the task of evaluating the Federal Reserve's monetary policy communications and suggest further improvements. A set of two dozen interviews, as well as our reading of published work, leads us to organize our recommendations around three objectives:

- simplifying public statements, while conveying any divergence of views;
- clarifying how policy will react to changing conditions;
- and highlighting policy uncertainty and risks.

Our purpose in this paper is to explore how policymakers can revise and enhance their agreed-upon communications practices to meet these objectives. In doing so, we take the annual Statement on Longer-Run Goals and Monetary Policy Strategy[3] as the foundation on which all other FOMC communication should be built. We also distinguish between ideal approaches and ones that, given governance challenges, may be more practical.

Simplifying public statements: Reaching the broadest possible audience requires communicating in plain English. Because the post-meeting statement conveys the key decisions, it is among the FOMC's most important communications tools and should be accessible to a broad audience. We discuss how to simplify the statement to make it more readable while adding relevant information.[4]

1. Appendix D provides a brief history of key changes in FOMC communications since 1993. Blinder and others (2008) review the theory and evidence regarding communication. In their study of 112 central banks from 1998 to 2015, Dinçer and others (2019) document the *global* trend toward greater monetary policy transparency.

2. For example, the dispersion (as measured by the interquartile range of responses) in the Survey of Professional Forecasters forecasts of 10-year consumer-price inflation has fallen by roughly 25 basis points per decade since 1991. See our discussion in Cecchetti and Schoenholtz (2019).

3. See https://www.federalreserve.gov/newsevents/pressreleases/monetary20190130b.htm.

4. See Haldane and McMahon (2018) on the need for innovation and experimentation in communication with the public. A "layered" communications strategy aims to convey policy-relevant information at multiple levels of complexity, consistent with having diverse audiences with varying degrees of interest and expertise.

Communication by multiple FOMC participants can foster confusion.[5] There is a sense in which this "cacophony" problem has been getting worse. Kliesen and others (2019) report that the frequency at which Reserve Bank Presidents speak has risen by about a third over the past decade, so that today there are roughly 60 days per year when more than one speaks. Some of this reflects the necessary clarification of differences in views—for example, when officials articulate the rationale for dissents— but we propose changes that could reduce noise and uncertainty created by the multiplicity of speakers.

Despite its great benefits, no one should take central-bank independence for granted. Consequently, it is in the collective interest of FOMC participants to encourage what Alan Blinder refers to as "group accountability."[6] This means establishing practices and norms that make communications more effective. For example, one useful practice is to encourage each participant to explain the Committee's decision, supporting it when they agree or explaining their dissent when they do not. To foster a stronger group mindset, we believe that participants could shift to using the first person plural ("we," "our," and "us") when explaining consensus decisions, and the first person singular ("I," "my," and "me") when describing dissents.

We conclude from our interviews that it would be useful to focus public comments more on the rationale for recent decisions, on the prospect for key policy drivers—such as inflation and economic growth— and on the justification for dissent; and less on the likely future path of interest rates.[7] Furthermore, in the absence of an explicit commitment to a future path for policy rates, communications should highlight uncertainty. As we discuss in detail, in June 2019, with the federal-funds-rate target range at 2.25 to 2.50 percent, the FOMC indicated that there is an even chance the policy rate will be between 1.0 and 4.2 percent by the end of 2021.[8] Taking all of this into account, we see little purpose served in answering questions like, "How many interest-rate increases (or decreases) do you believe are appropriate over the coming year?" Unless there is Committee agreement, so that

5. Throughout this paper, we follow the Federal Reserve's convention of referring to the FOMC voters as "members" of the Committee, and the combination of voters and nonvoters (the Governors plus all 12 Reserve Bank Presidents) as meeting "participants."

6. See Blinder (2016).

7. Faust (2016) comes to a similar conclusion.

8. This range reflects the FOMC's 50-percent confidence interval of plus/minus 1.6 percentage points around the March 2019 SEP median projection of 2.6 percent for the end of 2021. See Reifschneider and Tulip (2017).

the message is coordinated and consistent, having 19 people provide their own version of forward policy-rate guidance is unhelpful.

Clarifying how policy will react to changing conditions: When growth, unemployment, inflation, and other financial conditions deviate from what they expect, how will policymakers react systematically and predictably? In the language of monetary economics, what is their *reaction function*? Increasing transparency on this front is a demanding task. To see why, consider that a change in the policy rate could be the consequence of changes in the perception of current or expected future financial and economic conditions or in the desired response to these conditions. Moreover, even if every FOMC participant acts systematically, when perspectives on the economy diverge, new developments can shift the Committee consensus in complex ways.

Throughout this paper, we distinguish between statements about the economic outlook and forward guidance about the policy-rate path. If people understand the central bank's reaction function, then guidance about interest rates is only important when policymakers wish to provide stimulus *beyond* what occurs when people anticipate the central bank's response to news about the economy.

This leads us to focus on the *Summary of Economic Projections* (SEP)—not as a tool to provide explicit information about the future path of the policy rate, but as a way to help understand the Committee's likely reaction to changing conditions. While the SEP is useful for this purpose, we also see considerable room for improvement. Current practice is to publish the linkage among the four variables included in the SEP only with a lag of five years. That is, in the initial release we do not know the inflation- or unemployment-rate projections that are associated with a given interest-rate projection. Consequently, we cannot answer the simple question, "Does a particular FOMC participant project a relatively high interest rate because they believe the equilibrium real interest rate (r^*) is high, because they anticipate higher inflation and lower unemployment than their colleagues do, or because they believe in a more aggressive reaction to a shared forecast of these fundamentals?"

To address this clear shortcoming, we recommend that the FOMC immediately publish the "matrix" that links the projections for growth, unemployment, inflation, and interest rates for each FOMC participant. By clarifying where there are agreements and disagreements, the matrix would help observers understand the

Committee's collective reaction function, in part by facilitating inference about the nature and stability of the consensus. Ultimately, a true commitment to transparency also requires identifying respondents by name—information we currently receive only with a *10-year lag*! Associating names with the rows of the matrix not only makes it possible to link projections over time (something we expect observers will do probabilistically once they have the matrix), but also encourages greater discipline among the FOMC participants as they prepare forecasts.

Importantly, even a complete matrix would leave some key aspects of the FOMC reaction function opaque. To enhance transparency and add to credibility, we encourage the Committee to supplement the SEP by publishing the distribution of participant responses to specific scenarios that deviate substantially from the current outlook for the economy and financial conditions. These scenarios would focus on, but not be limited to, prominent tail risks. Collectively, information on the likely reaction to such specific circumstances ought to enhance the SEP and FOMC deliberations and foster a more systematic policy.

Highlighting policy uncertainty and risks: Communicating uncertainty about the likely evolution of the economy and the resulting policy path is essential. In our view, limited modifications to current FOMC practice could lead to significant improvements. Again, we look at the SEP. Publication currently occurs in two steps, with indicators of the uncertainty in the projections appearing with the minutes several weeks after the meeting for which they are prepared. This delay leads to what we view as an excessive public focus on the median projection.

We see a simple solution. The FOMC currently includes confidence intervals for its quarterly projections near the end of the complete SEP document. It also publishes participants' subjective assessments of the risks and uncertainty associated with their projections. We urge the Committee to convert the confidence intervals to something closer to a fan chart, move them (along with the subjective risk and uncertainty assessments) to the front of the publication, and release the complete SEP immediately following the FOMC meeting rather than with the minutes three weeks later.

Recommendations: With our three objectives in mind, we assess two of the most important elements of FOMC communications: the post-meeting statement and the SEP. We propose simplifying the statement and converting the SEP into a concise *Report on Economic Projections* released with the Chair's press conference immediately following the meeting; both would refer to the FOMC's foundational statement on longer-run goals.[9]

For the statement, we describe the key elements and a set of principles that should guide its formulation. We also produce two succinct examples that present the relevant information. These examples are readable by a U.S. high-school senior (grade 12).[10]

Over time, we hope that the FOMC will create a process for reaching agreement on a common set of projections and the uncertainty and risks associated with them. Such a consensus projection would provide a strong foundation for improving communications about the reaction function and, when desirable, about a policy-rate commitment.

However, governance challenges make this consensus approach difficult. As a practical, second-best alternative, we propose making three changes designed to convert the SEP into a concise quarterly *Report on Economic Projections*: i) reorder the material, putting the uncertainty charts at the front; ii) include a brief narrative that focuses on uncertainty and risks to the outlook; and iii) include the matrix of individual respondents linking growth, unemployment, inflation, and interest-rate projections. Our very simple version has fewer than 730 words and is readable by a high-school student (grade 9). A slightly more complex version would include a graphical summary of the distribution of participants' responses to various scenarios that deviate markedly from the current economic and financial outlook.

More broadly, a systematic application of our three objectives —simplifying public statements, clarifying how policy will react to changing conditions, and highlighting policy uncertainty and risks— can help streamline other elements of FOMC communications, such as the meeting minutes. Indirectly, these changes also are likely to be a helpful coordinating device for FOMC participants' public commentary. For example, the post-meeting statement and the *Report on Economic Projections* will naturally gain public attention, nudging participants to clarify further their implied reaction functions, to state if and why they disagree with the most recent decision, and to explain the key risks and uncertainties that they see.

9. For the concise *Report on Economic Projections*, we have in mind something like the Bank of England's brief visual summary ("In a Nutshell") of its *Inflation Report*, but constructed around the SEP. The BoE's latest (May 2019) visual summary is available at https://www.bankofengland.co.uk/inflation-report/2019/may-2019/visual-summary.

10. For reference, the text of this introduction (excluding footnotes) has 2009 words and a Flesch-Kincaid grade level index of 14.3, consistent with the reading level of a second- or third-year college student.

We now turn to a detailed discussion of central-bank communications. We base our recommendations and proposals in large part on comments gathered in the course of two dozen interviews during early 2019. In section 1, we summarize our interview methods and key results. In sections 2, 3, and 4, we discuss central-bank communications in general terms: why central bankers speak, what they should say, and how communications vary in the presence or absence of a policy-rate commitment. In section 5, we turn to FOMC communications that focus on clarifying the reaction function, namely the *Summary of Economic Projections*; first examining the median projections, then discussing the incremental value in publishing the matrix, and addressing how to use existing published materials to communicate uncertainty and risks. The section also briefly addresses scenario analysis as a means to illuminate the reaction function. Section 6 describes our highlighted proposals: the simplification of the FOMC's post-meeting statement (with examples in appendix B) and the reformulation of the SEP as a *Report on Economic Projections* (with an example in appendix C). Section 7 concludes with a brief recitation of our analysis.

1. Interview Methods and Key Results

To help us understand central-bank communications in general, and FOMC communications in particular, we contacted 35 former officials, academics, and market economists. Of these, 24 answered three open-ended questions:[11]

1. What do you see as the primary objectives of FOMC communication?

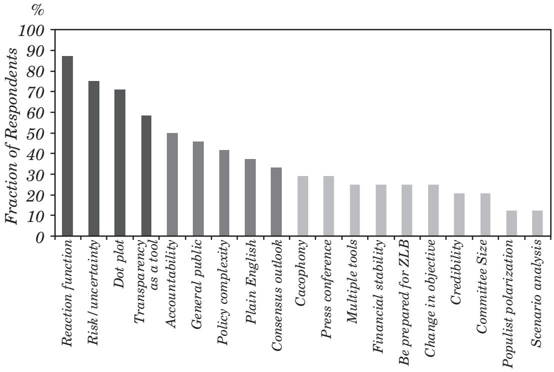
2. How do you think FOMC communication should evolve over the next five to ten years?

3. What do you view as the greatest challenges to effective FOMC communication?

Figure 1 summarizes the responses.

11. Appendix A reproduces our invitation to participate and lists those who agreed to answer our questions.

Figure 1. Frequency of Topics Mentioned by Interview Respondents



Source: Written or oral responses to interviews of 24 former central-bank officials, academics, and market economists in January to March, 2019. See appendix A for a list of those interviews and the dates. We use our judgment to allocate responses across topics.

The most frequently mentioned topic is the desirability of having a clear understanding of policymakers' reaction function—the systematic element of the central bank's response to economic and financial developments that drives the expected path of policy. Robert Di Clemente captured the sense of the group when he said, *"If you ask observers, 'What do you think the Fed would do if it appeared increasingly likely that inflation was going to rise by a percentage point or more in the next year?,' the goal of communications policy ought to be to find strong agreement about the likely course of action."*[12] Three quarters of those interviewed identified communicating the uncertainty and risks around the expected path of policy as a key topic. As Catherine Mann put it, *"What are the risks? You have to say something about the risks [to the outlook] and then say something about what the implications are for monetary policy."*

Seventy percent of our interview respondents mentioned the *dot plot* included in the *Summary of Economic Projections*. This is the visual display of FOMC participants' policy-rate projections. (In section 5, figure 2, we reproduce the dot plot from the March 2019 SEP.) Comments about the dot plot varied widely, with some interviewees

12. Italicized, attributed quotes that lack references come from our interviews. We include them with the explicit consent of the source. Quotes that are not in italics are from published sources.

advocating its elimination and others suggesting modifications.[13] We agree with Peter Hooper: *"Don't ditch the dots."* Indeed, as Federal Reserve Bank of Cleveland President Loretta Mester recently argued, "Omitting the dot plot would not eliminate the uncertainty around the projections, the divergence in views across FOMC participants, or the fact that policymaking always entails learning and recalibration, but it would be a significant step back in transparency."[14] Our conclusion, based on the detailed analysis in section 5, is that the publication of the dot plot does more good than harm by providing useful information that is difficult to convey in other ways.

Over one half of those we interviewed mentioned the use of transparency as a monetary policy tool. That is, communication itself can be a policy instrument, complementing, or substituting for conventional tools.

The role of communications as a tool is most prominent when it comes to forward guidance regarding a policy-rate commitment, which we discuss in section 4. However, forward guidance also is relevant for balance-sheet policy. And it may be useful to provide contingent guidance regarding longer-run policy strategy, such as the approach that policymakers plan to take when the policy rate hits the effective lower bound. As former Chair Janet Yellen put it, *"[t]he FOMC could adopt a set of principles about how it expects to operate in future zero-bound situations…That would provide more information than just changing a couple of words in the statement from a 2-percent inflation target to 2 percent on average."*

A number of respondents mentioned the need to communicate with the public in plain English. Lewis Alexander's comment is representative, *"Recently, Chair Powell argued in favor of using simple, non-technical, language to describe and explain the key economic concepts and evidence that drive FOMC decisions. I strongly agree."* Our proposals (in section 6) for a simplified FOMC statement and a concise *Report on Economic Projections* aim in part to address this concern.

Finally, we note that one third of those interviewed mentioned the difficulty created by the "cacophony problem." As then Governor Powell noted several years ago, "[M]arket participants often say that there are

13. This "mixed assessment" is consistent with the survey findings of Olson and Wessel (2016).

14. See Mester (2019).

too many voices saying too many different things about policy."[15] Based on the Brookings survey of FOMC communications, Wessel and Olson (2016) report that academicians and market participants want the Chair to speak more and the regional bank presidents to speak less. While placing a large burden on the FOMC Chair, the post-meeting press conference partly addresses this critique: As William Dudley said to us, "*[One] advantage of having a press conference every meeting is [it might] tamp down the importance of all the other talk.*"

With this background, we turn now to the rationale for monetary policy communications, as well as to the content needed to make it effective.

2. Why Central Bankers Speak

"One of the biggest challenges for the FOMC is to reach multiple audiences effectively." Richard Berner

For most of the 20th century, central bankers were infamously silent about their goals and actions. The motto ascribed to the interwar governor of the Bank of England Montague Norman—"never explain, never excuse"—aptly characterized the approach of U.S. central bankers until about 30 years ago. Indeed, just a month after taking office on August 11, 1987, Federal Reserve Board Chairman Alan Greenspan remarked:[16]

> *"Since becoming a central banker, I have learned to mumble with great incoherence. If I seem unduly clear to you, you must have misunderstood what I said."*

A key goal of such obfuscation was to ensure *maximum policy discretion*. In their view, for central-bank policy to be optimal, it was always to be free of constraint, including any limits that might arise from prior statements.

Today, however, central bankers have numerous reasons to speak clearly to a wide range of audiences. First, since the 1980s, governments have delegated considerable operational independence to central banks. By overcoming the problem of time consistency, this independence allows central bankers to make credible commitments about future policy that lead to improved economic performance.[17]

15. See Powell (2016).

16. *The Wall Street Journal*, as cited in Geraats (2007).

17. See Cecchetti and Schoenholtz (2018) for a primer on time consistency, complete with links to classic references.

To legitimize such a broad delegation of authority, legislatures must hold central banks accountable for achieving their legally mandated goals. This requires considerable transparency. As Paul Tucker put it, *"The first [objective of FOMC communication] is to explain to the public and the public's representatives in Congress how the Federal Reserve is going about exercising the powers delegated to it by Congress."*[18]

The requirement for democratic accountability means that the public at large is the most prominent audience for central-bank communication. To be sure, central bankers do not seek to win elections. To be effective, their policy horizon should extend well beyond the electoral cycle. Nevertheless, over the long run, people who lack confidence in the competence and trustworthiness of central-bank officials are unlikely to support the sustained delegation of authority.

Communicating with the voters and their representatives is difficult and requires both the development of a common vocabulary and the willingness of officials to engage in public discourse that focuses on monetary policy. Chairman Bernanke's appearance on *60 Minutes* (mentioned approvingly by a number of our interview respondents), his lectures to students at George Washington University, and Chairman Powell's town meetings are the sort of outreach that helps build understanding and support.[19] The *Fed Listens* outreach and review, of which this paper is a part, is another welcome move in this direction.[20]

While technical language barriers can make communicating with the public difficult, communication with financial-market participants is fraught for different reasons. The focus of financial markets on daily news encourages central bankers to comment on high-frequency developments. The result, as Peter Fisher puts it, is that *"[T]he Fed has a recency bias…always giving the greatest weight to the most recent data."* Yet, giving in to this inclination weakens the long-term focus needed to make central-bank commitments credible.

A related challenge arises from the fact that market participants react almost instantly when policymakers speak and act. Since

18. See also Tucker's (2018) recent book on the delegation of power to an independent agency in a democratic society. As he notes on page 546, and Brazier (2019) describes, central bankers should think of themselves as "citizens in power, not in charge."

19. Former Chairman Bernanke's lectures are available at https://www.federalreserve.gov/aboutthefed/educational-tools/lecture-series-origins-and-mission.htm.

20. For a listing of the 2019 "Fed Listens" events, see https://www.federalreserve.gov/monetarypolicy/review-of-monetary-policy-strategy-tools-and-communications-fed-listens-events.htm.

financial conditions play a central role in the transmission of monetary policy to the real economy, central bankers naturally care how people in financial markets receive their messages. As Woodford (2005) notes:

"[C]ommunication strategies improve only through a process of trial and error, even when central banks give considerable attention to the problem of how to tell the public more; for market participants must learn to interpret what the central bank is saying and the central bank must learn to anticipate how its statements will be interpreted.

At the same time, policymakers can become overly concerned with the market reaction to what they say. Jeremy Stein put it succinctly, *"I view the obsession with not surprising the market as counterproductive. The Fed should aim to build a culture and set of norms whereby FOMC members worry less about the short-run market reaction to its statements."*

3. What Should Central Bankers Say?

Both theory and experience have taught central bankers that *limiting policy discretion* can help them achieve their legal mandate. This is the central lesson of the research on time consistency. Viewed in this light, communications that articulate the central bank's goals and translate them into observable policies buttress the credibility of the commitment to the Federal Reserve's legal mandate. Over time, consistent matching of words and deeds fosters trust.

Monetary policy is most effective when it influences expectations.[21] Expectations guide the consumption and saving decisions of households, and the investment, production, and pricing decisions of firms. Meanwhile, financial markets translate expectations into long-term interest rates and prices of risky assets. For central bankers, stabilizing inflation expectations is central to stabilizing inflation. In a world with stable inflation expectations, central bankers also have greater flexibility to address temporary shocks that affect growth and unemployment.

Because it is intrinsically forward-looking, modern central banking is all about strategy and commitment. Simply promising to keep inflation low and stable lacks credibility, because policymakers have an incentive to renege on the promise if it is believed. From this perspective, transparency and communications are central components

21. See Coibion and others (2018) and de Haan and Sturm (2019) on the role of central-bank communications in managing expectations.

of a policy framework that—together with legally mandated goals and authorized tools—makes the commitment to price stability (and to other goals, such as maximum sustainable employment) credible. In some circumstances, such as at the effective lower bound for nominal interest rates, communications are among the most powerful central-bank tools for this purpose.[22]

What central bankers need to say depends on the monetary policy transmission mechanism. In addition to guiding expectations, policy affects the economy primarily by altering financial conditions. Central banks are most effective when financial-market participants *anticipate* their responses to economic developments and speed the adjustment of financial conditions.

Helping the public anticipate central-bank behavior starts with an explanation of how central bankers view *current* economic conditions.[23] As a result, officials expend considerable effort explaining how they assess recent economic and financial developments. The Federal Reserve has introduced a range of tools for this purpose, including the publication of indexes that summarize financial conditions and the provision of *nowcasts* that allow for efficient, high-frequency updating of current economic activity estimates.[24]

The most important way to help the public form expectations about monetary policy is to explain how central bankers would alter policy in response to unanticipated economic and financial developments. To be useful, such explanations pre-suppose that policy is systematic, so that there is a reliable link between a set of circumstances and the monetary policy that follows. Explaining how policy would respond to a set of plausible scenarios—a large supply shock that boosts inflation, a deflationary shock that depresses interest rates to the effective lower bound, and so on—can go a long way toward illuminating policymakers'

22. Bernanke (2015) states that "monetary policy is 98 percent talk and only 2 percent action."

23. With the important exception of Morris and Shin (2002 and 2018), who highlight the potential for private herding, academic researchers typically view the central-bank production of public information as welfare enhancing. See, for example, Svensson (2005) and Woodford (2005). The latter notes that, since policymakers have superior knowledge about their own reaction function, revealing it likely enhances welfare.

24. See, for example, the National Financial Conditions Index (https://www.chicagofed.org/publications/nfci/index) and the National Activity Index (https://www.chicagofed.org/publications/cfnai/index) of the Federal Reserve Bank of Chicago, as well as the GDPNow (https://www.frbatlanta.org/cqer/research/gdpnow.aspx) and Nowcasting Report (https://www.newyorkfed.org/research/policy/nowcast) of the Federal Reserve Banks of Atlanta and New York.

model of the economy. It also can reveal policymakers' preferences in the face of inevitable short-run tradeoffs among their objectives.

The systematic way in which a central bank responds to developments, both anticipated and unanticipated, constitutes a *monetary policy reaction function*. In line with the modern literature on monetary policy, explaining this reaction function heads the list of communications topics cited in our survey (figure 1).

One classic approach, based on optimal control theory, derives the reaction function by minimizing deviations from the central bank's stabilization goals in a specific model of the economy.[25] However, as Mark Gertler put it, *"We have some idea what [the true model of the economy] might look like, but we don't have a precise sense."* Since the optimal policy derived from one model may lead to severe underperformance when the model is wrong, policymakers often look to simple, robust rules for guidance. Recent editions of the Federal Reserve's semiannual *Monetary Policy Report* reflect this approach.[26]

Communication is far easier—and more effective in achieving widespread understanding—in the presence of systematic policy. As Charles Plosser notes, *"The unwillingness to give up on discretionary policymaking makes their communications less informative, less transparent, and more complicated than they otherwise might need to be."* Nevertheless, even when policy is systematic, fundamental uncertainties limit predictability. In addition to uncertainty about the state and model of the economy, central bankers cannot anticipate the shocks that will inevitably arise. While a systematic policy should identify an expected policy path, these uncertainties imply a distribution around that expected path that may be very wide.

Communicating such unavoidable uncertainty may be unwelcome. To quote Dennis Lockhart, *"I don't think the FOMC or the Fed can satisfy financial markets because financial markets are looking for more certainty than can be conveyed and can be communicated."* Similarly, as Roger Ferguson noted, *"[M]arket participants want to know what the Fed is going to do next. That's the one question the Fed really can't answer with the kind of clarity and certainty that the market would like."*

25. See, for example, Woodford (2003).

26. Taylor (1993) is the seminal work on simple policy rules. By using a range of models, Cochrane and others (2019) assess the robustness of the simple rules discussed in the Federal Reserve's semiannual *Monetary Policy Report* since July 2017 (see, for example, Board of Governors [2017], pages 36–39).

Yet, revealing the distribution of policy prospects is no less (and can be more) important than illuminating the expected path (figure 1). In most circumstances, central bankers do *not* wish to commit to the expected policy, nor should they. Highlighting uncertainty is one way to demonstrate the absence of a commitment.

To deepen understanding of the limits of the central bank's toolbox, it is useful for communication to highlight circumstances when policy may go beyond a simple rule. For example, it is helpful to explain how the presence of an effective lower bound on nominal interest may prompt policymakers to deviate from the expected policy-rate path to combat deflation risk, even if it means forgoing the usual objectives temporarily.[27] Such *risk management* considerations typically gain force when the probability rises of a high-cost tail event.[28]

Finally, institutional features influence what central bankers need to say. For example, the membership of the Committee changes each year. As former Chair Janet Yellen points out, *"For governance reasons, it is actually very hard to get a committee that is changing over time to bind itself to how it will behave in the future."* Consequently, to make its ultimate objectives credible, each January, the "new" FOMC re-commits itself (with only minor tinkering) to the Statement on Longer-Run Goals and Monetary Policy Strategy that informs all policy decisions.

4. Communications with and without a Policy-Rate Commitment

In thinking about the manner and timing of central-bank communications, it is useful to distinguish two separate regimes. The first, which we label "normal," prevails most of the time when interest rates are positive. The second, which involves a "policy-rate commitment," arises typically if central bankers wish to stimulate the economy further when the policy rate is close to the effective lower bound.

What is common to both regimes is the need to communicate the central bank's mandate (e.g., price stability and maximum sustainable employment). In addition, because private agents are forward-looking and because policy's impact on the economy occurs only with a lag,

27. For a discussion of risk management in monetary policy, see Greenspan (2004).

28. The development of tools to anticipate such tail events—such as GDP at Risk—facilitates such a risk-management approach. See Cecchetti and Schoenholtz (2017).

communications must be forward-looking as well. Thus, policymakers need to make clear the expected policy path that arises from the central bank's reaction function.

In the normal regime, it is essential to convey the uncertainty regarding the path of the fundamentals that drive the reaction function. This is what officials mean when they describe policy as "data-dependent."[29] As new observations arrive, policymakers update their perceptions of the state of the economy and financial conditions, as well as of key unobservable variables in their economic model, and adjust the likely path of policy accordingly.[30]

In this setting, forward-looking communication—such as economic or interest-rate projections—is unavoidably "Delphic" in character.[31] Regardless of what anyone might think, it emphatically is not a commitment to a specific interest-rate path. Indeed, for communications to be effective, the central bank must persuade outside observers that, when conditions deviate from forecasts, the policy path will too.

In this normal regime, public understanding of the policy reaction function is sufficient for the central bank to deliver adequate stimulus to the economy when inflation falls below target, output falls short of potential, or unemployment exceeds its equilibrium level. In contrast, at the effective lower bound, delivering more stimulus than conventional tools permit may require a commitment to keep the policy rate "low for longer."[32] Under these circumstances, communication becomes a policy tool, altering financial conditions and economic prospects when policy-rate changes cannot.

Going beyond a mere Delphic forecast, such an "Odyssean" commitment aims metaphorically to tie policymakers to the mast. The purpose of such a pledge to keep policy rates low is to reduce long-term interest rates and term *premia* that affect financial conditions more broadly. In this commitment regime, uncertainty about the policy-rate path is naturally lower than in the normal regime.

Provided the commitment is credible, theory suggests that such "forward guidance" will be extremely powerful. In some benchmark macroeconomic models, this gives rise to a "forward guidance puzzle" in which a commitment to a one-off temporary stimulus has greater

29. Williams (2019) is a recent, representative example.

30. See Clarida (2018) for how data may be used to update estimates of the real rate of interest (r*) or unemployment rate (u*) that prevail in long-run equilibrium.

