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ABSTRACT

Central Bank Design*

What set of institutions can support the activity of a central bank? Designing a central bank requires specifying its objective function, including the bank's mandate at different horizons and the choice of banker(s), specifying the resource constraint that limits the resources that the central bank generates, the assets it holds, or the payments on its liabilities, and finally specifying how the central bank will communicate with private agents to affect the way they respond to policy choices. This paper summarizes the relevant economic literature that bears on these choices, leading to twelve principles on central bank design.

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1 Introduction

Starting from a blank page, how could one design the institutions of a central bank for the United States? This paper examines what the relevant economic literature and the experiences of the past reveal about this question, unencumbered by the history of how the Fed got to what it is today or by the short-term political constraints it faced. The perspective is akin to setting up a mechanism design problem, but falling well short of a specific formalization and rather discussing what its main ingredients might look like. The goal is to investigate the trade-offs associated with different choices and to identify areas where there are clear messages about optimal central bank design.¹

This question is not as outlandish as it may seem. As soon as the Iraq war ended in 2003, “the first major issue that Coalition economists confronted: What should be done with the Iraqi dinar?” (Foote et al., 2004, page 60) The economists involved stated that adopting a new central bank law in March 2004 was one of their first and most important economic accomplishments, and this is true in most transition countries as well. Even looking at developed countries, just 20 years ago, Europeans had to come up with an answer to this question after they signed the Maastricht Treaty (von Hagen, 1997). The Federal Reserve has also not been an institution set in stone; slowly, and with turns in different directions, its structure has been molded over 100 years into what it is today.² My goal here is not to describe these historical developments but rather to try to survey the economic literature on the trade-offs involved in designing a central bank for the United States.

Stripped to its core, a central bank is the sole institution in a country with the power to issue banknotes to the public and borrow from banks in the form of reserves that trade on par with currency. More broadly, the central bank can choose some policy instruments that

¹Romer and Romer (1997) and Blinder (2006) are important precursors.

²See Friedman and Schwartz (1963) for the classic account of the history of the Federal Reserve and Meltzer (2003, 2010a,b) for a more recent alternative.

it controls directly, as well as a set of announcements about its knowledge of the economy or future policy intentions. Designing the central bank then consists of specifying three objects. First is the *objective function*, which comes from somewhere or someone, and includes only a few macroeconomic variables, potentially at different horizons. Second, the central bank faces a *resource constraint*, limiting both its ability to distribute dividends as well as the set of policies that it can pursue. Third is the set of *equilibrium constraints* mapping policy actions and announcements into the simultaneous evolution of private agents' beliefs and macroeconomic outcomes. In Ramsey problems, these would be called the “implementability constraints”. Implicit in them is a notion of equilibrium, and because they depend on agents' beliefs, the commitments by the central bank or transparency about its future intentions have an effect on outcomes today. The following three sections discuss each of these ingredients in turn, before a short conclusion in section 5.

2 The central bank's goals

Choosing goals includes reflecting on who makes those choices, which macroeconomic variables are included and at what time horizon, and how to consider differing views.

2.1 The strictness of the central bank's mandate

A central bank is nothing but an agent of the government that serves society. Basic democratic principles would suggest that society would give the central bank a clear goal.

However, the mandate of many central banks is vague. In the United States, the 1977 Amendment to the Federal Reserve Act established as goals for the central bank: “maximum employment, stable prices and moderate long-term interest rates.” Few Fed governors spend much time at their job without giving at least one official speech where they state their interpretation of this mandate, since maximum