31. See Campbell and others (2012) for the introduction of the terms "Delphic" and "Odyssean" in characterizing forward-looking FOMC communications.

32. See, for example, Reifschneider and Williams (2000).

impact today the further in the future its implementation.[33] However, these models assume a degree of credibility and time consistency that is virtually never achievable. Indeed, where the voting members of the policy committee frequently change—as the FOMC does every January—it is nearly impossible to see how the current committee could provide credible commitments of interest-rate actions in the distant future.

In addition to the limits imposed by its governance structure, the credibility of a monetary policy committee's interest-rate commitment depends on the central bank's policy framework. Suppose for example, that inflation has fallen short of policymakers' target for some time. In a conventional inflation-targeting framework where "bygones are bygones," promising to keep interest rates low well after inflation rises to its target is likely to be less convincing than in an "average inflation" targeting regime where policymakers explicitly account for past misses.[34]

In practice, policymakers make two types of Odyssean commitments: *date-contingent* and *state-contingent*.[35] A date-contingent promise is relatively easy to communicate: policymakers simply say that they will keep the policy rates at or near the effective lower bound for a specified period of calendar time. Far from making policy data-dependent, a date-contingent promise is equivalent to announcing that policymakers are willing to short-circuit their reaction function, ignoring economic and financial news until the commitment expires. If credible, date-contingent promises can have a powerful impact on financial conditions, as they mute private reactions to economic news, thus reducing volatility.[36] However, as conditions evolve, a central bank may face an incentive to renege.

Unlike date-contingent commitments, state-contingent pledges tend to reinforce the reaction function, thus helping to underpin credibility. In an inflation-targeting regime, for example, a common approach is to commit to a low policy-rate path until key goals are satisfied: inflation (or inflation expectations) rises to its target,

33. See McKay and others (2016).

34. The latter regime is "history dependent" in the sense that Woodford (2005) deems necessary for optimal policy.

35. The description and analysis of date- and state-contingent commitments draws heavily on Feroli and others (2017).

36. By using a cross-country dataset, Ehrmann and others (2019) find that date-contingent promises with a short horizon (less than or equal to 1.5 years) actually increase the responsiveness to news and are not effective in reducing forecaster disagreements.

unemployment sinks to its equilibrium rate, or both. In a targeting regime that accounts for past misses, the commitment could go further: keep the policy rate low until *average* inflation over a specified period reaches its target.[37]

Several factors favor state-contingent commitments over the procedurally simpler date-contingent variety. First, they are less likely to strain credibility because they tend to amplify, rather than mute, the reaction function. Second, because they do not blunt private agents' responses to economic news, the transition to a normal regime—one without a policy-rate commitment—is likely to be smoother. Once policy moves away from the effective lower bound, the case for state-contingent over date-contingent commitments becomes even stronger. Third, as Feroli and others (2017) highlight, observers tend to focus disproportionately on the time-based aspects of communications even when policymakers seek to qualify the commitment.

To summarize our discussion thus far, effective central-bank communication conveys a sense of policymakers' reaction function and a clear understanding of the uncertainty associated with the path of both the economy and policy. And it conveys the desired messages in simple, widely accessible, language. Through its various communications tools (discussed in appendix D), the FOMC is already working hard to meet these goals. The post-meeting statement and the Summary of Economic Projections are two of the most important communications tools. When we come to our specific recommendations in section 6, we propose some principles for simplifying and making the statement more informative. We also suggest using components of the SEP to construct a timely and concise *Report on Economic Projections*.

Before that, however, we turn to a discussion of tools for clarifying the reaction function, with a focus on the SEP. In our view, the SEP in its current form has been useful both in the presence and in the absence of a policy-rate commitment. But, as we will explain, we believe that a straightforward reorganization of existing published material—including some modest additions and changes in timing—could bring further significant improvements.

37. See Yellen (2018) for a brief discussion of alternative targeting frameworks, including price-level targeting and nominal GDP targeting, as well as average inflation targeting. Mertens and Williams (2019) analyze the benefits of targeting average inflation and the price level for reducing the constraint of the effective lower bound. Gust and others (2017) show that an asymmetric loss function can result in a "low-for-longer" commitment.

5. Clarifying the Reaction Function

The most prominent FOMC communications tool that links the economic outlook and the policy-rate choice—the reaction function—is the SEP. The complete SEP also illuminates policymakers' uncertainty about the outlook and the policy path. In this section, we explore what can be learned from the current version of the SEP, the extent to which additional information about the participants would enhance understanding of the Committee's reaction function, and how the addition of scenario analysis could add further to this understanding.

5.1 What we Learn from the SEP

"[I]f properly understood, the dot plot can be a constructive element of comprehensive policy communication." Federal Reserve Board Chairman Jerome Powell, March 8, 2019.[38]

In 2012, five years after they began its publication, the FOMC added explicit information on the federal-funds rate to the SEP. At the time, the Committee probably hoped that displaying the breadth of support for keeping interest rates close to zero would bolster its "low-for-longer" commitment. This is surely no longer the case.

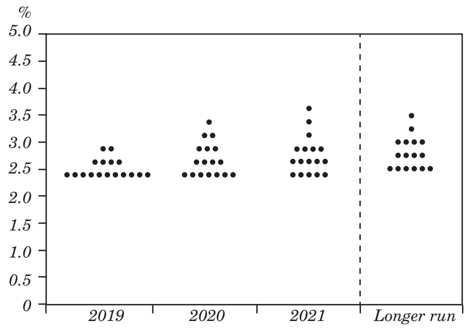
Today, what is the role of the SEP in the FOMC's communications framework? What can we learn from the release as it exists, and how might that information be enhanced and supplemented to meet the objectives of improving communication?

The current form of the SEP presents the median projections of economic growth, inflation, and unemployment for the next two or three years, as well as a plot of the policy-rate projections for all of the FOMC participants (without identifying them). Financial-market participants and the media focus intently on these "dot plots," like the one released following the March 2019 FOMC meeting and reproduced in figure 2.

A bit like pathologists analyzing a biopsy, "dotologists" study these plots in an effort to divine the intentions of policymakers. When will the next policy-rate move come? Will it be an increase or decrease? How many changes are coming over the next year? Over the next two years? The questions go on and on. The publication of the dot plot, and the questions it generates, has spawned a cottage industry of experts much like that which sought to identify actual policy shifts before the FOMC began to announce them in 1994.

38. See https://www.federalreserve.gov/newsevents/speech/powell20190308a.htm

Figure 2. FOMC Participants' Assessments of Appropriate Monetary Policy: Midpoint of Target Range or Target Level for the Federal-funds Rate (End of Period), March 20, 2019



Source: Copied directly from figure 2, Minutes of the Federal Open Market Committee (https://www.federalreserve.gov/monetarypolicy/files/fomcprojtabl20190320.pdf), March 19–20, 2019.

In examining the dots, it is important to understand what they are and what they are not. Bernanke (2016) explains that they are neither a policy commitment nor an unconditional forecast. Moreover, the dots themselves do not convey the considerable level of uncertainty associated with each individual's projections. Instead, the dots are a collection of projections from all FOMC participants (voters and nonvoters) "based on individual views of 'appropriate monetary policy'." As Bernanke explains, someone with views that clearly differ from the consensus would base their projections on their own views, not on what they believed is most likely to happen. Provided FOMC participants behave systematically, if we knew each individual's projections, then we could recover their approximate (implicit) reaction function. That is, the current procedure generates much more useful data than an alternative in which survey respondents would provide their view of the most likely future path of policy and the economy.[39]

We now proceed to a more detailed analysis of the SEP, starting with a look at the median projections. This information, including

39. There are other ways to obtain useful information on the Committee's reaction function. For example, several interview respondents suggested that the FOMC publish how policy is likely to change in various scenarios. That is, provide each participant a common set of paths for growth, unemployment, and inflation, and ask what they think the appropriate policy-rate path would be in each case. We return to this idea at the end of section 5.

interest-rate projections, is available quarterly since 2012. Next, we examine the incremental value of having the matrix of linked individual projections for unemployment, inflation, and the policy rate. As of this writing, the FOMC has published this matrix—without the names of the FOMC participants—only for 2012 and 2013. The revelation of the names is set to begin with a 10-year lag in 2022. Finally, we look at uncertainty, with respect to both the future state of the economy and the policy rate.

5.1.1 The Median SEP

"The SEP provides useful quantitative information about the FOMC's reaction function, and, in particular, why the projections of future interest-rate changes." Bernanke (2016).

To the extent that the dot plot is merely a collection of projections, the format in which it first appears would seem to limit its usefulness. Until five years after its initial release, the SEP provides no means to connect the inflation, unemployment, and interest-rate forecasts of individual respondents. The reported medians (and ranges) need not reflect any particular FOMC participant's view or reaction function. Moreover, the mix of individuals shifts from year to year, as both Governors and Reserve Bank Presidents change. In addition, only five of the 12 Presidents vote at a time, but the dots do not distinguish voters and nonvoters. So, one might be skeptical about using the information in the SEP to construct a coherent story about the FOMC's likely reactions to changing circumstances.

On closer inspection, however, we see that the medians contain very useful information. To come to this conclusion, we look at the 30 SEP publications from January 2012 to June 2019, collecting data on the median values for the policy interest rate, inflation (as measured by the core PCE price index), and unemployment.[40] Each SEP has forecasts for three or four years, resulting in a panel dataset with 107 observations. Treating all these as if they came from a single (representative) policymaker, we estimate a simple Taylor rule where the policy interest rate (i) is set equal to the short-run equilibrium real rate of interest (r^*) for a given year, plus current inflation (π), plus

40. In 2012, there were five SEPs, one more than the quarterly frequency in subsequent years.

a coefficient (α) times the inflation gap (π-π^*) and another coefficient (β) times the unemployment gap (U-U^*):[41]

$$i_{t,s} = r_k^* + \pi_t + \alpha(\pi_t - \pi^*) - \beta(U_{t,s} - U_{t,s}^*) + \varepsilon_{t,s}, \tag{1}$$

where the subscript t denotes the month-year of the SEP (e.g., March 2018), k is the year of the SEP (e.g., 2018), and s is the year for which the projection is made (e.g., 2018, 2019, 2020). The final term in equation (1), $\varepsilon_{t,s}$, is a mean zero, constant variance error. By including year-fixed effects, we are able to estimate the short-run real interest rate each year (r_k^*).

Estimating equation (1) yields several interesting results. First, the SEP-implied short-run reactions to changes in inflation ($1+\hat{\alpha}$) and unemployment ($\hat{\beta}$) are 2.0 and 0.6, respectively.[42] That is, for each percentage point the median inflation projection lies above or below the target of 2 percent, the median policy-rate projection moves by nearly *two and one half percentage points*. The SEP medians suggest far less sensitivity to the unemployment gap, with the policy rate moving by only about half a percentage point for each percentage point that projected unemployment moves relative to the estimate of the equilibrium rate (U^*). While the estimated ratio of $(1+\alpha)$ to β is surprisingly high, this regression fits reasonably well, accounting for nearly 75 percent of the variation in the panel of median interest-rate projections.

Second, estimates of the implied short-run equilibrium real interest rate follow an interesting evolution. After adjusting for the 2-percent inflation target, we can compare our estimates of r_k^* with the longer-run policy-rate projections reported in the SEP, which we label r_l^*. Figure 3 shows the results of this exercise. The solid line is the estimate of the annual short-run r_k^* computed from the Taylor rule (recall that this is the estimate for the year of the SEP publication). The shaded area depicts a 95-percent confidence interval around these short-run estimates. The dashed line is the median value of

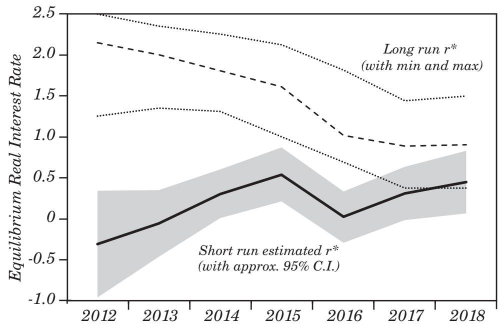
41. Since we use projections for the core PCE price index, the inflation objective π^* is equal to 2. To calculate the unemployment gap, we use the median of the "longer-run" unemployment rate in each SEP release as our measure of U^*.

42. The exact parameter estimates (with robust t-ratios in parentheses) are $(\hat{\alpha}) = 1.02$ (3.85) and $(\hat{\beta}) = 0.55$ (3.29). Standard errors computed by using the Driscoll and Kraay (1998) procedure are robust to heteroscedasticity and autocorrelation.

the longer run r_l^* (the average SEP median federal-funds rate in the longer run published that year minus the 2-percent inflation objective). The dotted lines show the range of the average minimum and maximum projections for r_l^* for the year.

Looking at the figure, we see that the short-run r_k^* starts at a level below zero in 2012 and fluctuates in a range between minus one quarter and plus one half of one percent. That is, the FOMC's recent forecasts for interest rates, inflation, and unemployment are consistent with a short-run r_k^* of about −0.2 percent. Over the same period, the SEP median longer-run equilibrium real rate r_l^* declines consistently. Starting above 2 percent (with a range from 1.25 to 2.5 percent) in 2012, the 2019 estimate of the contemporaneous longer-run real interest rate is between -0.1 and 1.5 percent, with a median of 0.65 percent.[43]

Figure 3. SEP-implied Short-run and Longer-run Equilibrium Real Interest Rates ($r_k^*$and r_l^*), 2012–19



Source: Data are from the 31 published SEPs from January 2012 to June 2019.
Note: Estimates of the short-run equilibrium real interest rate (solid line) are the time-fixed effects in equation (1). The shaded area is 1.96 times the Driscoll-Kraay (1998) standard error of each year's estimate. Estimates of the longer-run equilibrium real interest rate (dashed line) are the average of the median longer-run nominal federal-funds-rate projections in the SEP for the year, less the 2-percent long-run inflation objective. The dotted lines show the range of average minimum and maximum projections for r_l^* for the year.

43. We note that the March 2019 estimate from the Laubach and Williams (2015) model published by the Federal Reserve Bank of New York (FRBNY) (https://www.newyorkfed.org/research/policy/rstar) is 0.65, roughly equal to the average of the median from the March and June 2019 SEPs.

This brief casual analysis of the data suggests to us that, even as currently published, the SEP medians are quite informative. They help us to sketch the rough outlines of how the Committee might react as inflation and unemployment change and they highlight the evolving perception of what is neutral. Perhaps surprisingly, even over the turbulent period of the past seven years, the pattern is relatively stable: the implied levels of the short-run (and longer-run) equilibrium real rate of interest change gradually as new data prompts FOMC participants to update their views.

5.1.2 The Incremental Value of the Matrix

"One recommendation would be to adopt the so-called matrix approach for the SEP in order to reinforce the link between the economic forecast and the policy outlook for each individual member." David Greenlaw.

Given the value of the medians, what is the incremental information of publishing the matrix that would allow us to connect the inflation, growth, unemployment, and policy-rate projections for each individual FOMC participant? The answer is that it can help observers assess when the Committee median or consensus might shift.

Unsurprisingly, the median view in a group can be unstable. That is, even if all the participants follow a systematic, model-based, policy strategy, the identity of the median participant (and hence the properties of the median reaction function) can shift. To see why, consider the following extended example, in which the participants of a monetary policy committee fall into three distinct groups. They share much in common: their inflation target is 2 percent, their estimate of the equilibrium level of unemployment is 4 percent and their estimate of the short-run equilibrium real interest rate is 1 percent. Where they differ is in the weight they attach to the inflation and unemployment gaps, and to financial stability concerns in their reaction functions. Specifically, assume that each group employs a variant of the following Taylor rule in equation (1):

$$i = r^{*} + \pi + \alpha(\pi - \pi^{*}) - \beta(U - U^{*}) + \gamma FS, \tag{2}$$

where the added term, FS, is a financial stability indicator (such as financial system leverage or housing prices) which equals 0 or 1.[44] The values of the parameters in (2) distinguish the three groups, as shown in table 1:

Group A reacts to unemployment movements above all else, Group B has a balanced approach, albeit one explicitly integrating financial stability considerations, and Group C is the mirror image of Group A, focusing exclusively on inflation deviations from the target. These differences could arise from diverse perspectives on the central bank's loss function, variation in the underlying model of the economy, or some combination of the two.

Next, assume the median group controls policy outcomes so long as its members are able to obtain support from members of at least one other group. And a group is willing to vote with the median if the result is less than 50 basis points from their preferred policy choice; otherwise, they dissent.

Consider two scenarios in which the financial stability indicator is 0 or 1. In each scenario, we look at examples where the only thing that varies is the unemployment rate. Table 2 displays the results of this exercise. Starting with the top panel, where *FS* is zero, Group B—the balanced group—is *always* the median (the shaded cells in the table). In addition, no group prefers a policy rate that is more than 25 basis points from the median, so the vote is always unanimous.

Table 1. Policy Rules for Three Distinct Groups

Group	α	β	γ
A	0.0	1.0	0.0
B	0.5	0.5	0.5
C	1.0	0.0	0.0

44. We see the inclusion of a more graduated financial stability indicator as a potentially realistic addition to the reaction function. For example, in prepared remarks delivered on May 14, 2019, Federal Reserve Bank of Kansas City President Esther George warned that "lower interest rates might fuel asset-price bubbles, create financial imbalances, and ultimately a recession." See George (2019).

Table 2. Desired Policy Rate by Group

Scenario I. Financial Stability Indicator = 0						
Cases	*State of the Economy*			*Desired Policy Rate*		
	π	***U***	***FS***	*Group A*	*Group B*	*Group C*
1	2	3.5	0	3.50	3.25	3.00
2	2	4.0	0	3.00	3.00	3.00
3	2	4.5	0	2.50	2.75	3.00
Scenario II. Financial Stability Indicator = 1						
Cases	*State of the Economy*			*Desired Policy Rate*		
	π	***U***	***FS***	*Group A*	*Group B*	*Group C*
1	2	3.5	1	3.50	3.75	**3.00**
2	2	4.0	1	3.00	**3.50**	3.00
3	2	4.5	1	**2.50**	3.25	3.00

Note: The shaded cells denote the median voting-group policy rate, and numbers in bold italics denote cases where a group will dissent.

The bottom panel of table 2 displays the results when financial stability is a concern (*FS* equals one). Now, in every case, Group B prefers a policy rate that is 50 basis points higher than in the absence of a financial stability concern. As a result, Group B is *never* the median. Instead, the median fluctuates between Group A and Group C (or both). Also, there will be dissents in every case (bold italics). In case 1, Group C dissents because they set policy with a primary focus on inflation, which is at the target. In case 2, Group B dissents because their model implies tighter policy in response to financial stability risks. Finally, in case 3, Group A dissents because of their primary concern for unemployment.

This example highlights the challenge of deducing the reaction function for a *committee* even if all of the members are following systematic policies. Doing so requires understanding both the entire array of reaction functions, as well as when each group is likely to carry the day. To put it slightly differently, in order to understand how the committee will react to incoming information, we need to know how each individual's desired policy rate will change so that we can predict the voting pattern and assess where the consensus is likely to emerge. Information in the matrix, especially with projections linked across time, would make this possible.

Table 3. Monetary Policy Reaction Functions based on SEP Matrix, September 2012

2015 Funds Rate Range	*Estimated short-run r^**	$\hat{\alpha}$	$\hat{\beta}$	R^2	*Average U^**	*Average long-run r_l^**	*Number of participants*
0.0 to 1.0 percent	-1.15 (11.48)	-0.90 (3.51)	0.28 (5.05)	0.42	5.39	1.88	10
1.5 to 2.5 percent	-0.18 (0.62)	2.10 (2.01)	0.52 (2.94)	0.56	5.76	2.20	5
3.5 to 4.5 percent	1.69 (3.10)	-0.35 (0.07)	-1.43 (3.73)	0.58	5.88	2.31	4
Full sample	0.14 (0.62)	-0.08 (0.11)	-0.75 (5.61)	0.38	5.59	2.07	19

Notes: The table reports estimates of a simple Taylor rule: $i_j = r_j^* + \pi_j + \alpha(\pi_j - \pi^*) - \beta(U_j - U_j^*)$, where j represents the row of the matrix of projections for groups distinguished by their three-plus year projection of the policy rate. Each participant provides four projections—2012, 2013, 2014, and 2015—so the number of observations in each sample equals the number of participants times four. Numbers in parentheses are OLS *t*-ratios.

With existing public information, we are unable to estimate individual policy reaction functions with any precision. Instead, to sketch what we might learn from the full matrix, we take the sparse information that is available and look for groups that might have similar systemic responses to changing economic conditions. The September 2012 SEP reports the matrix for 19 participants with projections through 2015: this gives us 76 observations. We divide the data into three groups based on the participants' 2015 federal-funds-rate projections: (1) the 2015 federal-funds rate will be between 0.0 to 1.0 percent, (2) the 2015 federal-funds rate will be between 1.5 to 2.5 percent, and (3) the 2015 federal-funds rate will be between 3.5 to 4.5 percent. Taking these groups, we estimate three simple Taylor rules. The results are in table 3. Only the estimates for the second group make sense. The others suggest participants would *lower* the real interest rate in reaction to *higher* inflation—that is, $\hat{\alpha}$ is negative! Clearly, the existing information is insufficient for us to come to any reasonable conclusions about individual reaction functions.

As we mentioned in the introduction, a true commitment to transparency requires timely publication of the matrix *together with the participants' names*. Nevertheless, even without the names and without links across SEPs, new information-processing techniques likely will allow experts to extract more information from the matrix of projections. We would not be surprised to see a cottage industry of specialists applying natural-language-processing methods to policy-related speeches or writings in order to deduce the names while using machine-learning techniques to identify relatively stable groups with common reaction functions. While the results of such exercises can help discipline policymakers (increasing the incentive to act systematically), it seems better to preempt such private policy-discovery efforts, avoid the deadweight loss to society that they represent, and enhance the transparency of the SEP directly by providing the matrix with the names at the outset.[45]

5.1.3 Interest-Rate Policy Uncertainty

"*I believe the current emphasis on the medians of these disparate projections in Fed publications and explanations also works to undermine the emphasis on uncertainty.*" Donald L. Kohn.[46]

We now turn to the difficult but essential task of communicating uncertainty. Officials may be concerned that effective communication of uncertainty would underscore how little they actually know. However, it is important that the public understand the challenges of setting monetary policy. Above all, there should be a common appreciation that, as a result of the considerable uncertainties, a key feature of effective policy is a willingness to entertain differing assessments, correcting errors quickly as new information arrives.[47] As Mervyn King emphasized to us, "*Talking very openly about the degree of ignorance is crucial. Explain what we don't know and don't apologize for it: this is being honest and, frankly, no one else knows either.*"

45. Calomiris and Mamaysky (2019) highlight the incentive effects that natural-language-processing (NLP) techniques can induce by enhancing transparency. NLP techniques are already being widely used in the analysis of central-bank behavior. As noted in appendix D, Hansen and others (2018) use NLP to assess the impact on FOMC deliberations of publishing the transcripts. Prattle (2018), a private vendor, employs NLP to assess the sentiment of policymakers at several central banks.

46. See Kohn (2019).

47. Faust (2016) also notes the desirability of explaining the role of errors in making policy.

Fortunately, the FOMC compiles and publishes substantial information on uncertainty; but does little to attract attention to this valuable work. Based on the analysis of Federal Reserve Board economists, table 2 in the complete SEP that is currently released with the FOMC meeting minutes includes estimates of error ranges (measured as the root-mean-squared historical prediction error) for projections of real GDP growth, the unemployment rate, inflation, *and* the short-term interest rate.[48] Since this appears three weeks after the initial SEP release, only die-hard devotees consume this critical information.

To see how informative these error ranges are, consider the information included with the March 19–20, 2019 meeting minutes, available at https://www.federalreserve.gov/monetarypolicy/fomcminutes20190320ep.htm. There we learn that, for the unemployment rate, the median projection two years ahead is 3.9 percent, with an error range of plus or minus 1.7 percentage points. This tells us that, given historical experience, there is a 70-percent chance that, at the end of 2021, the unemployment rate will be between 2.2 and 5.7 percent. For inflation the median is 2.0 percent with an error range of plus or minus 1.1 percentage points, so the confidence interval goes from 0.9 to 3.1 percent. (For GDP growth the median projection is 1.8 percent with a root-mean-squared error of 1.9 percent; that is, the 70-percent confidence interval extends from -0.1 to +3.7 percent).

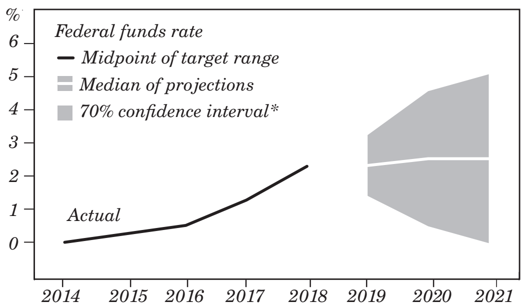
Uncertainty regarding the future level of unemployment and inflation (and real growth) translates directly into uncertainty about the path of the policy rate. Here, again, the FOMC is remarkably transparent about the unavoidable lack of precision. In March 2019, the error range for the 2021 projection of the short-term interest rate is plus or minus 2.5 percentage points. Given the median projection of 2.6 percent, this implies that the Committee believes there is a 70-percent chance that, at the end of 2021, the target interest rate will be between 0.1 and 5.1 percent. If the risks are symmetrical, that implies there is at least a 15-percent chance of returning to the zero lower bound in the next two years. (The 50-percent confidence interval for the policy rate over this same two-year horizon is plus or minus 1.6 percentage points).

Since 2017, the FOMC has also published a chart in the full SEP that helps visualize the uncertainty in the interest-rate path. Figure 4

48. See David Reifschneider and Peter Tulip (2017). Levy (2019a and 2019b) also recently proposed highlighting this material.

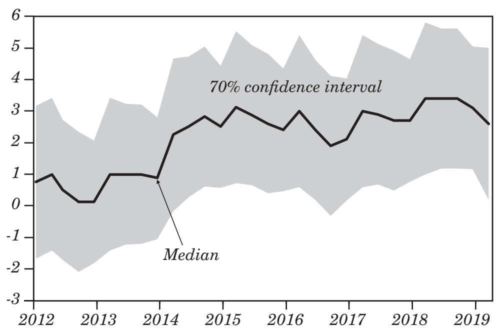
reproduces the version included with the March 19–20, 2019 minutes. This fan chart makes clear that, while the median suggests little change in the policy rate over the next 2-plus years (in white), there is considerable uncertainty that increases with the forecast horizon.

Figure 4. Uncertainty in the March 2019 Projections of the Federal-funds Rate
(with 70% confidence interval), 2019 to 2021



Source: Figure 5, Minutes of the Federal Open Market Committee, March 19–20, 2019 on the FOMC's section of the Federal Reserve Board website (https://www.federalreserve.gov/monetarypolicy/fomcminutes20190320ep.htm).

Figure 5. Uncertainty in the Two-year-ahead Projections of the Federal-funds Rate
(quarterly with 70% confidence interval), 2012-March 2019



Source: Minutes of the Federal Open Market Committee, 2012 to 2019; table 5 in Reifschneider and Tulip (2017); and authors' calculations.

To underscore the value of these published indicators of uncertainty, we examine the information from all 30 SEPs through March 2019 and combine it with the error ranges computed by Reifschneider and Tulip (2017) to generate a history of the uncertainty in the FOMC's two-year ahead policy-rate projections. Figure 5 displays the result. The black line is the two-year ahead median, while the gray area is the 70-percent confidence interval. Note that "two years ahead" is only an approximation, since the projection is always for the end of the calendar year that is two years ahead. We show the projections as of each publication date. For example, we plot the March, June, September, and December 2012 projections for the end of 2014 as four consecutive points in 2012. Specifically, the December 2012 median projection for the end of 2014 was 0.13 percent, with error bands ranging from -1.81 percent to +2.07 percent. (The fact that "two years ahead" is closer to December than it is to March explains much of the jagged pattern in the confidence interval: uncertainty declines as the forecast horizon shortens).

In our view, this information about the uncertainty in the projections is severely underutilized. Indeed, we believe that with a bit of work, it is possible to convert the SEP published with the meeting minutes (fan charts and all) into a concise *Report on Economic Projections* that would be a centerpiece of the FOMC's communications framework.

5.2 Further Mechanisms to Clarify the Reaction Function

Even with the names, the matrix alone is unlikely to clarify some important aspects of the Committee's reaction function. For this purpose, we also need information about how policy would adjust in circumstances that deviate markedly from the current economic outlook. For example, understanding how the central bank will respond to adverse tail events—episodes that have low probability but high severity—requires additional information. A straightforward way to obtain this information is to supply FOMC participants with specific scenarios and ask them to provide their preferred interest-rate and balance-sheet reactions. Such a procedure is analogous to the hypothetical portfolio exercises that bank supervisors use to assess the relative comparability of institutions' risk models.[49] As we previously

49. For a discussion of the use of hypothetical portfolio exercises in assessing bank risk models, see Cecchetti and Schoenholtz (2014).

mentioned, the addition of scenario analysis as a complement to the FOMC's existing communications framework is also consistent with the suggestions of several interviewees.

To see how this might work, consider asking FOMC participants how they would react to a repeat of the 2008–09 episode following the Lehman collapse or to the severely adverse scenarios in the annual bank stress tests (the Comprehensive Capital Analysis and Review).[50] A compilation of the resulting projections for interest rates and the balance sheet would effectively disclose the conditional consensus response. That is, for the economic and financial conditions in each scenario, the distribution of participants' answers reveals critical aspects of the *Committee's* reaction function, not just their own.

A second example would be to ask FOMC participants how they would respond to a large deviation of trend inflation from the stated longer-run goal of 2 percent. A specific scenario might consider a persistent one-percentage-point rise in the rate of increase of the personal consumption expenditure price index. How quickly, by how much, and for how long is the Committee likely to adjust the path of the policy rate? These responses would be an important supplement to the existing summary of the participants' views on the outlook and appropriate policy that is currently in the SEP.

6. Recommendations

Returning to where we started, three objectives guide our proposals for further improving FOMC communications: simplifying public statements, clarifying how policy will react to changing conditions, and highlighting policy uncertainty and risks. To illustrate the application of these objections and how they help further improve communications practices, we provide examples of a re-formulated post-meeting statement and a concise *Report on Economic Projections*, both of which refer to the FOMC's foundational statement on longer-run goals.

6.1 Simplifying the Post-Meeting Statement

To address the general public and their elected representatives as well as financial markets, the FOMC must speak in plain language. A simple and easily readable post-meeting statement will, in our view,

50. See https://www.federalreserve.gov/supervisionreg/ccar.htm

increase credibility and accountability, and improve the effectiveness of policy. It would form the basis of what Haldane and McMahon (2018) call a "layering" strategy. Layering aims to transmit key information about the outlook and policy plans at *multiple levels of complexity* and takes advantage of the variety of communications channels to reach different audiences. The new statement would serve as the simplest and most broadly accessible communications device, with other tools (like the Chair's press conference, the SEP, meeting minutes, participants' speeches, and the *Monetary Policy Report* to Congress) providing details aimed at audiences with specific interests and greater expertise.

With this objective in mind, we took a careful look at recent post-meeting statements. To simplify them, we recommend focusing on just three elements:

- the statement of the decision, including votes for and against,
- the rationale for the decision, including the reason for dissents,
- and a discussion of uncertainties and risks to the outlook.

For each of these, the FOMC should include information on both the policy-rate target and the balance sheet.[51]

We propose three principles to guide the drafting of the statement. First, keep it readable. In practical terms, we suggest aiming for the reading level of a high-school senior (grade 12) and capping complexity at what is readable by a second-year college student (grade 14). Based on standard measures of readability, this means keeping sentences short and avoiding words that have more than two syllables.

Second, to quote David Wessel, "*The FOMC should put more emphasis on its start-of-year statement of goals and objectives and refer to that when it is making policy decisions*." That is, each post-meeting statement should explicitly link the decision to the Committee's longer-run goals.

Third, we encourage the FOMC to adopt the first person plural in its communication. As we discuss in our introductory comments, the FOMC would benefit from practices that foster group accountability. For this reason, we believe it would be wise to drop references to the "Committee," as if it exists independent of the people involved, and substitute "we," "us," and "our." Where an FOMC participant wishes to express dissent, the substitute would be "I."

51. Blinder (2016) provides an alternative formulation of the FOMC statement that included the first two elements we propose.

As examples, by using the information in the original statements and in the minutes released three weeks later, we constructed alternative statements for the December 2017 and March 2019 meetings. Both meetings were associated with an SEP, and the first one included dissents. The new versions, as well as the originals, are in appendix B.

As table 4 shows, our alternative versions are much simpler than the originals. And, despite their brevity, we believe that they contain additional relevant information. Using the Flesch-Kincaid measure of readability, the indicative grade level of the original statements exceeds 16, consistent with the reading ability of a fourth-year college (or a post-graduate) student.[52] For December 2017, the last time there was a dissent, our alternative statement has a Flesch-Kincaid grade-level index of 12.8. The alternative statement for March 2019 has an index of 10.6.

It may not always be feasible to achieve this level of readability. However, in order to allow the broadest possible audience access to the Federal Reserve's key policy decisions, it is worth the effort to craft post-meeting statements that are easy to read. To reiterate, this would be the simplest layer of a multi-layered strategy that uses other tools for more nuanced and complex communication.[53]

Table 4. Comparing the Original and Alternative Versions of Two FOMC Statements

Statement Date	*Number of Words*		*Flesch-Kincaid Grade Level*	
	Original	*Alternative*	*Original*	*Alternative*
December 2017	427	290	16.4	12.8
March 2019	303	309	16.4	10.6

Note: The number of words and the grade-level readability index exclude the paragraph that reports the vote. We compute the readability index by using the calculator at http://www.readabilityformulas.com/free-readability-formula-tests.php. Both the original and alternative statements are in appendix 2.

52. Since the inception of the statement in February 1994, the median grade level is 16.6 with an interquartile range of 15.5 to 17.5. We discuss the evolution and context of FOMC post-meeting statements in appendix D, which includes a time-series plot of the Flesch-Kincaid grade level and the number of words for each statement (see figure D2 in appendix D).

53. In a three-page paper that uses only one-syllable words, Samuelson (1979) explains the fallacy of maximizing geometric mean returns in long sequences. The paper highlights the linguistic tradeoff between simplicity and precision and emphasizes the importance of setting a realistic goal for readability. Even with that caveat, however, the scope for simplifying the FOMC's post-meeting statements is notable.

To help explain its actions, we also suggest that the FOMC consider streamlining the meeting minutes. Currently, following long-standing historical precedent, the structure of the minutes follows the chronology of the meeting. As a result, this lengthy document places all of the key material at the end. An alternative structure that aims to highlight the Committee's decisions, rationale, and agreements or disagreements would completely reverse this order. It would begin with the Committee Policy Action (including balance-sheet decisions), followed by the section entitled Participants' Views on Current Conditions and the Economic Outlook (including any discussion of balance-sheet issues). The list of those attending the meeting, comments from the Staff regarding developments in financial markets, and Staff reviews of the economic and financial situations would be moved to the end, possibly in an appendix.[54]

Finally, in order to avoid undue emphasis on specific phrases or words, we suggest that the structure of the FOMC statement be flexible, changing relatively often. The threshold for change should be very low. One welcome side benefit would be to reduce the value of tracking changes in the statement wording.

6.2 An FOMC Report on Economic Projections

Many central banks produce periodic, often quarterly, inflation reports. They do this both to focus public-expectations formation on stated long-run objectives and to discipline pre-meeting preparations and post-meeting communications of the participants.[55]

As they describe how current and prospective policy supports the central bank's mandate, these reports have both a backward- and a forward-looking function. Retrospectively, they provide an evaluation of how policymakers have performed. This includes a discussion of the evolution of economic and financial conditions, and possibly some explanation of views on important unobservable variables like the long-run equilibrium real interest rate and unemployment rate (r^* and U^*), as well as a description of the level and growth rate of potential output. The summary and explanation of recent outcomes

54. Should complaints arise that minutes are a formal accounting and must follow the exact chronology of a meeting itself, we would simply relabel these as "meeting summaries."

55. The Bank of England's *Inflation Report* (https://www.bankofengland.co.uk/inflation-report/inflation-reports) remains the classic example.

in these reports allow legislators, financial-market participants, and the public at large to hold independent central bankers accountable for their actions.

Prospectively, the reports provide projections of key policy objectives along with a discussion of principal drivers, uncertainties, and risks. In addition, they identify and explain important divergences of views. This enhances transparency, thus shedding light on the policy reaction function and focusing the public debate on what policymakers believe to be the salient features in the outlook.

By creating accountability and transparency, inflation reports also have a powerful influence on internal committee dynamics. The obligation to publish both an *expected value* and a *range* for projections of the state of the economy and policy (something like figure 4) has a number of positive effects. It establishes staff priorities, thus increasing the quality of the background work needed, and focuses internal discussions on the need to reach a consensus.

Ideally, the FOMC would engage in the consensus-building associated with the production of a comprehensive forward-looking economic and policy report in the same manner that the Bank of England's Monetary Policy Committee does prior to publication of their *Inflation Report*. However, governance challenges make consensus formation difficult. As a result, we view many of our recommendations as practical, second-best alternatives.

Indeed, if meeting-by-meeting consensus is beyond reach, it is nevertheless critical that Federal Reserve policymakers agree on a mechanism for clearly communicating uncertainty. Changes that feature existing material more prominently can materially improve this dimension of FOMC communications. The static uncertainty measures in the SEP (shown previously in figure 4) are not consensus-based, but do include subjective information on whether they are representative of the current situation. Together, they provide a simple basis for a new *Report on Economic Projections*. Making the evolving scale and sources of uncertainty a focus of the Chairman's post-meeting press conferences and of FOMC members' public remarks would then follow naturally.

To be specific, we suggest highlighting the range of uncertainty around the median projections by publishing material that now appears with the minutes—namely, the table that shows the historical projection error ranges and the fan chart for the policy rate—more prominently and more quickly. The same applies to other figures included with the minutes that show the distribution of FOMC members' subjective perceptions of the uncertainty and risks in their projections for GDP growth, unemployment, and inflation.[56]

Our preferred approach is to release this material in the form of a *Report on Economic Projections* together with the post-meeting statement instead of waiting three weeks until publication of the minutes. Moreover, rather than feature the table with the median projections, start with a chart like the one we reproduce above (figure 4). In addition, the FOMC could include a brief qualitative description of the current state of the economy, of the sources of uncertainty and risk, and of divergences in views. The result would become a natural focus of public discussion by FOMC participants between meetings.

Importantly, such a report needs to be neither long nor complex. The visual summary of the Bank of England's quarterly *Inflation Report*—the May 2019 version has 729 words, four charts, and a Flesch-Kincaid grade-level readability score of 7.7—could serve as a model.[57] In appendix 3, we present a sample *Report on Economic Projections* based on the March 2019 meeting minutes and SEP. This very simple version has fewer than 730 words, with a modest Flesch-Kincaid grade-level score of 9.7.[58]

In a world where policymakers are rightly not committed to a specific interest-rate path, the FOMC can and should exploit existing tools to improve communications regarding the uncertainty of the future policy path. In March 2019, for example, the Committee revealed there is only an even chance the policy rate will be between 1.0 and 4.2 percent by the end of 2021. That range probably far exceeds what most observers believe about FOMC policy uncertainty.

Highlighting the inevitable uncertainty by publishing the fan charts and the historical forecast error table together with the initial SEP, and then presenting these at the Chair's press conference, would help shift the public discussion. Rather than responding with false precision to questions about the median path of policy rates, a focus on the uncertainty associated with the outlook would help to align the Chair's public comments with the risks that the FOMC perceives.

The same goes for the public comments by FOMC participants. If, in addition to the Chair, the Governors and Reserve Bank Presidents

56. For example, in the March 2019 minutes, participants' uncertainty about GDP growth has a positive skew, while the risks were skewed to the downside.

57. Find the May 2019 example at https://www.bankofengland.co.uk/inflation-report/2019/may-2019/visual-summary.

58. These metrics exclude the report's data appendix.

were to focus their communications on explaining the sources of uncertainty, this would help counter any excessive public attention to the SEP median projections. Moreover, should one or more members explicitly dissent from the Committee's decision, their comments can bring to light whether these disagreements arise from differing assessments of the current state and likely evolution of economic and financial conditions or from different views about the appropriate policy responses to agreed conditions.

Importantly, a *Report on Economic Projections* that gives prominence to uncertainty also can be helpful at the effective lower bound. What is striking about the SEPs of 2012 is the narrow range of interest-rate projections: these were largely stuck at zero until 2014 or 2015. Such a low-uncertainty SEP reinforced the FOMC's broad commitment to keep rates low for longer. Indeed, as figure 5 reveals, the uncertainty bands around the projected policy rate extended below zero into early 2014.

In closing, we note two other refinements that we believe would improve the usefulness of the SEP. First, and most importantly, asking FOMC participants how they would adjust policy in circumstances that deviate substantially from the current economic outlook would provide additional meaningful information about the Committee's reaction function. Even without introducing the *Report on Economic Projections* that we propose, the Committee could supplement the existing SEP with graphical representations of the distributions of participants' responses to a few key scenarios, including (but not limited to) prominent tail risks.

Second, given the simplicity of the *Report on Economic Projections*, the FOMC could choose to publish it following every meeting, rather than every quarter. The increased frequency of the Chair's press conference may have made this option more desirable, but it remains questionable whether there is sufficient economic news to warrant a Report twice each quarter.

7. Conclusions

We began by highlighting the enormous progress that the FOMC has made over the past quarter-century in developing a transparent communications framework that promotes accountability and allows for credible policy commitments. The FOMC already communicates a vast amount of information to a wide range of audiences including the public, elected officials, and experts. The Committee also recognizes the role of communication as a policy tool of its own.

We applaud the Committee's achievements and view our suggestions as incremental steps.

In line with comments received from two dozen former policymakers, academics, and market practitioners, we look for further improvements in the communications framework based on three guiding objectives: to simplify public statements while conveying any divergence of views, clarify how policy will react to changing conditions, and highlight policy uncertainty and risks.

Our proposals to simplify the post-meeting statement and publish a concise *Report on Economic Projections* are squarely in line with these objectives. The first seeks to broaden access to the Committee's most important written description of its actions, of the rationale for these actions, and of its ongoing concerns. The second aims to focus greater attention on the inevitable uncertainty involved in policymaking, underscore the Committee's commitment to correct any errors quickly and transparently as new information becomes available, and further illuminate the Committee's reaction function. Both link directly to the FOMC's Statement on Longer-Run Goals and Monetary Policy Strategy and can serve to coordinate more effectively FOMC participants' public communications.

We believe that implementation of these changes will add further to the effectiveness of FOMC communications in promoting the ultimate objectives of price stability and maximum sustainable employment mandated by the Federal Reserve Act.

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Appendix A

The Interview Process

On January 7, 2019, we sent the following email:

Dear XXX,

As you may know, the Federal Reserve is undertaking a review of its strategies, tools, and communication practices. Included in this is a research conference in early June 2019, available at https://www.federalreserve.gov/conferences/conference-monetary-policy-strategy-tools-communications-20190605.htm. Vice Chairman Clarida and his colleagues have invited us to contribute a paper on communication to that conference. To prepare, we would like to interview former officials, academics, and practitioners to get a sense of their views on the issue. Our hope is that you will agree to help.

Would you be willing to answer a few questions either in writing or in a telephone interview?

We have three questions:

1. What do you see as the primary objectives of FOMC communication?

2. How do you think FOMC communication should evolve over the next five to ten years?

3. What do you view as the greatest challenges to effective FOMC communication?

You are welcome to send written responses. Alternatively, should you wish to do this over the phone, we would ask for permission to record and transcribe the interview. Regardless of how you respond to the questions—written, or oral and transcribed—we would attribute any of your responses (in the form of quotes or otherwise) only with your explicit approval.

By way of background, we have interviewed central-bank officials on several past occasions. For example, at the time of the tenth anniversary of the European Monetary Union, we interviewed 17 senior officials for a paper entitled "How Central Bankers See It: The First Decade of European Central Bank Policy and Beyond," which is available at http://people.brandeis.edu/~cecchett/Polpdf/Polp44.pdf.

It would be most helpful if we could speak with you or obtain your responses by mid-February. Please let us know if you are willing to answer the questions and, if so, whether you prefer to do it in writing or in the course of a 20-minute phone call.

Thank you very much for considering our request.
Happy New Year and best regards,
Steve Cecchetti and Kim Schoenholtz

We contacted 35 people. Of these, 10 responded in writing and 14 agreed to oral interviews. The list of those who responded is in the following table.

For the interviews, we began by asking for permission to record the interview. We then reiterated the ground rules for attribution and then asked our questions. In some cases, following the three questions, we asked further clarifying questions.

Table A1. List of Interview Respondents
(written or oral interview, with date)

Lewis Alexander (written, Feb/19/2019)	Peter Hooper (written, Feb/26/2019)
Ben Bernanke (written, Jan/15/2019)	Anil Kashyap (written, Jan/7/2019)
Richard Berner (written, Feb/7/2019)	Mervyn A. King (interview, Feb/6/2019)
Seth Carpenter (written, Feb/25/2019)	Dennis Lockhart (interview, Jan/22/2019)
William C. Dudley (interview, Feb/7/2019)	Catherine Mann (interview, Feb/1/2019)
Robert DiClemente (written, Feb/5/2019)	Frederic S. Mishkin (interview, Feb/12/2019)
Roger W. Ferguson, Jr. (interview, Feb/4/2019)	Charles Plosser (interview, Jan/25/2019)
Michael Feroli (interview, Jan/15/2019)	Jeremy C. Stein (written, Jan/12/2019)
Stanley Fischer (interview, Jan/29/2019)	Paul M. W. Tucker (interview, Jan/16/2019)
Peter R. Fisher (interview, Mar/1/2019)	Paul A. Wachtel (interview, Mar/1/2019)
Mark Gertler (interview, Jan/17/2019)	David Wessel (interview, Jan/8/2019)
David Greenlaw (written, Feb/21/2019)	Janet L. Yellen (interview, Feb/11/2019)

Appendix B

Simplifying the FOMC Statement

This appendix contains a comparison of the original and alternative formulation of the post-meeting FOMC statements for December 13, 2017, and March 20, 2019. For the alternative statement, we include headers for the sections that we would not expect to see in an actual release.

Original FOMC Statement for December 13, 2017

Information received since the Federal Open Market Committee met in November indicates that the labor market has continued to strengthen and that economic activity has been rising at a solid rate. Averaging through hurricane-related fluctuations, job gains have been solid, and the unemployment rate declined further. Household spending has been expanding at a moderate rate, and growth in business fixed investment has picked up in recent quarters. On a 12-month basis, both overall inflation and inflation for items other than food and energy have declined this year and are running below 2 percent. Market-based measures of inflation compensation remain low; survey-based measures of longer-term inflation expectations are little changed, on balance.

Consistent with its statutory mandate, the Committee seeks to foster maximum employment and price stability. Hurricane-related disruptions and rebuilding have affected economic activity, employment, and inflation in recent months but have not materially altered the outlook for the national economy. Consequently, the Committee continues to expect that, with gradual adjustments in the stance of monetary policy, economic activity will expand at a moderate pace and labor market conditions will remain strong. Inflation on a 12-month basis is expected to remain somewhat below 2 percent in the near term but to stabilize around the Committee's 2-percent objective over the medium term. Near-term risks to the economic outlook appear roughly balanced, but the Committee is monitoring inflation developments closely.

In view of realized and expected labor market conditions and inflation, the Committee decided to raise the target range for the federal-funds rate to 1–1/4 to 1–1/2 percent. The stance of monetary policy remains accommodative, thereby supporting strong labor market conditions and a sustained return to 2-percent inflation.

In determining the timing and size of future adjustments to the target range for the federal-funds rate, the Committee will assess realized and expected economic conditions relative to its objectives of maximum employment and 2-percent inflation. This assessment will take into account a wide range of information, including measures of labor market conditions, indicators of inflation pressures and inflation expectations, and readings on financial and international developments. The Committee will carefully monitor actual and expected inflation developments relative to its symmetric inflation goal. The Committee expects that economic conditions will evolve in a manner that will warrant gradual increases in the federal-funds rate; the federal-funds rate is likely to remain, for some time, below levels that are expected to prevail in the longer run. However, the actual path of the federal-funds rate will depend on the economic outlook as informed by incoming data.

Voting for the FOMC monetary policy action were Janet L. Yellen, Chair; William C. Dudley, Vice Chairman; Lael Brainard; Patrick Harker; Robert S. Kaplan; Jerome H. Powell; and Randal K. Quarles. Voting against the action were Charles L. Evans and Neel Kashkari, who preferred at this meeting to maintain the existing target range for the federal-funds rate.

Alternative FOMC Statement for December 13, 2017

Actions:

To foster maximum employment and price stability, we agreed to raise the target range for the federal-funds rate to 1¼ to 1½ percent from the current range of 1 to 1¼ percent.

We will continue to shrink our balance sheet, letting it fall by $10 billion this month, and then by $20 billion per month starting in January 2018.

Voting for the FOMC monetary policy action were Janet L. Yellen, Chair; William C. Dudley, Vice Chairman; Lael Brainard; Patrick Harker; Robert S. Kaplan; Jerome H. Powell; and Randal K. Quarles. Voting against the action were Charles L. Evans and Neel Kashkari, who preferred at this meeting to maintain the existing target range for the federal-funds rate.

Rationale for action and divergence of views:

Most of us believe that gains in consumer and business spending, aided by supportive financial conditions and an improving global economy, are keeping growth at a pace above trend. Some of us also expect that labor market pressures will show through to inflation over the next few years.

Two of us disagree with the interest-rate decision, noting that inflation remains clearly below 2 percent and preferring to wait until inflation moves closer to our long-term goal or expected inflation rises.

Uncertainties and risks to the outlook:

The uncertainty of our projections for future growth, unemployment, and inflation has not changed over the past few months and remains similar to the average over the past 20 years.

While we see the near-term risks to the outlook as roughly balanced, changes in conditions could lead to faster or slower changes in policy. On the upside, fiscal stimulus or easy financial-market conditions could raise inflation above our goal and push growth further above its trend. On the downside, there is the chance that actual or expected inflation will fail to move up to our 2-percent goal.

Turning to the balance sheet, several of us note the importance of monitoring the impact of a fall in the size of our securities holdings on long-term interest rates and economic performance.

Original FOMC Statement from March 20, 2019:

Information received since the Federal Open Market Committee met in January indicates that the labor market remains strong but that growth of economic activity has slowed from its solid rate in the fourth quarter. Payroll employment was little changed in February, but job gains have been solid, on average, in recent months, and the unemployment rate has remained low. Recent indicators point to slower growth of household spending and business fixed investment in the first quarter. On a 12-month basis, overall inflation has declined, largely as a result of lower energy prices; inflation for items other than food and energy remains near 2 percent. On balance, market-based measures of inflation compensation have remained low in recent months, and survey-based measures of longer-term inflation expectations are little changed.

Consistent with its statutory mandate, the Committee seeks to foster maximum employment and price stability. In support of these goals, the Committee decided to maintain the target range for the federal-funds rate at 2–1/4 to 2–1/2 percent. The Committee continues to view sustained expansion of economic activity, strong labor market conditions, and inflation near the Committee's symmetric 2-percent objective as the most likely outcomes. In light of global economic and financial developments and muted inflation pressures, the Committee will be patient as it determines what future adjustments to the target range for the federal-funds rate may be appropriate to support these outcomes.

In determining the timing and size of future adjustments to the target range for the federal-funds rate, the Committee will assess realized and expected economic conditions relative to its maximum employment objective and its symmetric 2-percent inflation objective. This assessment will take into account a wide range of information, including measures of labor market conditions, indicators of inflation pressures and inflation expectations, and readings on financial and international developments.

Voting for the FOMC monetary policy action were: Jerome H. Powell, Chairman; John C. Williams, Vice Chairman; Michelle W. Bowman; Lael Brainard; James Bullard; Richard H. Clarida; Charles L. Evans; Esther L. George; Randal K. Quarles; and Eric S. Rosengren.

Alternative FOMC Statement for March 20, 2019:

Actions:

To foster maximum employment and price stability, we agreed to maintain the target range for the federal-funds rate at 2¼ to 2½ percent.

From May to the end of September 2019, we will slow and then cease the decline in our holdings of Treasury securities.

Voting for the FOMC action were: Jerome H. Powell, Chairman; John C. Williams, Vice Chairman; Michelle W. Bowman; Lael Brainard; James Bullard; Richard H. Clarida; Charles L. Evans; Esther L. George; Randal K. Quarles; and Eric S. Rosengren.

Rationale for action and divergence of views:

We foresee sustained real growth, a strong labor market, and inflation near our 2-percent long-run goal as the most likely outcomes over coming years.

As for the balance sheet, setting a date for ending the runoff of securities holdings reduces uncertainty and fits with our decision to continue setting policy in a regime of ample reserves.

There were no major disagreements.

Uncertainties and risks to the outlook:

The uncertainty of our projections for growth, unemployment, and inflation is similar to the norm over the past 20 years.

A number of risks could influence the path of interest rates. On the downside, these include softness in spending, a sharp decline in fiscal stimulus, the uncertainty from ongoing trade talks, Brexit, a further slowdown in Europe and China, and a failure of inflation to rise to the 2-percent target. On the upside, risks include a sharp rebound in consumer and business sentiment, a pickup in the trend rate of growth, and an increase in wage pressures. A few of us are concerned that financial stability risks could rise if policy interest rates remain low for longer.

Turning to the balance sheet, shrinkage beyond that planned has costs and benefits. On the one hand, reduced securities holdings might lead to greater interest-rate movements. On the other hand, by reducing reserves in the banking system, it could help us learn about banks' demand for reserves. Overall, the scope for further declines in the size of the balance sheet after September 2019 may be limited.

Appendix C

A Concise Report on Economic Projections

We construct a concise *Report on Economic Projections* from information in the minutes and the SEP associated with the March 19–20 FOMC meeting and released on April 20, 2019.[59] In the data appendix, we include the matrix of projections from March 19–20, 2013[60] as representative of what we recommend the FOMC publish immediately following each quarterly SEP meeting. We note that, when combined with the matrix published in the prior quarter, this information allows anyone who so wishes to reproduce all the charts in the complete SEP that accompanies the minutes.

Report on Economic Projections, March 2019

Consistent with our Statement on Longer-Run Goals and Monetary Policy Strategy, sustained expansion of economic activity, strong labor market conditions, and inflation near the Committee's symmetric 2-percent objective are the most likely outcomes over the next few years. While there is considerable uncertainty, most of us, the FOMC participants, project that for 2019, 2020, and 2021, inflation will remain near target, growth will slow to a rate near 2 percent, the unemployment rate will remain slightly below 4 percent, and the policy rate is likely to remain steady.

Inflation near target

Largely reflecting earlier declines in crude oil prices, inflation has been softer than expected. Most of us view this as temporary, expecting inflation to rise to the Committee's longer-run objective of 2 percent over the next few years. At the same time, many noted that inflation has not risen much in spite of faster wage gains and the impact of higher tariffs. This suggests to some of us that long-term inflation expectations could be below 2 percent.

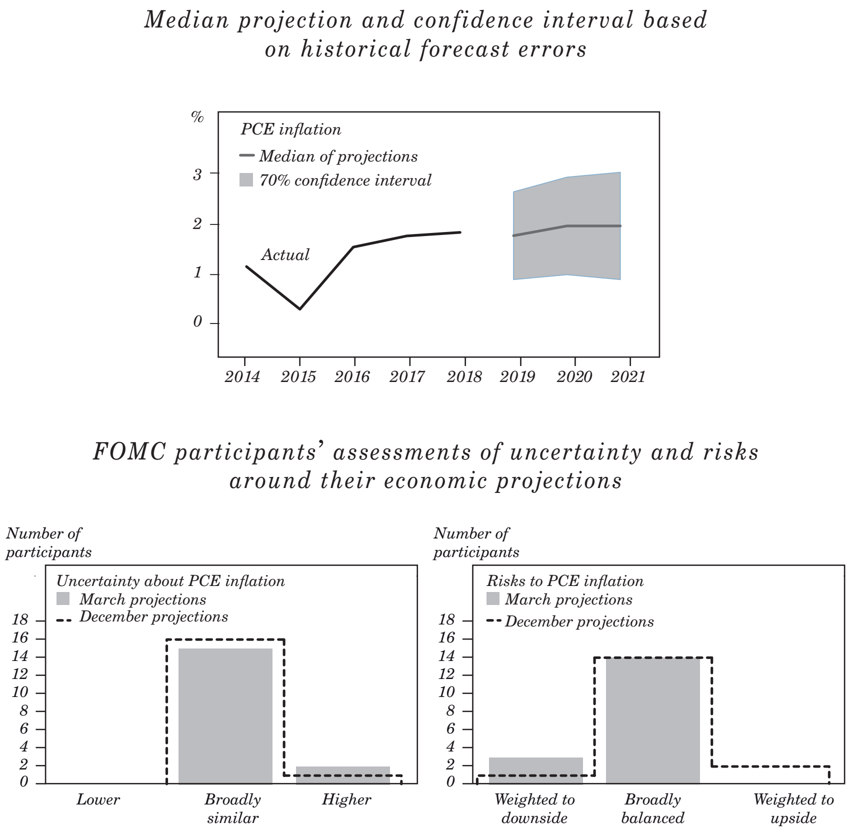
Over the next few years, most of us project inflation to remain steady near the long-run objective of 2 percent. We judge that the uncertainty of projections is roughly in line with historical levels, with an even

59. See https://www.federalreserve.gov/monetarypolicy/fomcminutes20190320ep.htm

60. See https://www.federalreserve.gov/monetarypolicy/files/FOMC20130320SEPcompilation.pdf

chance that prices will rise at a rate between 1.2 and 2.8 percent rate by 2021. Rising wages and tariff increases pose some upside risk, but past low inflation also could lower inflation expectations, so several participants see the risks tilted to the downside.

Figure C1. Projections for Inflation



Source: https://www.federalreserve.gov/monetarypolicy/fomcminutes20190320ep.htm

Growth slowing

The U.S. expansion is likely to continue, but at a slower pace than in late 2018, as growth slows abroad and the impact of 2018 tax cuts and increases in public spending wanes. In 2019 and 2020, growth will likely be closer to 2 percent, down from just over 3 percent in 2018. Even so, a strong labor market, rising incomes, and better financial conditions should sustain household spending.

Past levels of uncertainty imply that the chance of growth between 0 and 4 percent over the next two to three years is about 70 percent, but some of us view growth uncertainty as higher than in the past. A few of us see the risks as tilted to the downside, noting softness in housing, uncertainty regarding trade talks and Brexit, and the possibility of a greater slowdown in Europe and China. Estimates of growth in the longer run remain between 1.7 and 2.2 percent.

Unemployment rate stable

Labor markets remain strong, with solid job gains, a further increase in people returning to work, low layoffs, a near-record number of job openings, and reports of firms offering better pay and benefits to attract workers. Most of our projections show the unemployment rate barely rising over coming years, often remaining below the bottom of the range of projections for the longer run (from 4.0 percent to 4.6 percent). At the same time, some noted that the mix of low and steady inflation and rising employment points to further slack in the labor market.

Past norms imply an error range going from 2.2 to 5.6 percent for the projected unemployment rate in 2021. However, some of us are more uncertain about labor market projections than usual. Nevertheless, we generally see the risks around the unemployment outlook as roughly balanced.

Policy rates steady

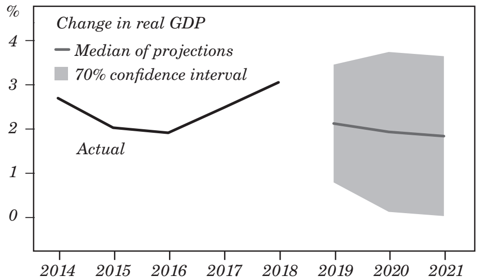
This year, a majority expects that the outlook and risks to the outlook will warrant leaving the policy rate unchanged. Some think that a continuation of above-trend growth could favor a modest policy-rate hike, while others note that new data and risks could shift their views of the policy-rate target in either direction. Over the next few years, many of us foresee the policy rate rising only slightly.

While the range of forecasts for the path of the policy rate widens after this year, the median projection barely changes, edging up to 2.6 percent at the end of 2021 from the current range of 2¼ to 2½ percent.

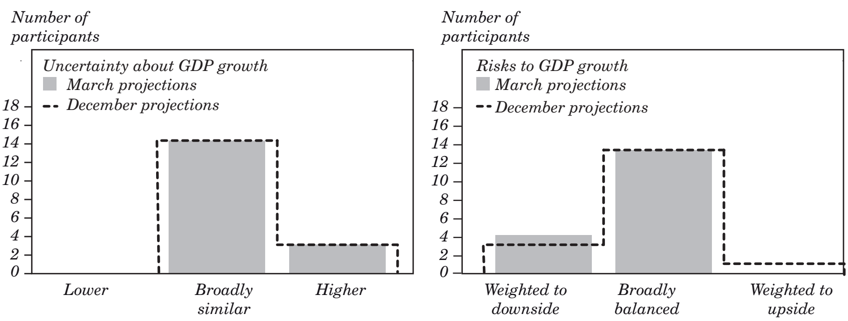
Uncertainty around interest-rate forecasts is very large compared to this small increase in the central forecast: based on past norms, there is only a 70-percent chance that the end-2021 target interest rate will be between 0.1 and 5.1 percent.

Figure C2. Projections for GDP Growth

Median projection and confidence interval based on historical forecast errors



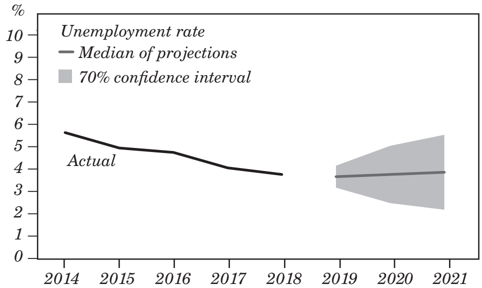
FOMC participants' assessments of uncertainty and risks around their economic projections



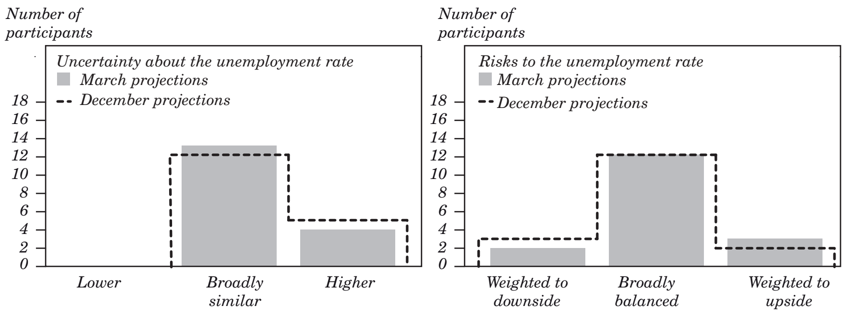
Source: https://www.federalreserve.gov/monetarypolicy/fomcminutes20190320ep.htm

Figure C3. Projections for Unemployment

Median projection and confidence interval based on historical forecast errors



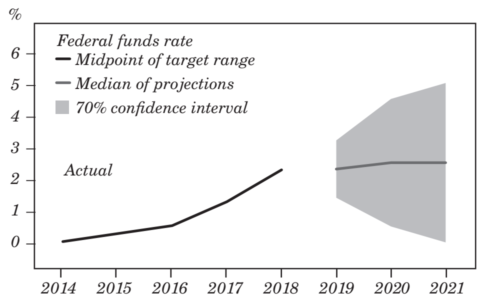
FOMC participants' assessments of uncertainty and risks around their economic projections



Source: https://www.federalreserve.gov/monetarypolicy/fomcminutes20190320ep.htm

Figure C4. Projections for the Federal-funds Rate

Median projection and confidence interval based on historical forecast errors



Source: https://www.federalreserve.gov/monetarypolicy/fomcminutes20190320ep.htm

Data Appendix

The following tables and figures provide more detail about the economic and policy projections of FOMC participants. Table C1 reports the median, central tendency, and range for the March 2019 and December 2018 projections of real growth, unemployment, inflation, and the federal-funds rate for the years 2019, 2020, and 2021, as well as for the longer run. Figure C5 plots the individual projections for the federal-funds rate. Table C2 reports the error ranges (based on past norms) that are used to compute the shaded areas in figures C1 to C4. Table C3 is the matrix of projections that links them by FOMC participant.

Table C1. Economic Projections of Federal Reserve Board Members and Federal Reserve Bank Presidents, under their Individual Assessments of Projected Appropriate Monetary Policy, March 2019

Percent

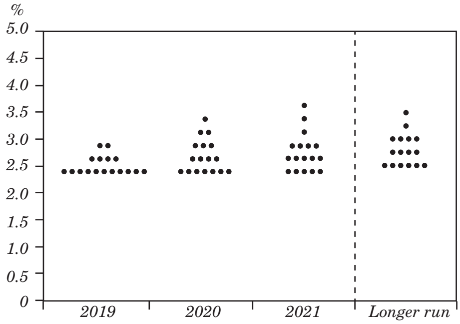
Variable	*Median*[1]				*Central Tendency*[2]				*Range*[3]			
	2019	2020	2021	Longer run	2019	2020	2021	Longer run	2019	2020	2021	Longer run
ChangeinrealGDP	2.1	1.9	1.8	1.9	1.9-2.2	1.8-2.0	1.7-2.0	1.8-2.0	1.6-2.4	1.7-2.2	1.5-2.2	1.7-2.2
Decemberprojection	2.3	2.0	1.8	1.9	2.3-2.5	1.8-2.0	1.5-2.0	1.8-2.0	2.0-2.7	1.5-2.2	1.4-2.1	1.7-2.2
Unemploymentrate	3.7	3.8	3.9	4.3	3.6-3.8	3.6-3.9	3.7-4.1	4.1-4.5	3.5-4.0	3.4-4.1	3.4-4.2	4.0-4.6
Decemberprojection	3.5	3.6	3.8	4.4	3.5-3.7	3.5-3.8	3.6-3.9	4.2-4.5	3.4-4.0	3.4-4.3	3.4-4.2	4.0-4.6
PCEinflation	1.8	2.0	2.0	2.0	1.8-1.9	2.0-2.1	2.0-2.1	2.0	1.6-2.1	1.9-2.2	2.0-2.2	2.0
Decemberprojection	1.9	2.1	2.1	2.0	1.8-2.1	2.0-2.1	2.0-2.1	2.0	1.8-2.2	2.0-2.2	2.0-2.3	2.0
CorePCEinflation[4]	2.0	2.0	2.0		1.9-2.0	2.0-2.1	2.0-2.1		1.8-2.2	1.8-2.2	1.9-2.2	
Decemberprojection	2.0	2.0	2.0		2.0-2.1	2.0-2.1	2.0-2.1		1.9-2.2	2.0-2.2	2.0-2.3	
Memo:Projectedappropriatepolicypath												
Federalfundsrate	2.4	2.6	2.6	2.8	2.4-2.6	2.4-2.9	2.4-2.9	2.5-3.0	2.4-2.9	2.4-3.4	2.4-3.6	2.5-3.5
Decemberprojection	2.9	3.1	3.1	2.8	2.6-3.1	2.9-3.4	2.6-3.1	2.5-3.0	2.4-3.1	2.4-3.6	2.4-3.6	2.5-3.5

Source: https://www.federalreserve.gov/monetarypolicy/fomcminutes20190320ep.htm

Note: Projections of change in real gross domestic product (GDP) and projections for both measures of inflation are percent changes from the fourth quarter of the previous year to the fourth quarter of the year indicated. PCE inflation and core PCE inflation are the percentage rates of change in, respectively, the price index for personal consumption expenditures (PCE) and the price index for PCE excluding food and energy. Projections for the unemployment rate are for the average civilian unemployment rate in the fourth quarter of the year indicated. Each participant's projections are based on his or her assessment of appropriate monetary policy. Longer-run projections represent each participant's assessment of the rate to which each variable would be expected to converge under appropriate monetary policy and in the absence of further shocks to the economy. The projections for the federal funds rate are the value of the midpoint of the projected appropriate target range for the federal funds rate or the projected appropriate target level for the federal funds rate at the end of the specified calendar year or over the longer run. The December projections were made in conjunction with the meeting of the Federal Open Market Committee on December 18-19, 2018. One participant did not submit longer-run projections for the change in real GDP, the unemployment rate, or the federal funds rate in conjunction with the December 18-19, 2018, meeting, and one participant did not submit such projections in conjunction with the March 19-20, 2019, meeting.

1. For each period, the median is the middle projection when the projections are arranged from lowest to highest. When the number of projections is even, the median is the average of the two middle projections.
2. The central tendency excludes the three highest and three lowest projections for each variable in each year.
3. The range for a variable in a given year includes all participants' projections, from lowest to highest, for that variable in that year.
4. Longer-run projections for core PCE inflation are not collected.

Figure C5. FOMC Participants' Assessments of Appropriate Monetary Policy: Midpoint of Target Range or Target Level for the Federal-funds Rate (end of period), March 20, 2019



Source: https://www.federalreserve.gov/monetarypolicy/fomcminutes20190320ep.htm

Table C2. Average Historical Projection Error Ranges
(in percentage points)

Variable	*2019*	*2020*	*2021*
Change in real GDP[1]	±1.4	±1.9	±1.9
Unemployment rate[1]	±0.5	±1.3	±1.7
Total consumer prices[2]	±0.9	±1.0	±1.1
Short-term interest rates[3]	±0.9	±2.0	±2.5

Source: https://www.federalreserve.gov/monetarypolicy/fomcminutes20190320ep.htm
NOTE: Error ranges shown are measured as plus or minus the root mean squared error of projections for 1999 through 2018 that were released in the spring by various private and government forecasters. As described in the box "Forecast Uncertainty," under certain assumptions, there is about a 70 percent probability that actual outcomes for real GDP, unemployment, consumer prices, and the federal funds rate will be in ranges implied by the average size of projection errors made in the past. For more information, see David Reifschneider and Peter Tulip (2017), "Gauging the Uncertainty of the Economic Outlook Using Historical Forecasting Errors: The Federal Reserve's Approach," Finance and Economics Discussion Series 2017-020 (Washington: Board of Governors of the Federal Reserve System, February), https://dx. doi.org/10.17016/FEDS.2017.020.
1. Definitions of variables are in the general note to table 1.
2. Measure is the overall consumer price index, the price measure that has been most widely used in government and private economic forecasts. Projections are percent changes on a fourth quarter to fourth quarter basis.
3. For Federal Reserve staff forecasts, measure is the federal funds rate. For other forecasts, measure is the rate on 3-month Treasury bills. Projection errors are calculated using average levels, in percent, in the fourth quarter.

Table C3. Economic Projections, 2013–2015 and over the Longer Run (in percent)

Projection	*Year*	*Change in real GDP*	*Unemployment rate*	*PCE inflation*	*Core PCE inflation*	*Federal funds rate*
1	2013	2.6	7.4	1.3	1.5	0.13
2	2013	2.4	7.6	1.4	1.5	0.13
3	2013	2.8	7.3	1.3	1.6	0.13
4	2013	2.7	7.5	1.4	1.6	0.13
5	2013	2.8	7.3	1.3	1.6	0.13
6	2013	2.6	7.5	1.4	1.7	0.13
7	2013	2.3	7.5	1.7	1.6	0.13
8	2013	2.3	7.4	1.7	1.7	0.13
9	2013	2.6	7.5	1.3	1.6	0.13
10	2013	2.5	7.4	1.4	1.6	0.13
11	2013	2.3	7.5	1.5	1.5	0.13
12	2013	2.0	7.6	1.6	1.6	0.13
13	2013	2.4	7.5	1.3	1.6	0.13
14	2013	2.3	7.5	1.8	1.5	0.13
15	2013	2.6	7.4	1.8	1.6	0.13
16	2013	2.9	7.2	1.7	1.6	0.13
17	2013	3.0	6.9	2.0	2.0	1.00
18	2013	3.0	7.0	1.6	1.6	0.13
19	2013	2.5	7.3	1.5	1.6	0.13
1	2014	3.4	6.8	1.7	1.8	0.13
2	2014	3.2	7.0	1.6	1.7	0.13
3	2014	3.4	6.8	1.6	1.7	0.13
4	2014	3.8	7.1	1.4	1.7	0.13
5	2014	3.5	6.7	1.8	1.9	0.13
6	2014	3.4	6.9	1.6	1.8	0.13
7	2014	2.6	6.8	1.9	1.8	1.00
8	2014	2.9	6.9	2.0	2.0	0.13
9	2014	3.2	7.0	1.5	1.7	0.13
10	2014	3.3	6.9	1.7	1.8	0.13
11	2014	3.3	7.0	1.5	1.5	0.13
12	2014	2.6	7.0	1.9	1.9	1.00
13	2014	3.2	7.0	1.5	1.7	0.13
14	2014	3.5	6.4	2.0	1.9	0.13
15	2014	2.9	7.0	1.8	1.7	0.13
16	2014	3.0	6.9	2.0	2.0	0.50
17	2014	3.0	6.2	2.0	2.0	2.75
18	2014	3.2	6.1	2.1	2.1	1.75
19	2014	3.2	6.7	2.0	2.0	0.13

Table C3. Economic Projections, 2013–2015 and over the Longer Run (continued) (in percent)

Projection	*Year*	*Change in real GDP*	*Unemployment rate*	*PCE inflation*	*Core PCE inflation*	*Federal funds rate*
1	2015	3.8	6.1	2.1	2.1	0.50
2	2015	3.5	6.3	1.7	1.8	1.00
3	2015	3.7	6.2	1.9	1.8	0.75
4	2015	3.7	6.0	1.6	1.9	1.25
5	2015	3.5	6.0	2.0	2.1	1.25
6	2015	3.7	6.1	1.7	1.9	0.50
7	2015	2.9	6.2	2.0	2.0	3.00
8	2015	3.0	6.3	2.0	2.0	1.25
9	2015	3.5	6.3	1.6	1.7	0.50
10	2015	3.4	6.4	1.9	1.9	0.50
11	2015	3.5	6.5	2.0	1.8	0.50
12	2015	2.9	6.5	2.0	2.0	2.00
13	2015	3.6	6.3	2.0	2.0	0.50
14	2015	3.5	5.7	2.0	2.0	1.00
15	2015	3.2	6.5	1.9	1.8	0.50
16	2015	3.2	6.5	2.0	2.0	1.25
17	2015	2.5	6.0	2.0	2.0	4.50
18	2015	2.8	6.0	2.6	2.6	3.75
19	2015	3.4	6.0	2.1	2.1	0.13
1	LR	2.5	5.2	2.0		4.00
2	LR	2.0	5.4	2.0		4.00
3	LR	2.3	5.3	2.0		3.80
4	LR	2.3	6.0	2.0		4.50
5	LR	2.3	5.5	2.0		4.00
6	LR	2.3	5.2	2.0		3.25
7	LR	2.1	6.0	2.0		4.00
8	LR	2.5	5.2	2.0		4.50
9	LR	3.0	5.4	2.0		4.00
10	LR	2.3	5.5	2.0		4.30
11	LR	2.2	5.4	2.0		4.00
12	LR	2.3	5.5	2.0		4.30
13	LR	2.5	5.2	2.0		4.00
14	LR	2.3	5.0	2.0		3.50
15	LR	2.5	6.0	2.0		4.00
16	LR	2.5	5.5	2.0		4.00
17	LR	2.5	6.0	2.0		4.50
18	LR	2.3	6.0	2.0		4.25
19	LR	2.3	6.0	2.0		3.50

Note: This version reproduces the material released with the transcripts of the March 19–20, 2013 meeting. It is indicative of the matrix that we propose to be released with the *Report on Economic Projections*. Ideally, the Report would substitute the names of the participants for the numbers in column 1.

Appendix D

A Brief History of FOMC Communications

Over the past three decades, Federal Reserve communication has evolved dramatically in an effort to improve accountability and make policy more effective.

Prior to 1993, there were no statements following FOMC meetings, no published minutes, no timely release of any FOMC materials, and certainly no press conferences. In other words, the FOMC never disclosed changes in policy. A cottage industry of private-sector experts worked to figure things out by taking actions like dissecting daily open-market operations. The lack of transparency made the "policy-discovery" process costly and inefficient.

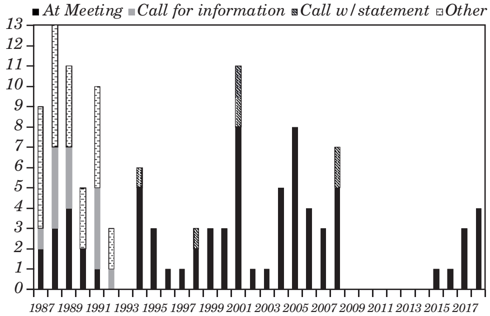
Opacity did not mean that the Fed kept policy stable. In fact, as of the late 1980s, there were interest-rate targets of a sort, and these changed frequently.[61] Figure D1 displays a simple count of the number of federal-funds-rate target changes from 1987 onward. In 1988, Chairman Greenspan's first full year in office, the target changed 13 times. Of these, however, only three changes occurred at or around the time of one of the eight scheduled FOMC meetings (black bars); four were announced to the FOMC, but not to the public, on impromptu conference calls (gray bars); and the remaining six were not associated with any documented FOMC communication (dashed-pattern bars). Put differently, it is not even clear when and how the FOMC members other than the Chairman learned of nearly half of the changes.

Since 14 of the 22 changes between August 1987 and May 1989 were smaller than 25 basis points, we suspect some of these were technical adjustments designed to keep reserve markets at the desired equilibrium level. Regardless, from today's perspective, three things stand out: changes occurred frequently; the bulk of the decisions to make the changes did not occur at a formal FOMC meeting; and, on many occasions, the Chairman did not appear to consult FOMC members prior to the policy implementation. Put differently, the FOMC Chairman really did control monetary policy.[62]

61. Based on an analysis of meeting transcripts, Thornton (2006) concludes that the "FOMC effectively switched to a funds rate targeting procedure in 1982."

62. For the comprehensive official history of FOMC communication in the last quarter of the 20th century, see Lindsey (2003).

Figure D1. Number of Changes in the Federal-funds-rate Target, 1986–2018



Source: Table 1 in Thornton (2006) and Federal Open Market Committee.

Table D1 reports notable developments in Federal Reserve communication policy. Two events in the early 1990s are notable. First, in 1993, the FOMC began publishing minutes of its meetings. (Initially released three days after the following meeting, the current practice of issuing minutes three weeks following a meeting began in 2004). Second, on February 4, 1994, the FOMC released the first immediate post-meeting announcement of a policy change:[63]

> "Chairman Alan Greenspan announced today that the Federal Open Market Committee decided to increase slightly the degree of pressure on reserve positions. The action is expected to be associated with a small increase in short-term money-market interest rates.
>
> The decision was taken to move toward a less accommodative stance in monetary policy in order to sustain and enhance the economic expansion.
>
> Chairman Greenspan decided to announce this action immediately so as to avoid any misunderstanding of the Committee's purposes, given the fact that this is the first firming of reserve market conditions by the Committee since early 1989."

For the next few years, the FOMC only released statements to announce policy shifts. These were equally succinct, albeit including

63. See https://www.federalreserve.gov/fomc/19940204default.htm.

announcements of discount rate changes. Starting in July 1995, statements explicitly mentioned a numerical target for the federal-funds rate; by 1996, they no longer referred to Chairman Greenspan; and in 1997, the statements began to include more than a one-sentence justification for the action. The current practice of issuing a statement following every meeting—regardless of whether the interest-rate target was changed—began in May 1999. Only in March 2002 did these statements reveal members' votes. In other words, the statements we have come to expect are a relatively recent innovation.

This move to public announcements marks a clear shift in the FOMC's balance of power. While the Chairman retains substantial influence over the direction of policy—controlling information and the tone of discussions to deliver a consensus for their desired outcome—the Chair's discretionary authority to change the interest-rate target between meetings effectively disappeared.

The publication of the statements also represents an unprecedented increase in policy transparency. As we indicated earlier, prior to 1994, market participants would look for hints of policy changes in signals they scraped together from open market operations (OMOs), reserve data, and weekly statistics on the size of the money stock—a process that required substantial technical expertise and the passage of time to observe various data. Once these announcements started, there was no turning back. Since 1994, observers no longer need to ask whether policy has changed, but whether it will change. The discussion is now completely forward-looking.

Returning to the timeline, November 2007 marks the publication of the first Survey of Economic Projections (SEP). Over the course of the next few years, the FOMC supplemented this initial version by adding projections for the longer run, histograms showing the subjective balance of risks and level of uncertainty, and then the projection of the federal-funds rate (the dot plot).

Finally, we note the FOMC Chair's press conference. Initiated in April 2011 as a complement to the publication of an enhanced SEP, it now follows every regularly scheduled meeting.

Table D1. Communications Timeline: Notable Developments, 1993–2019

Date	*Action*
Mar 1993	FOMC begins publishing minutes following the subsequent meeting
Nov 1993	FOMC votes to issue lightly-edited transcripts after a five-year lag
Feb 1994	FOMC begins issuing statements when policy changes
Aug 1997	FOMC communicates directive to FRBNY Markets Desk in terms of a federal-funds-rate target
May 1999	FOMC begins issuing statement following every meeting
Mar 2002	FOMC begins publishing individual votes in each statement
Aug 2003	FOMC includes time-dependent forward guidance in post-meeting statement
Dec 2004	FOMC shortens lag in publishing minutes to three weeks
Nov 2007	FOMC releases first quarterly Summary of Economic Projections as addendum to minutes, showing ranges and central tendencies of participants' growth, inflation, unemployment for up to three years
Nov 2008	Federal Reserve announces first large-scale asset purchase (LSAP)
Feb 2009	FOMC adds "longer-run" projections to SEP for growth, inflation, and unemployment
Apr 2011	Quarterly press conferences begin; FOMC releases SEP summary statistics at press conference
Nov 2011	Histograms in SEP show assessments of balance of risks and of level of uncertainty compared to past 20 years
Jan 2012	FOMC publishes first "Statement on Longer-Run Goals and Monetary Policy Strategy" specifying quantitative target for PCE inflation of 2%
Jan 2012	FOMC participants' projections for federal-funds rate added to SEP; "Dot plot" included in post-meeting summary

Table D1. Communications Timeline: Notable Developments, 1993–2019 (continued)

Date	*Action*
Dec 2013	Federal Reserve announces that it will start to taper LSAPs
Sep 2014	FOMC issues post-meeting statement regarding balance-sheet normalization
Sep 2015	Medians added to SEP summary and to the SEP addendum to the minutes
Jan 2016	FOMC specifies inflation goal as “symmetric”
Jan 2017	FOMC releases “matrix” version of 2012 SEP with transcripts (five-year lag)
Apr 2017	Fan charts added showing forecast errors around median SEP projections
Jun 2017	FOMC releases “Addendum” specifying balance-sheet normalization plans
Jan 2018	Release of Participant Key for first SEP (Oct 2007; 10-year lag)
Jan 2019	Press conferences after every meeting (rather than quarterly)
Jan 2019	FOMC releases statement regarding monetary policy implementation with abundant reserves
Mar 2019	FOMC detail balance-sheet normalization consistent with abundant-reserves policy management

Quotation marks denote key developments.

Source: Based significantly on Federal Reserve’s Transparency Steps,[64] Reuters, January 25, 2012, and on Timelines of Policy Actions and Communications: Summary of Economic Projections,[65] Federal Reserve Board. For communications since 2008 regarding forward guidance and balance-sheet policies, see Timelines of Policy Actions and Communications,[66] Federal Reserve Board.

Throughout this roughly 25-year period, the complexity and length of the FOMC statement have waxed and waned, but there appears to be no long-run trend. Following Davis and Wynne (2016), we use the Flesch-Kincaid grade-level formula, which converts a metric of

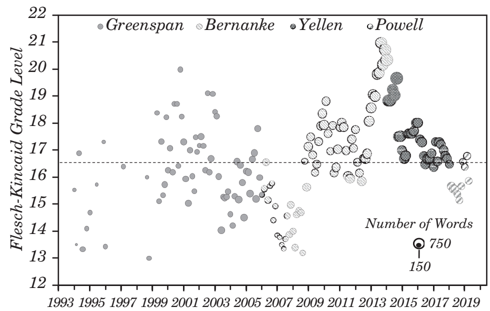
64. https://www.reuters.com/article/us-usa-fed-communications-idUSTRE80O2QQ20120125

65. https://www.federalreserve.gov/monetarypolicy/timeline-summary-of-economic-projections.htm

66. https://www.federalreserve.gov/monetarypolicy/review-of-monetary-policy-strategy-tools-and-communications-fed-listens-timelines.htm

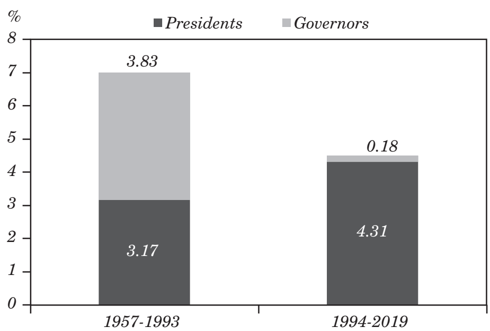
complexity into a U.S. grade-level-reading equivalent. Figure D2 plots the results of this simple exercise, with the grade level on the vertical axis and the number of words in the statement reflected in the size of each bubble. We also distinguish the statements under each Fed chair—Greenspan, Bernanke, Yellen, and Powell.

Figure D2. Complexity of the FOMC Statement, 1994-May 2019



Source: Davis and Wynne (2016) and authors' calculations using the readability calculator at http://www.readabilityformulas.com/free-readability-formula-tests.php.
Note: Each bubble represents a post-meeting statement, with the size indicating the number of words (see the internal legend). The dashed horizontal line represents the average Flesch-Kincaid grade level of 16.6.

Figure D3. Dissents by FOMC voting members as a share of total votes (percent), 1957–2019



Source: Fraction of recorded dissents in votes from January 1957 to May 2019. Based on data in figure 2 from Thornton and Wheelock (2014); updates since 2013 by the authors.

Policymakers and monetary economists alike believe in the value of transparency. They see it as a way to ensure accountability, create credibility, and improve the effectiveness of monetary policy. But the release of information does have limits for at least two reasons. First, laying decision-making open for all to see can damage the deliberative process, making it more formal and less open to controversial options. Second, increased communication runs the risk of sending confusing signals. As Lewis Alexander said, *"For statements of policy intentions to be useful, they must be credible. Not doing what you said you were going to do undermines that credibility. This is a reason not to say too much."*

Has the extraordinary increase in FOMC transparency since 1993 muted the aggressiveness and weakened the quality of internal committee debate? As *prima facie* evidence for this proposition, one could note the virtual elimination of open dissents by Governors since 1993 (figure A.4.3). Meade and Stasavage (2008) find evidence that the publication of meeting transcripts, approved by the FOMC in October 1993, diminished subsequent incentives to dissent. However, there has been little change in the frequency of dissent by regional bank presidents. Similarly, while confirming a "negative conformity effect" following the release of transcripts, Hansen and others (2018) conclude that the "discipline effect"—the increased incentive to prepare for and to influence the deliberations—dominated. Likewise, Woolley and Gardner (2017) find no impact from the publication of transcripts on the use of reasoned arguments in the internal deliberations, even as voting patterns shifted.

In closing, table A4.2 identifies, as of May 2019, the FOMC's eight primary communications tools, including information on the frequency and timing of their publication.

Table D2. Summary of Primary FOMC Communications Tools, May 2019

Type	*Frequency*	*Release Timing*
Policy statement	8 times per year	After each meeting
Minutes	8 times per year	3 weeks after each meeting
Press conference	8 times per year	After each meeting
Summary of Economic Projections	4 times per year	After designated meeting
Monetary Policy Report to Congress	2 times per year	February and July
Speeches and other public remarks	Continuous	NA
Statement on Longer-Run Goals & Policy Strategy	1 time per year	January
Policy Normalization Principles and Plans	Updated periodically	After meeting

Source: Table 1 in Kliesen and others (2019).

Comfort in Floating: Taking Stock of Twenty Years of Freely Floating Exchange Rate in Chile

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Chile offers an example of a country that has overcome the fear of floating by reducing balance-sheet mismatches; enhancing financial-market development; and improving monetary, fiscal, and political institutions; while strengthening policy credibility. Under

We benefitted from useful comments by Patricia Alonso-Gamo, Guillermo Calvo, Martin Cerisola, Mariana García, Andrés Sansone, Alejandro Werner and the participants at the XXIII Annual Conference of the Central Bank of Chile "*Independence, Credibility, and Communication of Central Banking*" and the WHD seminar at the International Monetary Fund. We thank Ivan Burgara, Isidora Lara, Emilio Guamán, and Sebastián Ramírez for excellent research assistance. We also thank Marcela Arriagada and Dagoberto Quevedo for their help in web-scrapping data, Alexander Hynes and Paulina Rodríguez for helping us access currency derivatives data, and *Comisión para el Mercado Financiero* for kindly giving us access to historic records on nonfinancial corporations under their supervision. The views expressed in this paper and those of the authors and do not necessarily represent the opinion of the Board of the Central Bank of Chile, or the views of the IMF, its Executive Board, or IMF Management. All errors are our own.

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the floating regime, Chile's economic adjustment to external shocks appears significantly improved, and its exchange-rate passthrough has substantially declined. Our results reinforce the case that moving to a clear and credible floating regime can be associated with a reduction in the fear of floating via economic transformation (like smaller balance-sheet mismatches, a larger hedging market, and a lower exchange-rate passthrough).

1. Literature Review

This paper offers a comprehensive overview of how Chile defeated the fear of floating. Remarkably, Chile's interest-rate reaction to the Asian and Russian crises was presented as a classic case of fear of floating.[1] Over the past two decades, Chile has been enjoying a fully flexible exchange-rate regime—after abandoning its crawling peg band in 1999—with extremely rare foreign-exchange intervention and an open capital account.[2] In this context, the paper focuses on policymaking in normal times, and not on tail scenarios, such as the one triggered by the unique circumstances of the social demonstrations in late 2019 or the Covid-19 outbreak. Indeed, over the past two decades, Chilean firms have significantly reduced their balance-sheet currency mismatches, aided by the deepening of internal financial markets, which both reduce the cost of domestic credit and create opportunities to hedge currency exposure. Chile also completed its transition towards a fully-fledged and inflation-targeting regime and benefitted from a robust monetary and fiscal policy design that has contributed to substantial policy credibility. This allows Chile to exhibit a healthy macroeconomic adjustment to external shocks while showing very low volatility of long-term interest rates.

The choice of the exchange-rate regime has been subject to intense debate for decades. On the one hand, the vast literature on optimum currency area highlighted the criteria under which countries may find it desirable to hold a pegged exchange-rate regime: a synchronous business cycle with the anchor country (due to economic structure, diversification, or openness), a large passthrough neutralizing exchange-rate movements, or substantial mobility of factors offering

1. See Calvo and Reinhart (2002).

2. See De Gregorio and Tokman (2004) for a description of previous exchange-rate regimes and the transition towards free floating in 1999.

alternative forms of economic adjustment.[3] A complementary argument is offered by the literature on macroeconomic discipline, which focuses on the benefits of pegging for countries that lack the credibility to manage an independent monetary policy while maintaining macroeconomic stability).[4]

On the other hand, various countries would like to retain monetary-policy independence by floating, as capital controls have become more and more difficult to implement effectively, and the 'trilemma' literature has continued to highlight that, in the absence of strong capital controls, it is virtually impossible to retain monetary independence under a pegged regime.[5] This regime choice is also supported by recent studies that have vindicated the superior economic performance and macroeconomic adjustment to external shocks associated with floating regimes.[6]

However, over the past few decades, floaters have effectively contained the fluctuations in the exchange rate arising from the fear of floating[7] driven by various factors: balance-sheet mismatches, limited hedging opportunities, costs from exchange-rate fluctuations, volatility of imported inflation posing challenges for monetary policy, and difficult access to capital market in the presence of limited

3. The literature on exchange-rate regime choice is very vast; the seminal paper for the optimum currency area argument is Mundell (1961); for surveys and discussions see for example Ricci (2008), Ghosh and others (2010), Rogoff and others (2004), and Mussa and others (2000).

4. See Giavazzi and Pagano (1988).

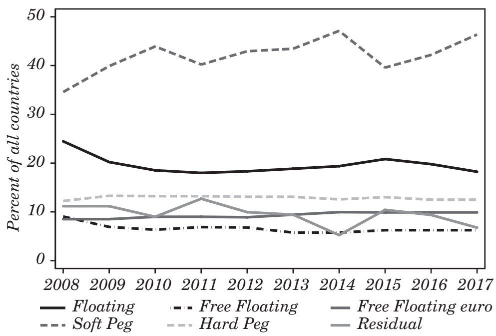
5. For recent studies confirming the trilemma, see Obstfeld (2015), Klein and Shambough (2013), and Ricci and Shi (2016). A classic reference is Obstfeld and others (2005). Aizenman (2017) extends the trilemma to the quadrilemma suggesting that countries have been more and more concerned with financial stability. Rey (2014 and 2015) argues that global credit cycles affect financial conditions in countries irrespective of their exchange-rate regime. Ricci and Shi (2016) show that, on average, floaters appear to be less affected by the U.S. interest rates in the short run.

6. See, for example, Obstfeld and others (2019), Grigoli and others (2019), Ghosh and others (2018), Ben Zeev (2019), International Monetary Fund (2016), Ghosh and others (2010), Levy and Sturzenegger (2003), Edwards and Levy (2003), and Ghosh and others (1996).

7. See Calvo and Reinhart (2002).

credibility.[8] Eichengreen (2019) highlights that, in the last few decades, the strong financial integration has exacerbated the domestic financial instability associated with exchange-rate flexibility, thus intensifying the continued tension among the attempt to maintain monetary-policy independence, the fear of floating, and the ability to maintain capital controls. Ilzetzki and others (2019) find that, although there is some tendency toward more intermediate regimes, the world remains heavily skewed towards less flexible exchange-rate regimes instead of managed-floating and free-floating ones. When looking at the new International Monetary Fund's (IMF) classification of exchange-rate regimes revised in 2018 (figure 1), we see that the number of (non–euro area) freely floating countries remains very small (about 5 percent).

Figure 1. IMF Exchange-Rate Regime Classification



Source: Annual Report on Exchange Arrangements and Exchange Restrictions.

8. For the relevance and macroeconomic effects of balance-sheet mismatches in the context of exchange-rate policy see Aghion and others (2000), Céspedes and others (2004), Kearns and Patel (2016), and Krugman (1999). Exchange-rate fluctuations drive fear of floating in Lahiri and Végh's (2001). As, more generally, Obstfeld and Rogoff (1995) put it: "Although the associated costs have not been quantified rigorously, many economists believe that exchange-rate uncertainty reduces international trade, discourages investment, and compounds the problems people face in insuring their human capital in incomplete asset markets. Furthermore, workers and firms hurt by protracted exchange-rate swings often demand import protection from their governments." This argument was also used in support of the move towards the European monetary union. See Baldwin (1991) for a quantification of the effect).

This paper describes how Chile has dealt with the two main burdens that have traditionally deterred other emerging market economies (EMEs) from adopting clean floating regimes, namely, financial and price stability.[9,10] In addition, it provides evidence about the benefits of both macroeconomic and financial adjustments to shocks that result from such an exchange-rate regime.

Among the main results, we highlight the following. First, we document a significant, monotonic compression of the complete distribution of foreign-exchange (FX) exposure towards very low current levels, which occurs *after* the transition to exchange-rate flexibility in 1999. Moreover, this decline is mostly driven by an enhanced matching of USD-denominated assets and liabilities—essentially, firms initially indebted in U.S. dollars tend to reduce their foreign-currency liabilities. We also provide evidence about the determinants of FX derivatives use by firms, finding it more prevalent in i) those involved in international trade; ii) firms with larger balance-sheet mismatches; and iii) firms that recently experienced losses (though not gains) due to currency fluctuations. Our results are consistent with previous findings that moving to a floating exchange-rate regime reduces balance-sheet mismatches, as in Martínez and Werner (2002) for Mexico, Cowan and others (2006) for Chile, and Kamil (2012) for six Latin American countries (Argentina, Brazil, Chile, Colombia, Mexico, Peru). Looking at Brazil, Rossi (2004) finds that the number of companies exposed to currency risk during the floating exchange-rate regime is much lower than under the fixed one, not only as companies trade currency derivatives more extensively to reduce their foreign-exchange-rate exposure, but also as they reduce the currency mismatches on their balance sheets.

Second, the exchange-rate passthrough (ERPT) to domestic prices has monotonically declined. While this trend is consistent with the evidence presented by other authors,[11] our extended sample finds that ERPT has fallen even further in the last decade. This is consistent with the enhanced credibility of Chile's monetary-policy regime, a

9. In addition to financial and price stability, the nature of Chile's productive structure as a resource-intensive economy helps dampen the effect of exchange-rate fluctuations on real economic activity, as compared to more diversified economies with larger manufacturing sectors (Carrière-Swallow and García-Silva, 2013), as in commodity-exporting sectors the response of supply and employment to short-term movements in the exchange rate are more muted than in the manufacturing sector.

10. See Ötker and Vávra (2007) for a broader discussion about the operational aspects of the transition to greater exchange-rate flexibility based on country experiences.

11. See De Gregorio and Tokman (2004), and Justel and Sansone (2016).

dominant topic in the extensive literature linking ERPT to underlying macroeconomic fundamentals and the role of institutions.[12]

Third, the switch to a freely floating regime is associated with a better macroeconomic performance when comparing the last two severe crises—the Asian/Russian crisis, which Chile faced with a crawling peg, and the Global Financial Crisis (GFC), which was confronted after a decade of free floating.[13]

Fourth, the paper also documents the strong financial sector resilience to external shocks, and in particular, the role that exchange-rate flexibility plays in cushioning the impact of global financial shocks on domestic asset prices.[14] Specifically, we document that, as compared to other emerging countries following less clean floats, the reaction of the exchange rate is high relative to the one of long-term bond yields and stock markets, in response to both monetary-policy (MP) shocks in the U.S. and fluctuations in global risk aversion.

Our results are not necessarily inconsistent with recent findings arguing that intermediate floating regimes (i.e., with some intervention) offer better growth performance and macroeconomic adjustment to shocks than both fixed regimes and pure floats, as the latter contain excessive exchange-rate fluctuations.[15] Indeed, the average purely floating country in the sample in these studies may have not yet reached the adequate conditions for the flexible exchange rate to perform well while adequately coping with exchange-rate volatility; namely, a development of financial markets that may provide sufficient domestic funding and/or opportunities for hedging exposure

12. Numerous studies have investigated empirically the characteristics, determinants, and the evolution of ERPT over time and across countries. Céspedes and Valdés (2006) document that greater central-bank independence is associated with lower ERPT. Edwards (2006), and Mishkin and Schmidt-Hebbel (2007) suggest that inflation targeting has contributed to moderating ERPT by enhancing monetary-policy credibility. Carrière-Swallow and others (2016) find a strong link between monetary-policy regime's performance in delivering price stability and low ERPT. Ca'Zorzi and others (2007), and Choudhri and Hakura (2006) find a positive relationship between the ERPT and the average inflation rate. Gopinath and others (2010) show that the currency choice in pricing and invoicing plays an important role for ERPT, and Gopinath and Itskhoki (2010) find that higher frequency of price adjustments is associated with larger ERPT. Caselli and Roitman (2016) find important nonlinearities in ERPT during large depreciation episodes in EMEs.

13. See Cowan and De Gregorio (2007) for a comparison of the first episode with the late 1970s.

14. See Blanchard and others (2015), Obstfeld and others (2019), and Cáceres and Lindow (2018).

15. See Frankel and others (2019), and Obstfeld and others (2019).

through FX derivatives. In the case of Chile, the surge of pension funds as vehicles of investment for mandatory pension savings has been crucial in lowering the cost of local credit, thereby reducing the incentives of firms to undertake currency risk on their balance sheets by borrowing abroad. Moreover, as pension funds invest abroad a sizeable share as well, their demand for FX derivatives has contributed to the development of the hedging market, lowering insurance costs for nonfinancial corporates. That said, the significant decline in currency exposure and the surge in the derivatives market after the introduction of the freely floating scheme in Chile suggests that these factors may be, at least partially, endogenous to the currency regime in place.

This paper may also address a recent argument put forward by Diamond and others (2018) for exchange-rate intervention as a "macro-prudential tool to mitigate adverse monetary-policy spillovers from source countries." To the extent that limited balance-sheet exposure and strong hedging reduce the effect of exchange-rate fluctuations on the net worth of companies while good institutions enhance governance and pledgeability (these outcomes being crucial in their analysis), there is a smaller "rationale for countries to limit exchange-rate movements to avoid spillovers affecting financial stability from accommodative monetary policies in funding countries."

In future work, it would be valuable to assess the extent to which these desirable economic transformations observed *after* a move to a floating regime—smaller balance-sheet mismatch, a larger hedging market, and smaller passthrough—correspond to endogenous response to the change in regime, *vis-à-vis* a by-product of a gradual deepening of financial markets and enhanced credibility as countries develop. Such an analysis would complement and generalize the findings of the "endogenous optimum currency area literature" which highlights that a move to a fixed exchange rate endogenously makes the shocks more symmetric across pegging countries, thus validating the choice of the exchange-rate regime.[16]

16. See Frankel and Rose (1998), and Ricci (2006).

2. The Transition towards Fearless Floating: Key Elements

2.1 Evolution of Currency Exposure and the Role of Derivatives

A first burden to overcome in order to cope with the fear of floating is the financial stability risk involved in currency mismatches of both financial and nonfinancial corporations. In this section, we document the evolution of exposure to exchange-rate risks for different agents, starting in the years before the flexible regime choice of 1999, to the present. Subsection 2.1.1 briefly discusses the situation for banks and regulated financial institutions, showing that the adjustment towards low currency exposure occurred well before 1999, following the adoption of new banking regulation as in response to the early-1980s financial crisis in Chile.

In subsection 2.1.2, we provide new evidence about the evolution of net currency exposure for nonfinancial corporates based on a panel of large, supervised firms. We highlight two results. First, there is a significant reduction in currency exposure that starts with the introduction of the freely floating regime. Importantly, to appreciate this result, it is necessary to look at the whole distribution of firms—while the average/median firm shows very little currency mismatch in its balance sheet to begin with, the most exposed quartiles do exhibit important initial currency exposures that progressively compress to very low levels today. Second, and perhaps contrary to common wisdom, such a decline is quantitatively more related to changes in exposure than to increased use of derivatives. Indeed, the data strongly suggest that the bulk of the reduction in balance-sheet exposure stems from reducing the stock of USD-denominated liabilities and of USD-denominated assets for those firms initially exposed to a peso depreciation/appreciation, respectively.

Subsection 2.1.3 delves deeper into the use of derivatives by nonfinancial corporates. We find that they are more likely to be used in firms related to international trade, in those with larger balance-sheet currency exposure and, crucially, in those that have recently experienced losses (but not gains) stemming from FX exposure. Complementing this point, subsection 2.1.4 documents that firms with recent losses from exchange rate fluctuations are also more prone to reducing their overall balance sheet currency mismatch in the following quarters.

2.1.1 Low Currency Exposure in Financial Institutions

The balance-sheet currency mismatch (defined as FX liabilities minus FX assets, implying that a positive mismatch is a short FX position) for Chilean banks and other supervised financial institutions has been consistently close to zero even before the nominal exchange rate (NER) was set free to float. Low currency exposure in banks is partly a reflection of several layers of regulation that can be traced to the aftermath of the financial crisis in the early 1980s. While several external factors contributed to the deterioration of the macroeconomic outlook for Chile in 1982, the consensus points out to domestic elements as amplifiers of the downturn. In particular, weak regulation and supervision of the financial sector led to widespread lending in U.S. dollars to local firms, many of them interrelated (through ownership ties). While banks themselves did not exhibit major balance-sheet mismatches, firms did. As external interest rates rose and the price of copper fell dramatically, a large devaluation of the Chilean peso (CLP) became inevitable, and this rendered many firms that had borrowed in U.S. dollars insolvent. The devaluation had a major impact on inflation, but more importantly, on the solvency of the main banks, at the same time as external credit was drying up due to the sudden stop. All this led to a sharp contraction in local credit, widespread intervention by regulators, and a massive rescue package by the Central Bank.

The 1986 Banking Law reformed many aspects, including limitations to credit to related parties. In terms of currency mismatches in the balance sheets of the banks themselves, Matus (2015) describes the evolution of regulation. The first explicit limitation goes back to May 1982, which imposed a limit to the difference between credit and deposits in foreign currency of 10 percent of capital plus reserves. In August 1982, this limit was extended to 20 percent, and the definition of assets and liabilities subject to the limit was widened. In 1998 the regulation was updated to incorporate the fact that foreign currencies, different from the U.S. dollar, were also relevant. Finally, in 2005, further regulatory changes were introduced related to the measurement of market risk to consider foreign-currency, credit, and interest-rate exposure.[17] All these reforms contributed to inducing

17. In particular, the new limit establishes that the sum of risk-weighted assets times the minimum share established in article 66 of the Banking Law, plus the sum of risk stemming from interest-rate and foreign-currency risk should not go above 100 percent of effective equity of the bank. Foreign-currency exposure also includes net positions in FX-derivative contracts.

banks to reduce their currency mismatches and keep them contained. Next section focuses on nonfinancial institutions.

2.1.2 Declining Currency Exposure in Nonfinancial Corporations

The exposure to currency risk of nonfinancial corporations in Chile has been addressed in several previous studies.[18] In this section, we study the evolution of currency exposure based on standardized accounting information available for the sample of firms supervised by the securities-issuance regulator (previously SVS, now CMF[19]). This balance-sheet information is then merged with two datasets: i) the derivatives registry, which records virtually all FX-derivative contracts and counterparties; and ii) the customs registry, which records all goods exports and imports for the universe of Chilean firms.

Relative to previous papers, for instance, Cowan and others (2006), our sample has the following advantages. First, it has broader firm coverage—we observe 267 firms in 1997 and up to 373 firms in 2012, quarterly, for all but the first three years of our sample.[20] We were able to reconstruct these historical data from three sources: a) manual input from physical archives of annual reports for years prior to 1999, b) information from the so-called annex number 5 to statements of income submitted to the CMF for years 2000–2008, and c) information reported through the CMF to the Central Bank of Chile (CBC) for 2009–2018.[21] Second, rather than focusing on just the first few years after the inception of the floating regime, we can extend the sample by about 16 years (in total spanning from 1997 to 2018). Third, we can study separately the behavior of firms involved in international trade from those more focused on the domestic economy. This turns out to be a relevant separation to make, as shown below.

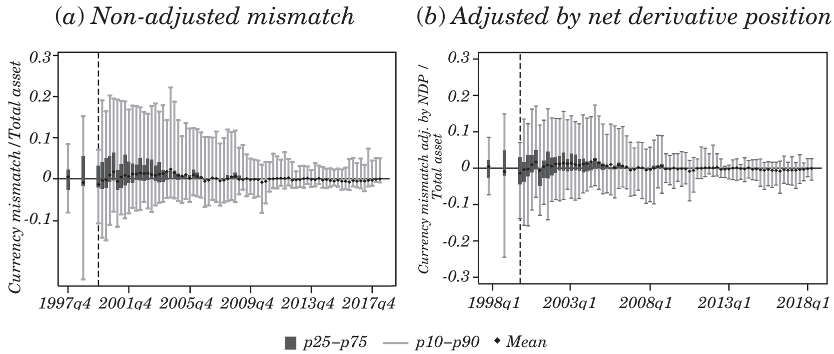
18. See De Gregorio and Tokman (2004), Caballero and others (2005), Chan-Lau (2005), Cowan and others (2006).

19. *Superintendencia de Valores y Seguros* (SVS), and *Comisión para el Mercado Financiero* (CMF), respectively.

20. Cowan and others (2006) use FECU data from 1995 to 2003 on a yearly basis, at around 132 average firms per year. We observe an average of 324 firms per year.

21. In the analysis below, we exclude firms with accounting in USD, for two reasons. First, from a financial stability perspective, our focus is on domestic firms since many corporations with USD accounting are subsidiaries of larger multinationals, such as mining companies. Second, for such multinationals, the currency exposure of local subsidiaries may give an incomplete picture of the overall exposure of the parent company across its different countries of operation.

Figure 2. Evolution of Balance-Sheet Net Currency Exposure in Supervised Firms
(USD liabilities – USD assets, as a fraction of total assets)

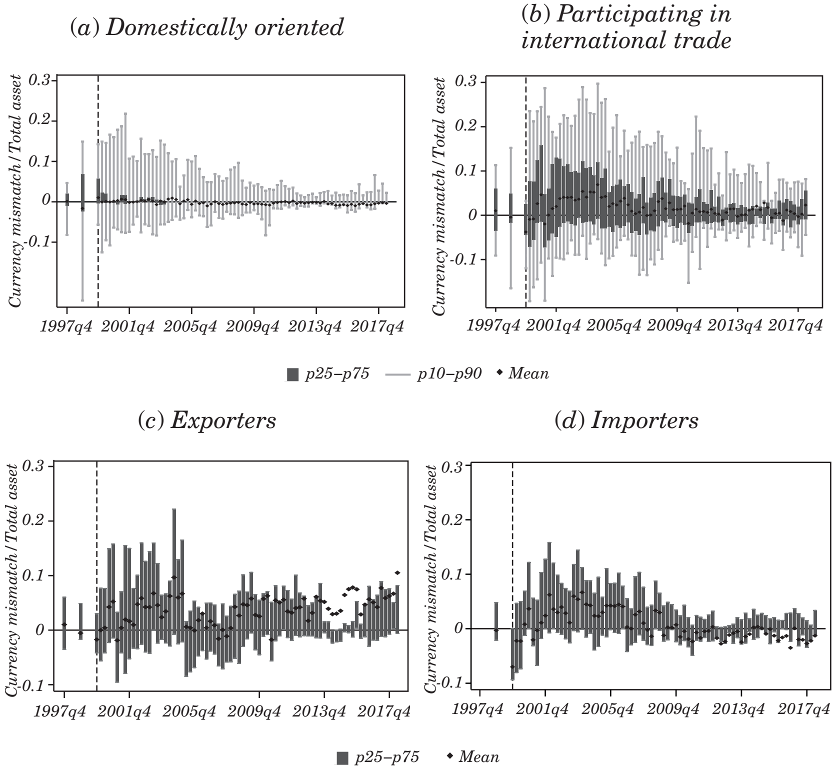


Source: Authors' calculations based on Central Bank of Chile and Financial Market Commission data.
Notes: Yearly data for 1997–1999, quarterly data from 2000q1. The squares show the mean exposure, the dark gray bars contain the interquartile range, and the endpoint of the light gray bars denote the 10th and 90th percentiles of the distribution.

Figure 2 shows the net currency exposure, as a share of total assets, for the complete distribution of firms from the fourth quarter of 1997 to the second quarter of 2018 (for years 1997–1999 we have yearly information only). FX exposure or currency mismatch on balance sheets is defined as the difference between foreign-currency-denominated liabilities and foreign-currency-denominated assets, as a share of total assets. Panel a) plots the FX exposure not adjusted by the net derivative position (NDP), while panel b) makes this adjustment.

Notably, while either the mean or median of the distribution show quite low levels of net FX exposure even at the start of the regime change in 1999—as documented in previous studies—, the conclusion is rather different if one considers the broader distribution. For instance, firms in the 90th percentile show initial exposures of up to 20 percent of total assets (that is, USD liabilities exceeded USD assets by 20 percent of total assets). Likewise, firms in the 10th percentile show a negative initial exposure of around 15 percent of total assets. From a financial stability perspective, it is precisely these firms at the tails of the distribution that matter most. Thus, as a first main result in this section, we highlight the fact that the complete distribution of firms' FX exposure shows a significant, progressive, and almost monotonic compression towards the current low levels of balance-sheet mismatch (with a mild increase in the last few years).

Figure 3. Balance-Sheet Net Currency Exposure in Domestically and Trade-Oriented Firms

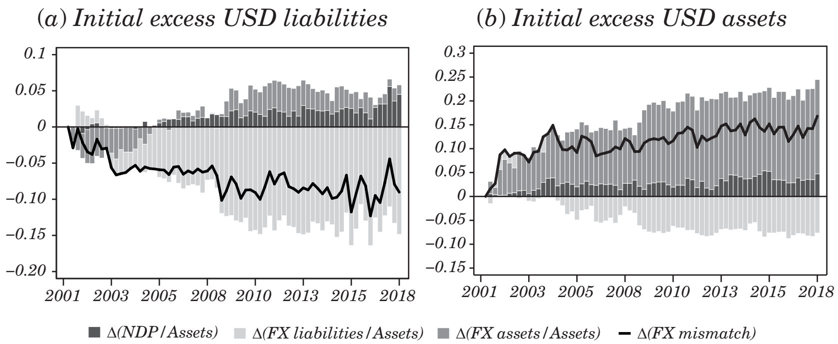


Source: Authors' calculations based on Central Bank of Chile and Financial Market Commission data.
Notes: Yearly data for 1997–1999, quarterly data from 2000q1. The definition of an importer (exporter) requires imports (exports) to be at least 10 percent of total sales. Sample sizes for exporters ranges from 32 to 73 firms and from 58 to 130 firms for importers, depending on the period.

Interestingly, the behaviors of domestically oriented and international trade-related firms evolve differently (figure 3). On the one hand, firms not related to trade (panel a)) initially show less exposure to exchange-rate risk, although there is a fair amount of FX mismatch in the top deciles at the start of the sample, which then compresses toward zero almost monotonically over time. On the other hand, firms related to international trade (panel b)) show a wider distribution of FX exposure in their balance sheets, which tends to persist throughout the sample. Further separating the latter group, we find that exporters (panel c)) are generally short on the dollar in their balance sheets (a natural hedge), with the mean fluctuating just below or around 10 percent of total assets, while importers (panel d)) show a more compressed exposure, with the mean converging towards zero, from mostly positive values at the earlier sample.

As a second result, we stress the fact that the bulk of this adjustment seems to be driven by an adjustment of assets/liabilities mismatch, with net derivatives positions playing some but not the dominant role. This can be seen comparing panels a) and b) of figure 3, which suggest that, whether or not we adjust our measure of net currency exposure by derivatives positions, the evolution of the distribution of firms' balance-sheet exposure shows a similar pattern.[22] To look at this point further, figure 5 focuses on the quartiles of the most exposed firms and describes how the reduction of currency mismatch was accomplished. To avoid compositional effects, the figure studies the evolution of the balance sheets for a given set of firms throughout the sample.[23]

Figure 4. Cumulative Reduction of Initial FX Exposure



Source: Authors' calculations based on Central Bank of Chile, Financial Market Commission and Chilean Customs data.
Notes: Information for firms at the top (panel (a)) 25 percent, and bottom (panel(b)) 25 percent of the distribution of currency mismatch in the initial period (2001q1). Assets and NDP to assets are shown with the opposite sign. Each panel uses information of 42 firms on the top/bottom of the 2001q1 currency mismatch distribution.

22. This result is consistent with the evidence presented by Alfaro and others (2020), who highlight that FX derivatives are more likely to be used to hedge cash-flow currency mismatches than overall balance-sheet positions, partly due to the increasing cost of financial derivatives on maturity.

23. This selection criterion forces us to start the figure in 2001, as the share of firms operating in 1999 that persisted for the next twenty years is too low for the results to be representative. The sample considered here accounts for about 16% (8% on each side) of the total unbalanced panel plotted in figure 3.

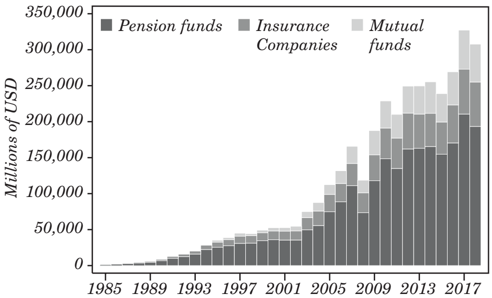
Panel a) of figure 4 shows the cumulative reduction in the initial FX exposure of the firms in the 25th percentile most exposed to a currency depreciation (that is, the USD-liabilities position exceeds the corresponding USD-asset position). The starting point is normalized at zero, so the decrease (increase) in panel a) (panel b)) corresponds to the reduction in the initial positive (negative) mismatch. For these firms, the bulk of the mismatch reduction is explained through a fall in USD liabilities (light gray bars). Net derivative positions seem to go the other way, that is, the change actually contributes to increasing exposure. One possible interpretation is that, at the beginning, firms were partly hedging their USD-denominated liabilities by holding either USD assets (medium gray bars), and/or a positive net position on FX derivatives (long USD). Overall, as USD-denominated liabilities drop throughout the sample, so does the need for holding assets and derivatives. Panel b) shows the corresponding behavior for the 25th percentile of firms most exposed to a currency appreciation (USD-denominated assets exceed USD liabilities). Likewise, most of the reduction in exposure was achieved through a reduction in USD asset holdings, while initial USD liabilities (probably held initially as a hedge) also dropped.

These results may contrast somewhat with the often heard view that the development of the derivatives market was the main vehicle through which firms reduced their balance-sheet currency exposure. Instead, the evidence presented here suggests that firms that were likely benefiting from a more developed capital market with cheaper credit (in the case they had excess USD liabilities) or better investment opportunities abroad (to the extent they had excess USD assets) faced progressively fewer incentives to do so and acted by reducing the corresponding exposure directly in their balance sheet. This is not to imply that firms do not use derivatives at least partly to hedge either balance-sheet exposure and/or revenue risks in the case they participate in international trade (both elements appear significant in the panel regressions studied in the following section), but their quantitative importance should be assessed with this evidence in mind.

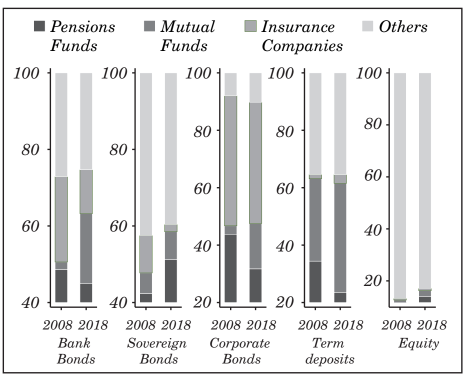
In summary, nonfinancial corporations have significantly reduced balance-sheet exposure to foreign currency. The fact that this begins to occur shortly after the switch to free floating in 1999 is suggestive that firms' choices may be partly endogenous to the exchange-rate regime. However, an alternative, complementary hypothesis may also have played an important role. Namely, the deepening of financial markets—in particular, the growth in importance of pension funds and other institutional investors—also increased availability of domestic credit and better local investment opportunities, as well as higher liquidity in the derivatives market. In particular, figure 5 shows the evolution of internal credit supply by institutional investors, which have progressively built up corporate debt in their portfolios, leading to a current participation in this market close to 85 percent. As a result, reliance on banking credit of these corporations has gone from an estimate of 91 percent of debt in 1986 to around 25 percent in recent years.[24]

Figure 5. Evolution of Credit Supply by Institutional Investor

(*a*) *Total assets under management by institutional investor (millions of USD)*



(*b*) *Main holders of financial instruments (percentage)*



Source: Berstein and Marcel (2019), based on data from *Depósito Central de Valores* and *Bolsa de Comercio de Santiago*.

24. See Marcel (2019).

2.1.3 A Closer Look at the Growing Derivatives Market

The market for FX-derivatives contracts has increased substantially since the transition to the freely floating regime in 1999. While FX derivatives have not been the main vehicle through which most nonfinancial corporations have compressed their balance-sheet mismatches after the adoption of the floating regime, it has played a role for some firms and especially other agents (figure 6). This section documents the overall evolution of the FX-derivatives market and the participation of different economic agents and provides evidence from panel regressions to understand the drivers of derivatives use by nonfinancial corporates.

Data of FX derivatives come from the Central Bank of Chile registry of derivatives, which compiles transaction-level information reported by participants of the so-called Formal Exchange Market (MCF, for its acronym in Spanish), which comprises commercial banks and other financial institutions.[25] These institutions are required to inform the Central Bank of Chile of transactions within a 24-hour window. These data constitute almost all the FX-derivatives transactions conducted in Chile since 1997 and amounts to more than three million observations involving more than 11 thousand firms.[26]

Figure 6 shows the gross (panel a)) and net (panel b)) positions in FX derivatives, both long or from the buyer's side (positive sign), and short or from the seller's side (negative sign).[27] The gross FX-derivatives positions in panel a) show a few interesting aspects. First, the figure documents the almost ten-fold increase in the size of notional positions traded in the market since the beginning of the clean floating regime in 1999, bringing the gross derivative position on each side of the market to represent roughly 60 percent of current GDP.[28]

25. The requirement of information is detailed in Chapter IX of the *Compendio de Normas de Cambios Internacionales* available at *https://www.bcentral.cl/en/cnci-capitulos.*

26. The first record of information goes back to 1993; however, only after 1997 the market starts showing more transactions. A detailed description of the data can be found in Rodríguez and Villena (2016).

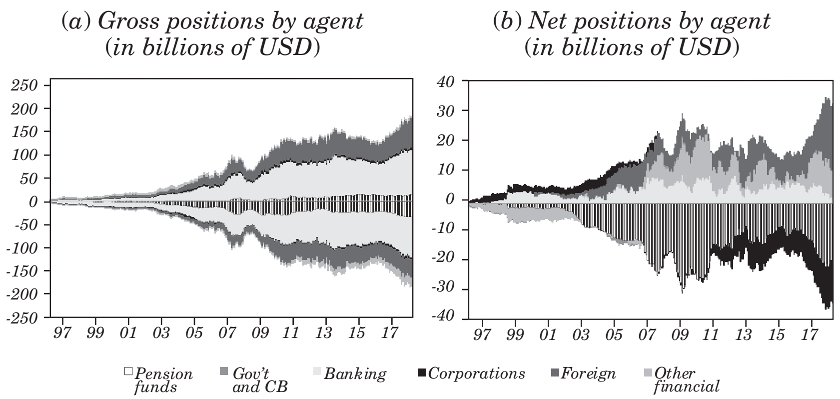
27. In this section, we only consider derivatives that involve the Chilean peso or UF ("*Unidad de fomento*", Chilean inflation-indexed unit of account) on one side. That is, we exclude all observations that involve two foreign currencies on both sides of the contracts, as these contracts may aim at something different than removing foreign-currency risk from balance sheets and cash flows denominated in pesos.

28. The numerator in this calculation corresponds to the monthly average of all outstanding notional amounts traded throughout 2018. The denominator corresponds to annual GDP, each quarter evaluated at spot exchange rates.

Second, it also shows the relative sizes of the main players. As is well known, pension funds (center bars) play a relevant role, taking mostly (but not exclusively) short positions on foreign currency (as confirmed by their net positions in panel b)). This makes sense since pension funds allocate a significant fraction of domestic savings in foreign securities (approximately around 40 percent of their portfolio in 2018), for which they are required to partially hedge currency exposure—thus becoming natural sellers of USD forward contracts.[29] Pension funds were not active participants in this market at its onset, since regulation did not allow these institutions to invest abroad until the year 2001.

Foreign investors also play a relevant role and hold a more balanced mix of buyer/seller forward positions. This is also to be expected since nonresidents encompass a multitude of different agents with diverse economic and financial exposures, and possibly different expectations on the future evolution of the peso/U.S. dollar and/or the profitability of a given interest-rate differential.

Figure 6. Main Participants in Chile's Derivatives Market



Source: Authors' calculations based on Central Bank of Chile data.
Notes: Data subject to revisions for the pre-2007 data. Both panels show positions from the perspective of the referred agent. By definition, the net derivative position of all local agents must mirror the (inverse) position of nonresidents.

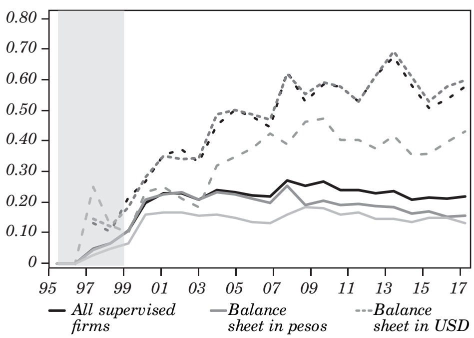
29. The so-called *Reform to Capital Markets I* (Law 19,769)—among other things—allowed the investment portfolio of pension funds to be divided into five different new ones; with different associated risk profiles—usually referred to as '*multifondos*'. The same law allowed these funds (in different degrees) to invest in foreign assets and imposed the maximum share of these investments that can lack hedging against currency risk.

Finally, the light gray area show the gross positions of banks. Together with other financial institutions (gray outer area), banks constitute the largest participants in the FX-derivatives market.

Banks' gross derivative positions (panel a)) are an order of magnitude larger than their net positions (panel a)). They generally act as market makers and counterpart to other agents in the economy seeking to buy/sell FX derivatives. However, in the end, they retain very little currency exposure, and most of their net derivative position is offset in the spot market (consistent with the evidence presented in subsection 2.1.1). Nonfinancial corporates, on the other hand, account for a small fraction of the market. This suggests that, rather than providing a pivotal role in the spreading of FX-derivative contracts, nonfinancial corporates have benefited from the increased depth and liquidity brought about to these markets by other large players.

We now zoom in on the spreading and the reason for the use of derivatives by nonfinancial corporates for which we have better information–the subset of supervised firms with publicly available balance sheets and income statements. First, figure 7 shows that the fraction of supervised firms that use derivatives rose to around 20 percent by the early 2000s and remained roughly at that level. However, the percentage continued to increase until the global crisis for firms with balance sheets denominated in U.S. dollars and for firms participating actively in international trade, reaching about 40 and 60 percent, respectively. Moreover, the usage per firm increased substantially for all firms.

Figure 7. Derivatives Use among Groups of Supervised Firms
(fraction)



Source: Authors' calculations.
Notes: Shaded area shows period prior to adopting a floating exchange-rate regime. Firms that trade are defined as those that engage in any type of international trade in a given period. Trade (*B*2) firms are those whose imports/exports are above 5% of their corresponding assets, (*A*1) more than 10% of their sales.

The main determinants behind the decision to use derivatives are empirically investigated in the (logit) panel regressions shown in table 1. The dependent variable of this regression is a dummy which takes the value of one if a firm uses FX derivatives in the corresponding quarter—either long or short positions. The independent variables include an accounting line in the firm's income statement that specifically quantifies gains (positive) or losses (negative) due to exchange-rate (ER) fluctuations ("Income due to ER variation"), the level of the currency mismatch in the previous period as a fraction of total assets, interactions of these variables, and the firm's participation in international trade. Notably, by using microdata from income statements, we have a direct proxy for how exchange-rate volatility affects a firm; a single variable neatly picks up this effect.

First, from columns 1 and 3 we learn that firms that have experienced losses due to exchange-rate fluctuations ("Income due to ER variation < 0") are more prone to use derivatives in the next period. To facilitate interpretation, we separate our accounting variable in gains (positive) and losses (absolute value of a negative variable) realizations in columns 2 and 4 to 7. Notice that the reaction is asymmetric, as the effect is not significant if firms experienced gains ("Income due to ER variation > 0"), but instead losses from ER variation (which are positive in absolute value) increase the probability of using FX-derivatives.

Second, firms with a higher difference between FX liabilities and assets (which in our definition corresponds to higher balance-sheet mismatches) are more likely to rely on derivatives. This is true both when this difference is positive (the higher the FX liabilities relative to assets—i.e., larger absolute value of balance-sheet mismatches when positive—, the more likely is the use of derivatives) and when it is negative (the higher the FX assets relative to liabilities—i.e., a larger absolute value of balance-sheet mismatches when negative—, the less likely is the use of derivatives).

Third, the previous result that firms making losses from ER variation are more likely to use derivatives depends on firms having positive currency mismatches. Indeed, columns 5 to 7 show that losses due to ER fluctuations are more likely to be associated with the use of FX derivatives if the currency mismatch is on the positive side (that is, more liabilities than assets denominated in FX currency). In particular, since table 1 shows the average marginal effects, and the standard deviation of losses due to ER variation is 1 percent of assets, then a one standard deviation higher losses when the balance-sheet currency mismatch is positive entails a 7 percent higher probability of using FX derivatives in the following period.

Table 1. Determinants of Participation in the FX-Derivatives Market

Dependent variable: dummy = 1 if firm uses FX derivatives (binary choice model: logit for panel data)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Income ER variation if >0, lag		-1.418		-2.060	-1.637	-1.579	-1.602
		(2.682)		(2.576)	(2.595)	(2.569)	(2.593)
abs(Income ER variation if <0), lag		6.319**		4.022			
		(3.083)		(3.058)			
Income ER variation lag	-3.629**		-3.053*				
	(1.742)		(1.665)				
Balance sheet mismatch			0.725***				
			(0.135)				
abs(Balance sheet mismatch if <0), lag				0.843***	0.790***	0.774***	0.792***
				(0.201)	(0.207)	(0.205)	(0.208)
Balance sheet mismatch if >0, lag				-0.562**	-0.535**	-0.532**	-0.532**
				(0.222)	(0.220)	(0.219)	(0.219)
abs(Income ER variation if <0) * 1(mismatch > 0)					7.504*	7.343*	7.686*
					(4.459)	(4.417)	(4.467)
abs(Income ER variation if <0) * 1(mismatch < 0)					1.164	1.365	1.146
					(4.120)	(4.070)	(4.127)
Flag A importer/exporter						0.0725	
						(0.0722)	
Flag B importer/exporter							-0.0519
							(0.0612)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,181	2,181	2,181	2,181	2,181	2,181	2,181

Source: Authors' research.
Notes: Average maginal effects reported. The variable "Income due to ER variation" corresponds to the account with the same name in the Income Statement for each firm, and does not include income/loss due to inflation. Flag A (Flag B) defines whether a firm is an importer/exporter if its import/exports represent more than 10% (5%) of total sales (assets). Includes firm fixed effects in all specifications.
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

This evidence speaks to the idea that firms adapt to the financial conditions they face. We have already established that the enhanced financial development and more availability of funds and investment opportunities facilitated the access of firms with positive (negative) mismatches to alternative sources of funding (projects). The evidence presented here complements this analysis by establishing that firms with skin in the game that lost money with greater ER volatility are more likely to hedge.

Table 2 shows the results of a panel regression exercise investigating the net position (as opposed to the probability as in table 1) of the use of FX derivates by firms, hence conditional on using such derivatives. In other words, it considers the same independent variables as in the logit regression of table 1, but the dependent variable is the end-of-quarter net derivative position (in absolute value) for each firm, which tries to capture the intensive margin use of derivatives.

First, from columns 3 to 7, we see that the extent of the use of FX derivatives is mostly associated with the size of currency mismatch in its balance sheet, independently of the sign of the mismatch. In other words, firms with larger absolute values of mismatches engage in larger amounts of derivative contracts (captured in rows 4 and 5 in columns 3 to 7). In terms of the effect, the NDP is about 2 percent higher if the firm incurs a one standard deviation increase in the absolute value of the balance-sheet currency mismatch (columns 4 to 7).

In addition, we also find evidence that losses from ER variation in the presence of a positive currency mismatch also affect the amount of NDP (table 2 columns 4 to 7) and not just whether firms engage in derivatives (as from table 1): in terms of the effect, the NDP is about 2.3 percent higher if the firm incurs a one standard deviation loss due to ER variation when balance-sheet currency mismatch is positive (row 7, columns 4 to 7).

Table 2. Participation in FX-Derivatives Market (Intensive Margin)

Dependent variable: absolute value of net derivative position (% assets) (panel data model)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Income ER variation, lag	0.0526						
	(0.531)						
Income ER variation if >0, lag		1.153	0.948	0.892	0.918	0.917	0.869
		(1.054)	(1.041)	(1.037)	(1.040)	(1.038)	(0.988)
abs (Income ER variation if <0), lag		0.895	0,403	0.396			
		(1.020)	(1.030)	(1.030)			
Balance sheet mismatch > 0			0.188***	0.168***	0.183***	0.183***	0.186***
			-0,0504	(0.0519)	(0.0523)	(0.0524)	(0.0520)
abs (Balance sheet mismatch, if < 0)				0.244***	0.229***	0.229***	0.227***
				(0.0866)	(0.0834)	(0.0833)	(0.0836)
abs (Income ER variation if < 0) * 1 (mismatch > 0)					2.302*	2.302*	2.197*
					(1.170)	(1.170)	(1.119)
abs (Income ER variation if < 0) * 1 (mismatch < 0)					-0.713	-0.712	-0.918
					(1.394)	(1.394)	(1.181)
Flag A importer/exporter						-0.000579	
						(0.00768)	
Flag B importer/exporter							-0.0289
							(0.0273)

Table 2. Participation in FX-Derivatives Market (Intensive Margin) (continued)

	Dependent variable: absolute value of net derivative position (% assets) (panel data model)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	0.0671***	0.0635***	0.0331***	0.0414***	0.0410***	0.0412***	0.0550***
	(0.000308)	(0.00312)	-0.00892	(0.00695)	(0.00690)	(0.00712)	(0.0133)
Observations	1,116	1,116	1,116	1,116	1,116	1,116	1,116
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of firms	116	116	116	116	116	116	116
R^2	0.590	0.591	0.610	0.610	0.613	0.613	0.617

Source: Authors' research.

Notes: The variable "Income due to ER change" corresponds to the account with the same name in the Income Statement for each firm, and does not include income/loss due to inflation. Any variable followed by <0(>0) is the same continous varible truncated at zero, and not an indicator variable. Indicator (dummy) variables are expressed by 1(true expression) notation. Flag A (Flag B) defines whether a firm is an importer/exporter if its import/exports represent more than 10% (5%) of total sales (assets). Standard errorrs are clustered at firm level.

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 3. Adjustment of Currency Mismatch

Dependent variable: absolute value of net derivative position (% assets) (panel data model)						
	(1)	(2)	(3)	(4)	(5)	(6)
Mismatch, delta lag	0.321**	0.321**	0.323**	0.301**	0.301**	0.301**
	(0.133)	(0.133)	(0.133)	(0.130)	(0.130)	(0.130)
Income ER variation, lag	-0.349*	-0.349*				
	(0.211)	(0.211)				
Income ER variation if >0, lag			-0.295	-0.560	-0.557	-0.560
			(0.381)	(0.386)	(0.388)	(0.386)
Income ER variation if <0, lag			-0.926**			
			(0.455)			
(Income ER variation < 0) * 1(mismatch < 0)				2.023***	2.026***	2.023***
				(0.664)	(0.664)	(0.664)
(Income ER variation < 0) * 1(mismatch > 0)				-3.420***	-3.436***	-3.422***
				(0.747)	(0.756)	(0.749)
Flag A importer/exporter					0.00484	
					(0.00739)	
Flag B importer/exporter						0.000601
						(0.00288)
Constant	0.00953*	0.00953*	0.0100*	0.0109**	0.00984*	0.0107**
	(0.00514)	(0.00514)	(0.00521)	(0.00514)	(0.00541)	(0.00523)

Table 3. Adjustment of Currency Mismatch (continued)

	Dependent variable: absolute value of net derivative position (% assets) (panel data model)					
	(1)	(2)	(3)	(4)	(5)	(6)
Observations	4,961	4,961	4,961	4,961	4,961	4,961
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of firms	303	303	303	303	303	303
R^2	0.0306	0.0306	0.0291	0.0107	0.0106	0.0107

Source: Authors' research.
Notes: The variable "Income due to ER variation" corresponds to the account with the same name in the Income Statement for each firm, and does not include income/loss due to inflation. Flag A (Flag B) defines whether a firm is an importer/exporter if its import/exports represent more than 10% (5%) of total sales (assets). Standard errorrs are clustered at firm level.
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

2.1.4 Consistency between Regression Analysis on Derivatives and Mismatches

In table 3 we focus on the change in the balance-sheet mismatch and thus complement the previous descriptive analysis on the secular reduction in balance-sheet foreign-currency mismatches following the adoption of a floating exchange-rate regime. The dependent variable in our panel regression exercise is the change in the balance-sheet currency mismatch (scaled by total assets). The independent variables are the same as those used in tables 1 and 2, notably the account in the income statement measuring profits/losses directly linked to balance-sheet foreign-currency mismatch and ER fluctuations

Not surprisingly, in line with the previous results, we find that negative profits directly linked to currency mismatches result in the reduction of these mismatches in the following period as revealed by column 3: indeed, losses from exchange rates corresponding to a rise in the variable "abs (Income ER variation<0)" entail a reduction in currency mismatches. Put differently, with further losses due to currency mismatches, firms are likely to reduce mismatches. As before, there is no evidence that positive profits motivate an increase in currency mismatches. In columns 4 to 6, we examine whether the relation between ER losses and reduction of mismatches depends on the sign of the mismatches (by interacting of losses from ER variation and dummies that take a value of one if the initial level of currency mismatch was positive or negative): irrespective of whether the balance-sheet mismatch is positive or negative, ER losses are associated with the reduction of the absolute value of the balance-sheet mismatch in the following period, i.e., bringing the mismatches towards zero. These results are consistent with the evidence sketched in figure 3 and are also consistent with the idea of a learning process of firms to a new environment of higher ER fluctuations.

2.2 Evolution of the Exchange-Rate Passthrough over Time

A second burden to overcome in order to float with comfort is the difficulty of meeting inflation targets when confronted with wide fluctuations in the value of the currency. In Chile, the definition of the inflation goal as an *inflation forecast targeting*—based on a convergence of projected inflation towards 3 percent over the two-year policy horizon—provides the first key ingredient that facilitates the handling of temporary ER fluctuations. Of course, achieving the inflation forecast goal is easier if the degree of ERPT to domestic prices is low/moderate. Naturally, and as stated in the various papers cited in the introduction document, ERPT is not exogenous, with credibility in the institutional and monetary framework playing an important role in its moderation. This section begins with a brief review of the evolution of both the link between monetary-policy credibility and ERPT and some key institutional quality proxies for Chile. Following a large literature, it then documents a further reduction of the degree of ERPT over time for Chile.

2.2.1 ERPT and Credibility

Institutional settings and the credibility of policy frameworks play a key role in determining the effectiveness of macroeconomic policies, including the transmission of monetary policy and the exchange-rate passthrough.[30] In this context, countries with a more credible monetary-policy record would typically have lower ERPT to consumer prices. For instance, in a recent paper, Arias and Kirchner (2019) estimate a large scale DSGE model for Chile, relaxing the assumption of rational expectations by assuming agents learn about the underlying structural parameters of the economy by observing actual inflation. In their setting, agents place a larger weight on recent inflation forecast errors when making forecasts, to the extent that errors have accumulated in one particular direction—a notion closely related to the concept of expectations becoming unanchored.[31] Intuitively, when expectations become more reactive to inflation surprises, a given fluctuation in the exchange rate will tend to have a larger impact on inflation, as firms and workers reshape their expectations about future inflation and adjust pricing decisions accordingly.

Figure 8 reproduces the ERPT—defined as the cumulative effect on total CPI divided by the cumulative response of the nominal exchange rate—that arises from the two main exogenous shocks that drive the lion's share of nominal exchange-rate variation in Arias and Kirchner (2019): a shock to imported prices in panel a) and a shock

30. See Carrière-Swallow and others (2016), Edwards (2006), and Mishkin and Schmidt-Hebbel (2007).

31. See Bernanke (2007), and Carvalho and others (2017).

to the uncovered interest rate parity (UIP) relationship in panel b).[32] The figure confirms the qualitative intuition: in a situation when expectations are well anchored (for instance, when inflation forecast errors of agents have been unbiased), the impact on inflation of an exchange-rate depreciation is lower than when expectations are unanchored and agents become more reactive to inflation shocks in forming their forecasts. The difference is especially marked over the shorter run in the case of import prices, which is the shock that accounts for the largest share of the variability of the exchange rate in their model.

In light of this argument, it is crucial to notice that the anchoring of expectations, and hence of monetary-policy credibility, has been gradually improving over time in Chile. Panel a) of figure 9 shows that the inflation expectations' anchoring index, constructed by Bems and others (2018), has mainly followed an upward trajectory since the introduction of the fully floating regime in Chile. While Chile's score was close to the median of the set of EMEs in 1999, it has climbed to the top among EMEs over the last decade, suggesting continued gains in monetary-policy credibility.

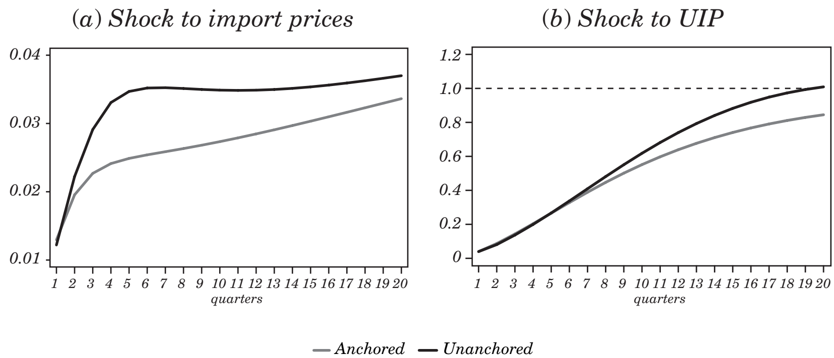
Naturally, the degree to which inflation expectations are anchored is intimately tied to the level of credibility about the ability and willingness of central banks to achieve their targets. In turn, this is related to the quality of institutions. Figure 9, panel b), suggests that Chile has been an outperformer among a set of comparator emerging markets in terms of regulatory quality for the last few decades, a proxy for the quality of institutions.[33] This finding suggests that Chile enjoys more favorable perceptions relative to other EMEs about the ability of public institutions to implement sound policies and regulations that would promote private sector development. Such perceptions are likely to reflect underlying institutional strengths that have helped foment economic activity in Chile over a prolonged period.

32. For more details, see Arias and Kirchner (2019). We thank the authors for kindly computing the impulse responses, which were not a part of the original publication.

33. The Regulatory Quality forms part of the World Bank's Worldwide Governance Indicators. The sample includes Argentina, Brazil, China, Colombia, Czech Republic, Hungary, Egypt, India, Indonesia, Iran, Malaysia, Mexico, Morocco, Nigeria, Pakistan, Peru, Philippines, Poland, Russia, South Africa, South Korea, Thailand, Turkey, Uruguay, and Vietnam.

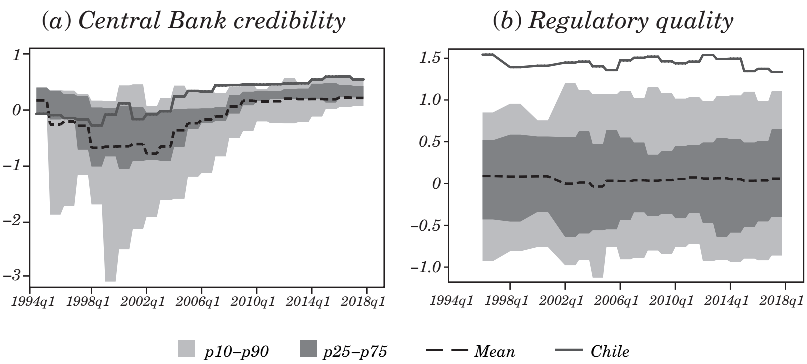
Overall, this section argues that an increasing central-bank credibility and anchoring of expectations, coupled with high quality institutional and regulatory environments, have favored, *ceteris paribus*, a low and declining ERPT in Chile.

Figure 8. Simulated ERPT under Alternative Inflation Expectations Regimes



Source: Simulations based on the model of Arias and Kirchner (2019).

Figure 9. Institutions and Credibility



Source: World Bank World Governance Indicators, and Bems and others (2018).
Note: Dark gray columns denote the 25th and 75th percentiles, light gray columns denote the 10th and 90th percentiles, and dark gray line denotes Chile.

2.2.2 Univariate Regressions

As a first approach to estimating ERPT, we focus on univariate OLS regressions of different measures of inflation on the change in the CLP/USD nominal exchange rate given by the following specification:

$$y_t = \alpha + \beta_0 x_t + \sum_{i=1}^{12} \beta_i x_{t-i} + \varepsilon_t \tag{1}$$

where y_t is the month-on-month (mom) percentage change in the CPI (or the alternative subcomponent of the CPI), x_t is the mom percentage change in the CLP/USD nominal exchange rate, x_{t-i} is the change in the exchange rate lagged by i months, and ε_t is the error term. All results are based on monthly data and month-on-month changes in the corresponding variables.

The pass-through is calculated as the sum of the coefficients $\beta_0 + \sum_{i=1}^{12} \beta_i$, which show the cumulative response of inflation to the contemporaneous and 12 lags changes in the nominal exchange rate. Table 4 shows the results for the complete sample (1982–2019) as well as for the pre- and post-flexibility samples. Figure 10 complements these results by plotting the sum of the coefficient based on a 72-month rolling window, for both CPI and core inflation (i.e., CPI excluding food and energy).[34] The estimated ERPT (contemporaneous plus 12 lags) has been larger in the pre-1999 period than in the post-1999 period. In addition, both of these coefficient sums are significant at the 1 percent significant level when tested through a joint F test, and they are also statistically different (in the simple sense that they are outside each other's confidence interval).

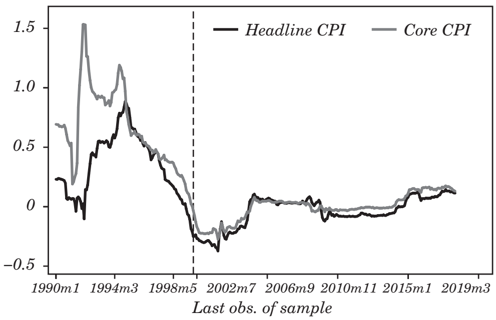
Table 4. ERPT in Univariate OLS Regressions

	Full sample (1982-2019)	*Pre-September 1999*	*Post-September 1999*
Sum of coefficients			
(conteporaneous plus 12 lags)	0.167	0.45	0.04
F-test statistic	31.73	26.57	7.03
P-value	0.000	0.000	0.009

Source: Authors' calculations.

34. Results based on alternative rolling windows ranging from 24 to 96 months are broadly consistent.

Figure 10. ERPT Rolling Coefficient Estimates for Headline and Core CPI



Source: Authors' calculations.
Note: Horizontal axis shows the last observation of a rolling-window subsample.

Figure 10 provides several observations about the ERPT to headline inflation. First, the ERPT was higher in the pre-floating period than in the period afterward. Second, it has already been on a steep downward path during the transition to the fully flexible regime and reached its lowest level around the official start of the fully flexible regime in September 1999.[35] Third, the ERPT increased somewhat over the free-floating period though always remaining below the pre-floating period levels. Figure 10 also presents the results from similar regressions for the core CPI inflation. As in the case of headline inflation, the ERPT was on a downward trend over the transition toward the freely floating exchange-rate regime and reached its lowest point around the official start of full floating in September 1999. However, the key difference is that ERPT is much more marked for the decline of core inflation, than for that of headline inflation.

2.2.3 Results from VAR Estimations

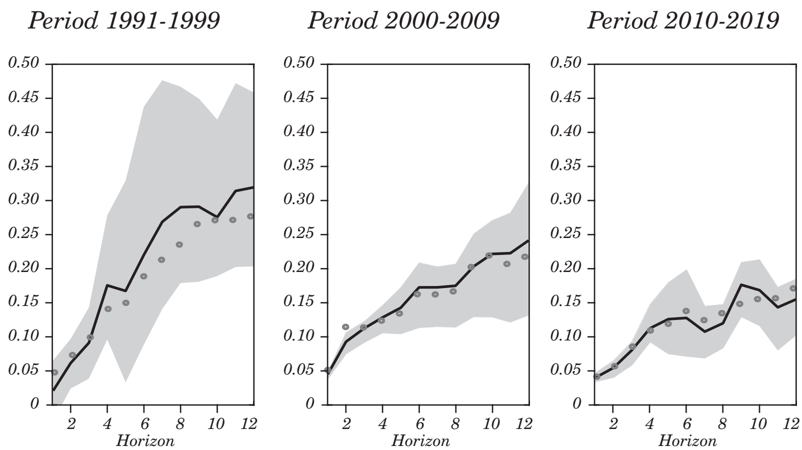
An alternative empirical approach to investigate the ERPT is through the estimation of VAR, which also helps address some possible concerns related to potential endogeneity of the variables included in the regressions in subsection 2.2.2.

35. The significant drop in ERPT to even negative values could be related to the economic downturn in this period.

Following a specification similar to that used in Albagli and others (2015), and Justel and Sansone (2016), the VAR comprises blocks of exogenous and endogenous variables. The exogenous block includes i) U.S. industrial production, ii) U.S. CPI, iii) Oil prices (WTI), iv) world food prices (FAO), and v) the fed funds rate. As an endogenous set of local variables, the VAR includes, in this order: i) real monthly GDP (Imacec), ii) the monetary-policy rate, iii) CLP/USD nominal exchange rate, and iv) CPI. Identification of structural errors follows a simple Cholesky decomposition. All variables are expressed in mom log differences, except the monetary-policy rates that are expressed in differences (and divided by 100).

The ERPT is calculated as the ratio of the cumulative response of inflation and the cumulative response of the NER change to an autonomous shock of the NER over twelve months. Figure 11 shows the results for Chile's ERPT for three subsamples: i) the pre-floating period (1991–1999); ii) the period between the beginning of the freely floating regime and the subprime crisis (2000–2009), and for the last decade (2010–2019). In the figure plots, the dots show the estimated results for the actual subsample, while the solid lines and the shaded area show the median and interquartile range estimations that arise from a block-bootstrap exercise (5,000 replications) for each-subsample.

Figure 11. ERPT from VAR Regressions (Block trap)



Source: Authors' calculations using data from the Central Bank of Chile, FRED, FAO, and Bloomberg.
Note: VAR includes both exogenous and endogenous blocks, following Albagli and others (2015), and Justel and Sansone (2016). The dots show results for the actual subsamples; black lines and the gray area show the median and interquartile range estimations from 5,000 block-bootstrap replications.

The figure reveals that Chile's ERPT has dropped significantly and monotonically across the subsamples considered. Before the transition to free floating, the estimated ERPT at a 12month horizon is about 32 percent (using the bootstrap median). In the first decade afterwards, it drops to 24 percent and then reaches 15 percent in the last decade.[36]

2.2.4 The Rare Use of Foreign-Exchange Intervention

It can be argued that comfort in floating should imply that exchange-rate interventions (FXI) should be—if any at all—very infrequent. Indeed, this is the experience in Chile over the past two decades. With the adoption of the floating regime in 1999, the Central Bank of Chile has intervened in the USD spot market four times in two decades. The intervention episodes of 2001/2002 and 2019, during which the Central Bank sold reserves, were justified based on a comprehensive assessment that unusual circumstances—usually a crisis—had led to excessive bouts of exchange-rate volatility that could be harmful to the correct functioning of markets. The interventions in which the Central Bank bought U.S. dollars, in 2008 and 2011, were in turn motivated by the wish to accumulate reserves. Also, each time a plan was put in place, it was transparently communicated to the public and its reasoning explained in advance.

More specifically, in 2001, shortly after the Asian crisis and the formal adoption of the inflation-targeting scheme, the Chilean peso depreciated sharply in the aftermath of the Argentine crisis. The CBC sold U.S. dollars to limit the associated inflationary effects in a context in which weak economic activity made raising the interest rate not optimal.[37] In 2008, in an inflationary context with notable currency appreciation, the CBC engaged in a program of reserves accumulation of USD 8 billion, justified under the logic of strengthening the international liquidity position of the Chilean economy to confront a potential worsening of the international conditions. The program was interrupted by Lehman Brothers' collapse and did not complete its initial target.[38] The rationale for the 2011 program was based on the

36. Using a similar methodology, Justel and Sansone (2016) also find a reduction of ERPT for Chile.

37. See Claro and Soto (2013) for more details.

38. During the crisis, a comprehensive set of policies were adopted to help secure liquidity and normal functioning in the USD-denominated market, particularly through swaps. Calani and others (2011) provide the detailed list of instruments, dates, and amounts used by the CBC. Notably, the CBC did not engage in an outright intervention.

assessment that the level of international reserves (as a fraction of GDP) was low in comparison to similar economies and the appreciated currency facilitated reserves accumulation. Notably, both the 2008 and 2011 programs were based on pre-announced amounts and not on ER target levels. Finally, the 2019 ER intervention was announced after one of the sharpest depreciations of the Chilean peso, in the middle of a domestic political crisis. The CBC announced a calendar for selling USD 10 billion in the spot market and USD 10 billion in the forward market. On this occasion too, no specific exchange-rate target level was announced, but it was the view of the CBC Board that the exchange-rate volatility had reached excessive levels, thus impeding the normal functioning of the price formation process. If not addressed, such excessive volatility could distort the functioning of both financial markets and real economy. A more in-depth description of earlier intervention episodes and their motivation can be found in Vial (2019).

Finally, it can be argued that ER interventions do not necessarily have to be carried out by the Central Bank.[39] Instead, the government can—and effectively does—participate in the foreign-currency market by selling proceeds of newly issued sovereign debt and through the management of its sovereign wealth funds. The most notable wealth fund is the Economic and Social Stabilization Fund (FEES, for its acronym in Spanish). The largest fund withdrawal from FEES was in 2009 (around 9 billion), and the funds were used to finance the fiscal deficit, contribute to the Pension Reserve Fund (around 1 billion), and to inject capital to mining company Codelco (around 1 billion) and *Banco Estado* (around 0.5 billion). The Fiscal Responsibility Law (Law 20.208) ensures that withdrawals from FEES—hence, ER operations—by the Ministry of Finance are to be related to funding the fiscal deficit or prepayment of sovereign debt. However, the government does not withdraw funds from sovereign wealth funds to explicitly target the value of the ER, which could be considered as an ER intervention.

3. Macroeconomic Adjustment: a Tale of Two Crises

The two main economic crises faced by Chile in the last two decades serve as a natural laboratory for checking how the different exchange-rate regimes in operation affected the macroeconomic adjustment.

39. We thank Guillermo Calvo for this comment.

In this section, we show that the Chilean economy indeed responded quite differently to the Asian/Russian crisis of 97–98 and to the Global Financial Crisis roughly a decade later. Besides the different nature and size of the shocks endured, this is likely also a consequence of the changes in the policy framework that took place in between, which include not only the free-float of the currency but also the introduction of the cyclically adjusted fiscal balance rule in 2001. Overall, while the first episode indicates the fear of floating highlighted by Calvo and Reinhart (2002) quite clearly (interest rates were jacked up), the second episode summarizes the comfort with floating fairly neatly as well (interest rates were slashed, letting the exchange rate go).

3.1 Key Findings from the Crisis Episodes: Chile (1997–98 vs. 2008)

Figure 12 shows the behavior of several key economic and financial indicators around the time of eruption of these crisis episodes. The attack on the Thai baht in 1997Q3 is taken as the start of the Asian financial crisis, and the collapse of Lehman Brothers as the start of the Global Financial Crisis (note that it was the combination of the Asian and Russian crises that affected Chile in the first episode, but for ease of comparability across countries in the subsequent exercise, we maintain the origin of the shock as 1997Q3). The analysis covers a 30-quarter period (7½-year), from 10 quarters before the start of the crisis until 20 quarters afterward.

The findings presented in figure 12 suggest that the macroeconomic adjustment was generally better in the second episode relative to the first one, especially when considering the stronger external shock in the second crisis. In particular, the key findings from the analysis that compares the magnitude of exogenous shocks, policy responses, and Chile's macroeconomic performance in the two crisis episodes include the following:

3.1.1 Exogenous shocks

The exogenous adverse shock in the second crisis episode was considerably stronger than the exogenous shock in the first episode. First, the collapse in trading partners' real growth was much deeper in the second episode. Second, the decline in (non-FDI) capital inflows was much sharper in the second crisis episode. Third, the drop in real copper prices was also more profound in the second episode.

3.1.2 Policy responses

Interest rates show two very different trajectories: while they were hiked after the first crisis in order to defend the exchange rate showing the fear of floating, they were significantly slashed after the second crisis, letting the exchange rate assume its shock-absorbing role and stimulating the rebound of the economy. After several quarters, the strategy was reversed in the first crisis episode as well, when interest rates were eventually reduced.

The **fiscal deficit** widened more and faster in the second episode, thus reflecting the cyclically adjusted fiscal balance rule as well as the deviations from the rule purposed by the authorities following the eruption of the GFC. At least to some extent, the faster reaction of fiscal policy in this episode was made possible by the earlier introduction of the fully flexible exchange-rate policy, which reduced the concerns about the impact of fiscal expansion on the sustainability of the exchange-rate regime. In addition, the fiscal balance started improving faster and more markedly in the second episode, thus reflecting also the constraint imposed by the cyclically adjusted fiscal rule.

Both the nominal effective exchange rate (NEER) and the real effective exchange rate (REER) depreciated more and faster, and subsequently also recovered faster after the second crisis episode. While the movements of the NEER and REER reflected also movements in copper prices, the reaction of the NEER and REER preceded the changes in copper prices in the second episode.

3.1.3 Outcomes

Real GDP growth experienced a faster recovery after the second crisis despite the stronger shock, while the tight monetary policy associated with the fear of floating during the first episode contributed to the decline in growth via a contraction in private credit and hence real private investment.

The **unemployment rate** increased following both crisis episodes (though its upward trend started somewhat later in the first episode, in line with the later impact on real GDP growth). Nonetheless, despite a weaker shock, the unemployment rate registered a sharper increase after the first crisis and stayed considerably higher for several years afterwards, as compared to both the pre-crisis period and the second crisis episode. Conversely, the unemployment rate started declining quite quickly after the second crisis and dropped below pre-crisis levels within several quarters.

Inflation continued its downward trend after the first crisis, while it spiked before dropping sharply after the second crisis, thus reflecting in part the passthrough from the exchange-rate movements.

The **external current account deficit** widened sharply at the start of both crisis episodes but recovered considerably faster after the second crisis. Note that this improvement preceded the recovery of copper prices by several quarters, which suggests that other mechanisms beyond copper prices (like the floating exchange rate) were at play.

Movements of the current account balance reflect underlying changes in **real exports** and **real imports**. The milder drop in real exports growth, coupled with the fast switch away from imports, helps explain the faster recovery of the current account balance in the second crisis episode, which points also to an adjustment role of the exchange rate.

Real private credit growth experienced a protracted decline in the first episode, thus **contributing to the prolongation of the economic downturn**. After the eruption of the second crisis (also significantly affected by the global concerns about credit markets), the growth of real private credit experienced a fast decline, which was however followed by a V-shaped recovery with the implementation of monetary easing. Real private investment followed a growth pattern similar to the one of the GDP, but its level ended up recovering much less in the first episode.

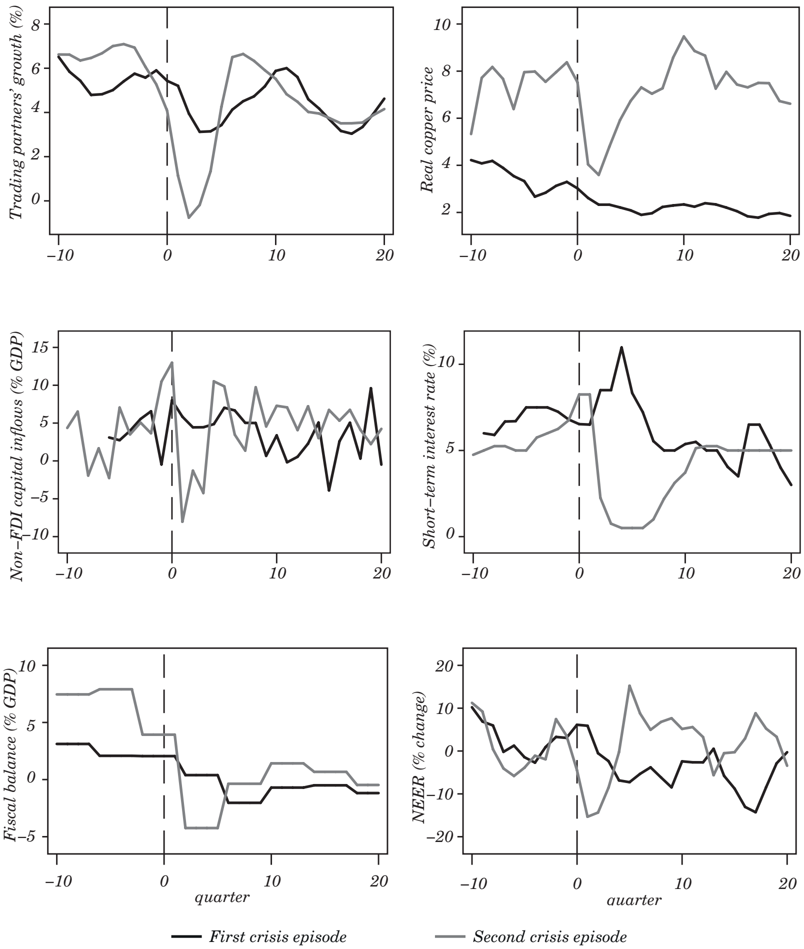
3.2 Comparing Chile with key EMEs over the Two Crisis Episodes

The previous section showed that Chile's macroeconomic adjustment was easier under the fully flexible exchange-rate regime in the aftermath of the Global Financial Crisis relative to the episode of the Asian/Russian crisis in the late 1990s. A complementary approach to looking at the performance of Chile is to compare the evolution of its macroeconomic and financial indicators with those of other EMEs over the same crisis episodes. The analysis encompasses 25 key EMEs that had good coverage for quarterly data for the set of indicators over the periods 1995q1–2000q1 and 2006q1–2011q1, respectively.[40]

40. The EMEs included in the analysis are Argentina, Brazil, China, Colombia, Czech Republic, Hungary, Egypt, India, Indonesia, Iran, Malaysia, Mexico, Morocco, Nigeria, Pakistan, Peru, Philippines, Poland, Russia, South Africa, South Korea, Thailand, Turkey, Uruguay, and Vietnam. While South Korea has been classified as an advanced economy in the meantime, it was considered as an EME for part of the period covered in the comparison.

Figure 12. Chile's Macroeconomic Performance in Two Crisis Episodes (1997–98 vs. 2008)

Panel A

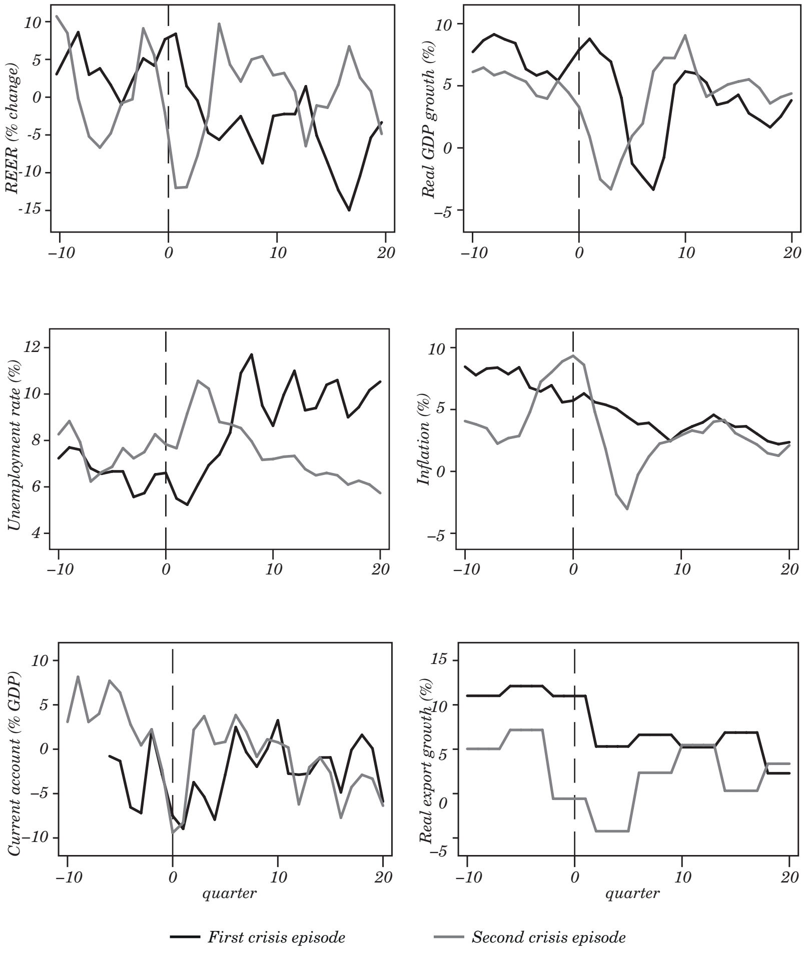


Sources: IMF World Economic Outlook database, International Financial Statistics, INS, Haver, Bloomberg, and authors' calculations.

Note: Black lines mark first crisis episode, and gray lines mark the second crisis episode. The vertical line marks the start of the crisis episodes.

Figure 12. Chile's Macroeconomic Performance in Two Crisis Episodes (1997–98 vs. 2008) (continued)

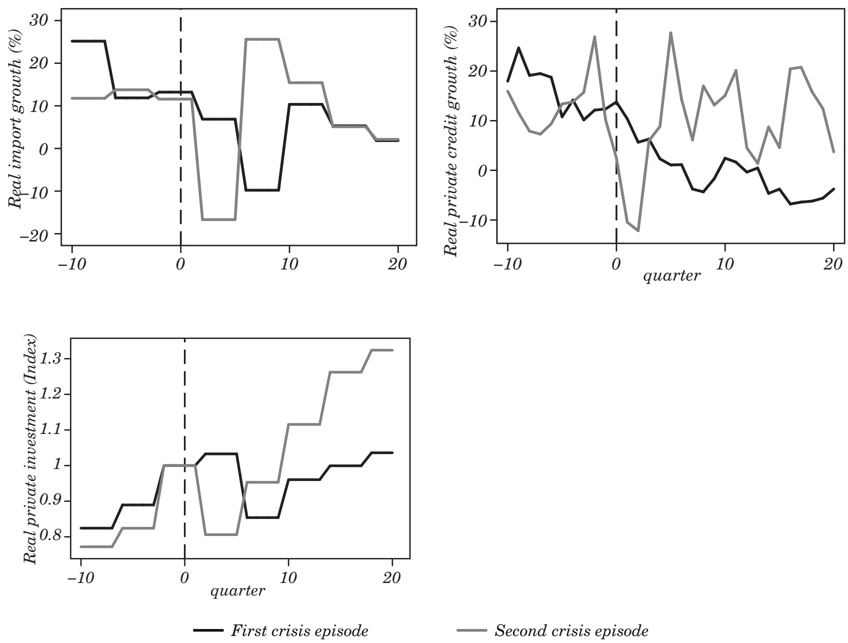
Panel B



Sources: IMF World Economic Outlook database, International Financial Statistics, INS, Haver, Bloomberg and authors' calculations.
Note: Black lines correspond to first crisis episode, and gray lines correspond to the second crisis episode. The vertical line marks the start of the crisis episodes.

Figure 12. Chile's Macroeconomic Performance in Two Crisis Episodes (1997–98 vs. 2008) (continued)

Panel C



Sources: IMF World Economic Outlook database, International Financial Statistics, INS, Haver, Bloomberg, and authors' calculations.
Note: Black lines mark first crisis episode, and gray lines correspond to the second crisis episode. The vertical line marks the start of the crisis episodes.

Figure 13 presents charts that compare the performance of Chile (black solid line) with the inter-quartile range (IQR) of EMEs (darker gray area) and the range between the 10th and the 90th percentile of EMEs (lighter gray area).

The findings in this figure suggest that, in general, Chile had one of the best comparative cross-country experience in both crisis episodes, though key differences in Chile's responses between the two crisis episodes documented earlier seem to remain. Some of the main findings are the following:

3.2.1 Exogenous shocks

The adverse exogenous shock, as measured by the decline in **trading partners' real GDP growth,** was substantially sharper in the second crisis episode for most countries. While trading partners' growth remained in the positive territory for 90 percent of the set of EMEs included in this analysis during the first crisis episode, it turned clearly negative for most EMEs during the second crisis episode. In addition, Chile was substantially more affected by the adverse financing shock during the second crisis episode, when non-FDI capital inflows rapidly turned negative, as compared to the first crisis episode, in which Chile was affected mildly (in contrast to other EMEs).

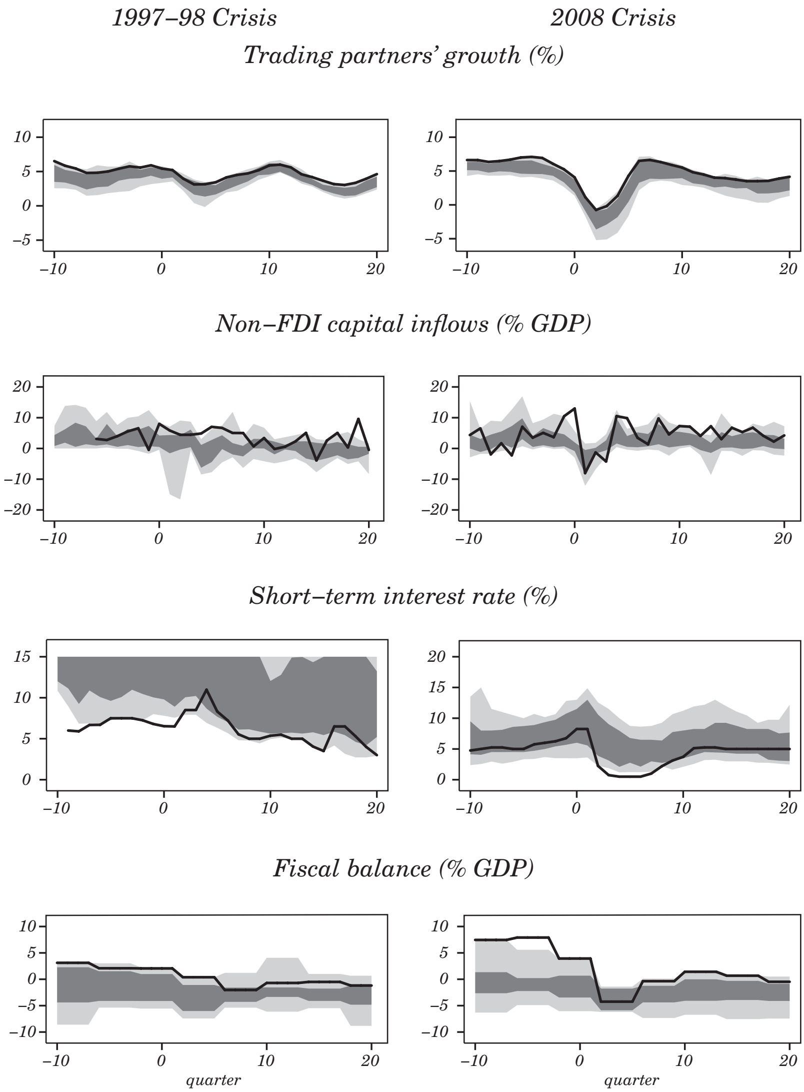
3.2.2 Policy responses

The **short-term interest rates** in Chile were at the bottom of the EMEs distribution at the onset of the first crisis but quickly rose to above the 25^{th} percentile, only to return at the bottom of the distribution after 2 years. (Note that the gray areas showing the top 10^{th} percentile are not in the chart in order to allow comparability of the vertical axis with the second episode, given the high nominal rates of some key outliers). By contrast, rates dropped from the IQR to below the 10^{th} percentile of EMEs in the second crisis and then gradually returned to the IQR.

The **fiscal balance** started at the top of the distribution and then deteriorated after both crises. However, the relative worsening of the fiscal balance was deeper in the second crisis, as much as its recovery towards the top of the distribution was also faster. As seen earlier, this finding provides further evidence about the relatively stronger countercyclical response in the more recent crisis, facilitated by both the cyclically adjusted fiscal balance rule as well as the floating exchange rate.

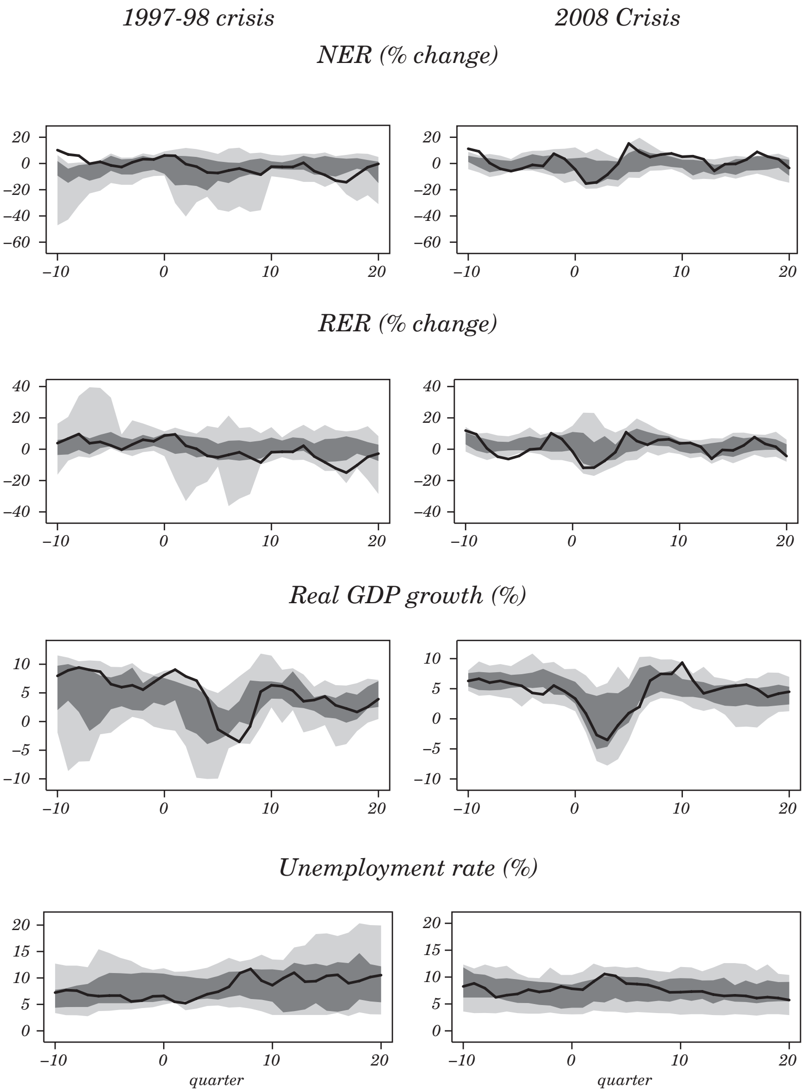
The **NEER and REER** were relatively stable and remained within the IQR of EMEs in the first crisis, while they dropped below the IQR immediately after the second crisis before rebounding above IQR within 5 quarters after the crisis. This suggested a much stronger exchange-rate fluctuation in Chile, as compared to other typical EMEs. Indeed, while the median country experienced a mild depreciation in both episodes, Chile depreciated by about 20 percent in the second episode, moving from the top to the bottom of the distribution in a few quarters, and the recovery was equally fast. This highlights the important role that the flexible exchange rate played in facilitating the macroeconomic adjustment of the Chilean economy following the Global Financial Crisis.

Figure 13. Chile vs. EMEs: Comparison of Response to Two Crisis Episodes



Sources: IMF World Economic Outlook database, International Financial Statistics, INS, Haver, Bloomberg, and authors' calculations.
Note: Dark gray areas denote the 25th and 75th percentiles, light gray areas denote the 10th and 90th percentiles, and black solid line denotes Chile. A value of zero in the horizontal axis marks the start of the crisis. The horizontal axis denotes the number of quarters before and after the start of the crisis.

Figure 13. Chile vs. EMEs: Comparison of Response to Two Crisis Episodes (continued)

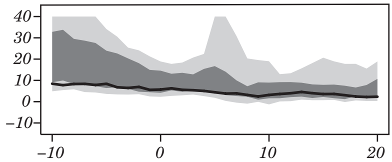


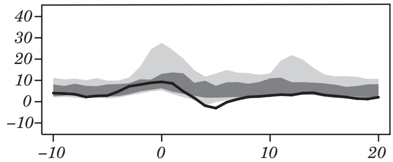
Sources: IMF World Economic Outlook database, International Financial Statistics, INS, Haver, Bloomberg, and authors' calculations.
Note: Dark gray areas denote the 25th and 75th percentiles, light gray areas denote the 10th and 90th percentiles, and black solid line denotes Chile. A value of zero in the horizontal axis marks the start of the crisis. The horizontal axis denotes the number of quarters before and after the start of the crisis.

Figure 13. Chile vs. EMEs: Comparison of Response to Two Crisis Episodes (continued)

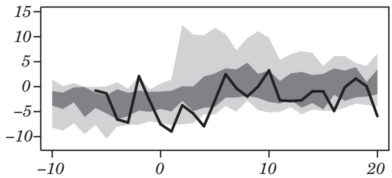
1997-98 crisis | *2008 Crisis*

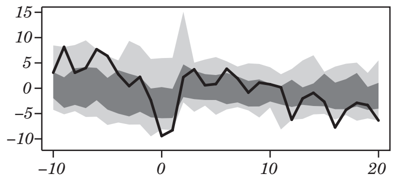
Inflation (%)



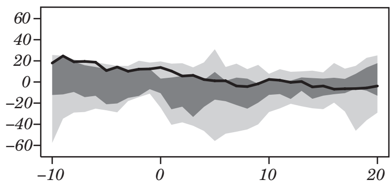


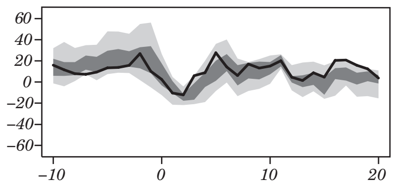
Current account (% GDP)



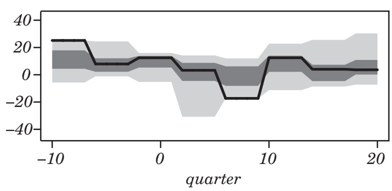


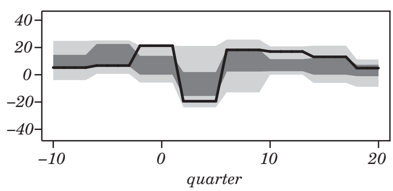
Real private credit growth (%)





Real private investment growth (%)





Sources: IMF World Economic Outlook database, International Financial Statistics, INS, Haver, Bloomberg, and authors' calculations.

Note: Dark gray areas denote the 25th and 75th percentiles, light gray areas denote the 10th and 90th percentiles, and black solid line denotes Chile. A value of zero in the horizontal axis marks the start of the crisis. The horizontal axis denotes the number of quarters before and after the start of the crisis.

3.2.3 Outcomes

Real GDP growth in Chile took some time to decline after the Asian crisis but then moved from one of the best of the distribution to the bottom of the distribution, partly owing to the interest-rate reaction due to the fear of floating, which exacerbated the growth decline. However, in the second crisis episode, GDP growth recovered faster and moved quickly towards the upper percentile range of the distribution.

The **unemployment rate** was initially relatively low in the first crisis though kept growing and reached the 75th percentile among EMEs about a year and a half following the eruption of the crisis. In the second crisis, the unemployment rate reached the 75th percentile of EMEs much faster (less than a year following its start) but also dropped faster to a lower position in the IQR of the distribution of EMEs.

The **current account balance** dropped below the 10th percentile in both crisis episodes but recovered much faster in the second episode. Indeed, while the current account balance oscillated closer to the bottom of the IQR for several quarters following the first crisis, it rebounded faster and remained around the upper bound of the IQR in the second crisis.

Inflation was among the lowest around the first crisis, largely because most EMEs suffered from protracted high inflation, while it was around the median and then dropped below the 10th percentile of EMEs in the second crisis.

As a reflection of the differential responses to the two crisis episodes, Chile's relative standing among EMEs in terms of **real private credit and investment growth** changed substantially following the two crises: it was close to the top of the IQR before the first crisis but gradually converged towards the bottom of the IQR afterwards. In contrast, credit growth was close to the bottom of the IQR before the second crisis but gradually moved toward the top of the IQR afterwards.

3.2.4 Comparison with Peru's experience

How does the performance of Chile's framework compare to Peru, a regional peer with many important economic similarities that followed an alternative multi-instrument inflation framework? While Chile has been following a fully flexible exchange-rate regime and using the monetary-policy rate as the primary policy instrument, Peru has been complementing such a standard approach with changes in reserve requirements and FX interventions. Recent analysis[41] finds that Peru's policy deviation from the standard approach was temporary and modest, and did not result in superior macroeconomic performance, as both frameworks performed similarly in terms of growth and inflation, and the associated volatilities. At the same time, time Peru's policy choice entailed the need for substantially higher reserves (especially as a ratio to GDP) while resulting in lower exchange-rate volatility.

3.3 Financial Adjustment under Free Floating: a Less Appreciated Tradeoff?

Another consequence of exchange-rate regime choice is the effect it may have on the response of asset prices to global financial shocks. As shown by Blanchard and others (2015), (sterilized) exchange-rate interventions dampen the exchange-rate effects of capital inflows in reaction to financial shocks but, in doing so, reinforce such inflows. Intuitively, in the absence of FXI, foreign capital inflows appreciate the currency of recipient countries, thereby reducing investors' expected returns as the likelihood of a future depreciation of the local currency *vis-à-vis* the U.S. dollar increases (a reversal of the initial appreciation). This market stabilization mechanism is less effective to the extent that central banks contain currency fluctuations through FXI. A similar argument holds for the second moment of returns, as central banks prone to intervention seem to be effective, at least in the short term, in diminishing currency volatility. [42] As documented by recent studies, this mechanism may end up rotating volatility from the exchange rate into domestic asset prices, such as long-term bonds and equities.[43]

This section provides new evidence on how Chile fares in terms of the responses of asset prices to global shocks. To do so, we compile daily data on nominal exchange rates (all expressed as local currency units per U.S. dollar, so an increase corresponds to an appreciation of the U.S. dollar), local 10-yr bond yields, and stock-market returns, for a sample of 10 advanced economies (AEs) and 10 EMEs.[44]

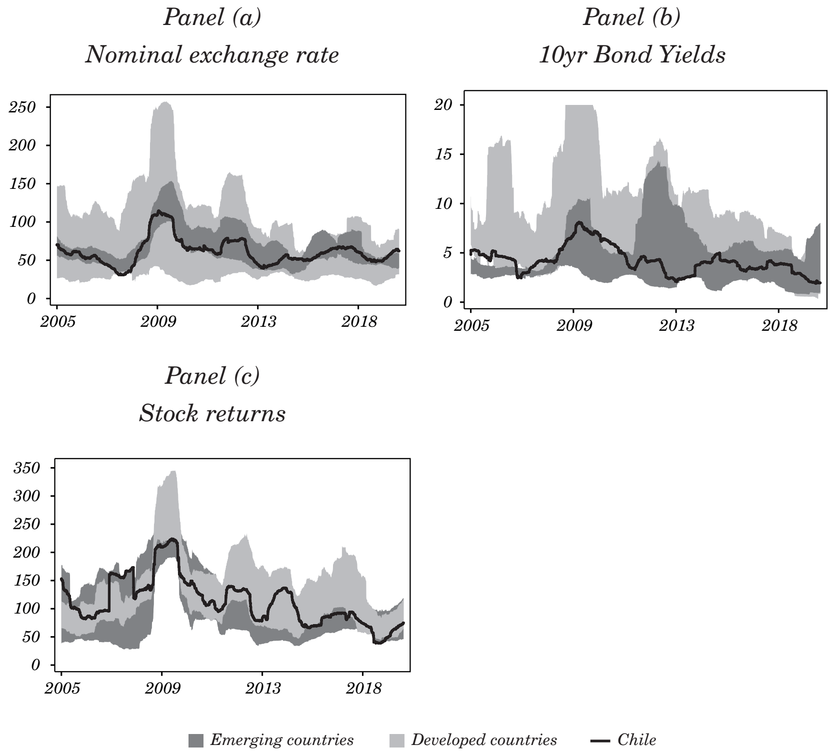
41. See International Monetary Fund (2020).

42. See Fratzscher and others (2019).

43. For recent empirical evidence, see Obstfeld and others (2019), and Albagli and others (2019).

44. The country classification as developed/emerging economy is based on the criteria followed by the IMF. Our sample of developed economies include Canada, France, Germany, Italy, Japan, Norway, Sweden, Switzerland, the Czech Republic, and the United Kingdom. Among emerging countries, we include Chile, Hungary, India, Indonesia, Israel, Mexico, Poland, South Africa, South Korea, Taiwan, and Thailand.

Figure 14. Volatility in Selected Asset Markets



Source: Authors' calculations using data from Bloomberg.
Note: Series plot the upper and lower envelopes of volatility for each country group. Volatility is defined as the 12-month rolling window of daily volatility of each series, defined as changes in basis points (so a drop in the stock market of 1% corresponds to 100 bp).

Figure 14 plots the relative position of the (12-month rolling window) daily volatility of these variables for Chile in relation to the distribution of both country groups (the EME sample in the figure excludes Chile; all variables in daily basis points). To summarize the relevant moments, the figure includes the upper and lower envelopes of each group of countries' volatilities. Panel a) shows NER volatility. Interestingly, the range of NER volatility among EMEs (light gray) contains that of AEs (dark gray). This probably reflects, on the one hand, the relatively high volatility of the countries in this group that either follow regimes closer to free floating and/or are subject to larger shocks; on the other hand, EMEs include several countries which intervene on a regular basis, thus diminishing their ER volatility. [45] Chile ranks about the middle of the range of both EMEs and AEs, over most of the sample.

Panel b) presents results that contrast those of Panel a). In particular, the volatility of long-term bonds in Chile usually ranks below the minimum volatility among EMEs—the most volatile group in this dimension—and much closer to the middle of the range of AEs.

Panel c) presents the corresponding moments for stock-market returns. Along this dimension, both groups exhibit comparable volatility levels, with Chile ranking at the lower part of the distribution.

As everyday volatility may reflect several factors, many of them idiosyncratic to each country, a regression analysis is implemented to better understand the responses of asset prices to global shocks. Table 5 presents panel regression results for the reaction of currencies, long-term bonds, and local stock-market indexes to U.S. monetary-policy shocks and uncertainty/risk sentiment shocks, run separately for each group of countries. With respect to the first shock, the analysis follows the definition adopted by Albagli and others (2019), which focuses on the change in 2-year U.S. treasuries around a two-day window bracketed around each FOMC meeting. Intuitively, at each meeting, the Fed may signal a change in policy direction and/or speed; the market perception following the meeting should, in turn, be reflected in the change in 2-year yields around the meeting.[46]

As visible in table 5 panel a), in the case of the NER (column 1), the elasticity to U.S. MP shocks is significant for both groups of countries. For instance, a positive one-standard-deviation shock (of about 8 bp) would lead to an appreciation of the U.S. dollar against the average AE currency in the full sample by about 50 bp, or half a percent. Notice that the effect is more marked in the second half of the sample (starting around the peak of the financial crisis, which represents a natural watermark for the start of unconventional MP.[47] The effect is about half for EMEs, depending on the particular sample. In the case of 10-yr domestic yields in column 2, the effect is similar for both country groups, with a coefficient between 0.32 (AEs) and 0.36 (EMEs). That is, the typical U.S. MP shock would move long-term yields by about 2.5 bps, although the effect is larger again in the latter sample

45. See table 12 in Albagli and others (2019) for a summary of papers detailing the currency regimes and intervention policies for the countries included in the sample.

46. Similar strategies are followed by Hanson and Stein (2015), and Gilchrist and others (2019).

47. See Gilchrist and others (2019).

period, especially for EMEs. The reaction of stock-market indexes to these shocks, in column 3, is somewhat more limited. For AEs, it is nonsignificant for the full sample (although positive, significant, but small for the later subsample). In the case of EMEs, it has a more intuitive negative coefficient, which is also significant for the full sample (for instance, the typical shock would lower stock indexes by 10 bp, or just over 0.1 percent, for the full sample).

Interestingly, the reaction of the NER in the case of Chile is similar to the EME group, but the response of 10-yr yields is lower. Indeed, column 4 computes the ratio of columns 1 and 2, showing that the relative response of the exchange rate is higher for Chile than for the EME group as a whole, especially in the post-2008 sample where the difference in terms of the elasticity of 10-year yields with respect to other EMEs seems particularly marked.

Panel b) of table 5 shows the analogous results for uncertainty/risk-sentiment shocks, defined as events when the daily change of the VIX (in absolute value) exceeds two standard deviations of the daily volatility of the index. The typical shock, as defined by these events (a change of 6.2 of the index value), implies a drop in AEs stock indexes of just over 2.7 percent (full sample), while its impact on long-term yields is a more modest 2 bps—not that different from the U.S. MP shock of the average FOMC meeting. Its negative sign suggests that, on average, bonds in AEs react as safe havens to uncertainty/risk-aversion spikes. For EMEs, the impact on stock markets is somewhat smaller —a drop of about 1.7 percent for the average episode considered— although its impact on bond yields is a larger, positive effect of about 5 bp evaluated at the average episode of the full sample. Clearly, as a whole, EMEs fixed-income securities are treated as risky asset classes around such events.

The case of Chile exhibits interesting differences around these events as well. On the one hand, the volatility of the exchange rate is particularly elevated—about 3 times as large as for the other country groups in the full sample. On the other hand, the effects on long-term yields are essentially nil, while the impact on stock markets is comparable to the other EMEs and smaller than AEs for all subsamples considered. Once again, column 5—the ratio between the effects on NER and stock returns—suggests that the burden of the adjustment is borne by the exchange rate, thus helping to cushion what would otherwise likely materialize as higher volatility of domestic asset prices.

Table 5. Global Financial Shocks and Domestic Asset Prices

(a) U.S. MP Shocks
Changes in 2-yr UST around FOMC meetings[1]

	NER	10-yr yields	Stocks returns	NER/10yr (x10)	NER/Stock
AEs	(1)	(2)	(3)	(4)=(1)/(2)	(5)=(1)/(3)
2000-2008	4.86***	0.26***	0.66	1.9	N.S.
2008-2018	9.51***	0.37***	3.04***	2.6	3.1
Full sample	6.62***	0.32***	0.84	2.1	N.S.
EMEs					
2000-2008	1.83***	0.20***	-0.52	0.9	N.S.
2008-2018	5.81***	0.47***	-2.67**	1.2	-2.2
Full sample	3.10***	0.36***	-1.34**	0.9	-2.3
Chile					
2000-2008	1.42	0.23	-2.54	N.S.	N.S.
2008-2018	4.76*	0.27*	-7.89**	1.8	-0.6
Full sample	2.64**	0.26**	-3.64**	1.0	-0.7

(b) Uncertainty/risk-sentiment shocks
Daily VIX changes (abs. Val.) >2 st. Dev.[2]

	NER	10-yr yields	Stocks returns	NER/10yr (x10)	NER/Stock
AEs	(1)	(2)	(3)	(4)=(1)/(2)	(5)=(1)/(3)
2000-2008	6.42***	-0.30***	-57.08***	-2.1	-0.1
2008-2018	4.00***	-0.31***	-41.95***	-1.3	-0.1
Full sample	3.97***	-0.34***	-43.96***	-1.2	-0.1
EMEs					
2000-2008	5.72***	1.21***	-36.40***	0.4	-0.2
2008-2018	5.03***	0.87***	-25.58***	0.6	-0.2
Full sample	4.60***	0.80***	-26.81***	0.6	-0.2
Chile					
2000-2008	13.57***	0.01	-35.64***	N.S.	-0.4
2008-2018	12.30***	-0.12	-26.28***	N.S.	-0.5
Full sample	11.90***	-0.14	-27.56***	N.S.	-0.4

Source: Authors' research.
(1) U.S. MP shock: change in 2-yr treasury yields (in bps) between the closing of the day after and the closing of the day before, the FOMC decision and press release. The change in all financial variables (also in bps) are measured in the corresponding two-day window. St. dev. U.S. MP shock: 7.8 bp (full sample).
(2) Uncertainty/risk-sentiment shock: change in the level of VIX, around a two-day window between the closing of the day after and the closing of the day before, a volatility spike event. Such event is defined as a daily change exceeding (in absolute value) two st. dev. of daily volatility. St. dev. of VIX (daily): 1.32 (full sample). St. dev. during volatility spike events: 6.2 (full sample).

While there may be other forces and channels at work, the evidence presented in this section is consistent with the empirical predictions highlighted in the papers discussed above. Namely, that a freely floating regime should rotate volatility away from domestic asset prices and towards the local currency, and that, by following a virtually clean floating regime for most of the last twenty years, Chile has chosen (deliberately or otherwise) a clear position regarding such tradeoff.

Of course, a note of caution is in order in terms of a more structural determination behind these results. In particular, asset markets differ in terms of liquidity and foreign-investor participation. Also, and especially in the case of Chile, pension funds may play a relevant role in cushioning the impact on domestic asset prices by providing liquidity when nonresidents rush to sell securities.[48] These and other related issues warrant further study.

4. Conclusion

This paper provides an overview of the evolution of the Chilean economy in the twenty years following the transition towards a free-floating regime. Specifically, it describes how Chile has dealt with the two main burdens that have traditionally deterred other EMEs in adopting clean floating regimes, namely, financial and price stability. It also provides evidence about the benefits of both macroeconomic and financial adjustment to shocks that result from such an exchange-rate regime. In doing so, the paper focuses on policymaking in normal times (not on tail scenarios such as the situation of late 2019 or Covid-19 in 2020).

Among the main results, we highlight the following. First, the exposure to currency risk in the nonfinancial firms' balance sheets has monotonically compressed towards very low current levels starting *after* the transition to free floating, while hedging markets have significantly developed in parallel. Second, the exchange-rate passthrough onto domestic prices has monotonically declined, in line with enhanced credibility of the monetary-policy regime. Third, the switch to a free-floating regime is associated with a better macroeconomic performance when comparing the last two severe external crises: the Asian/Russian crisis, during which Chile had a crawling peg, and the Global Financial Crisis, which was confronted

48. See Álvarez and others (2019).

after almost a decade of free floating. Fourth, exchange-rate flexibility also appears to play a role in containing the impact on domestic asset prices of global financial shocks, rotating volatility towards the currency.

It is important to place these results in the appropriate context, especially since currently there is heated debate over whether exchange-rate flexibility should be adopted only after countries have achieved certain macroeconomic conditions—such as credible institutions, strong policy frameworks, and/or developed financial markets—, or rather countries should first free-float, expecting macroeconomic conditions to improve endogenously. This is a big question, and one unlikely to be resolved by the experience of a single country. Our contribution to this debate is to show that Chile's experience in the last two decades suggests that the truth may lie somewhere in between. On the one hand, deep financial markets are important in enhancing domestic funding—providing an alternative to foreign-currency borrowing and thereby facilitating the reduction of currency mismatches—and allowing deeper FX hedging opportunities for firms, just as a credible inflation-targeting design is important in achieving a low exchange-rate passthrough. It is also important to note that financial-market deepening was supported by a growing pension-fund industry. On the other hand, the *endogeneity* of such conditions should not be overlooked: freely floating exchange rates will create incentives for the private sector to seek financing at home and/or to hedge FX exposure, thus contributing to the development of financial markets. At the same time, a commitment to a credible and clear free-floating regime will require the authorities to strengthen the quality of the monetary institutional framework, which will enhance its credibility.

Overall, the paper shows that the fear of floating can be overcome, to reach a fearless, clear, and credible freely floating regime, which can be conducive to a healthier adjustment to external shocks, while remaining consistent with an inflation *forecast* target at the appropriate horizon, thus facilitating the job of a Central Bank and contributing to its credibility.

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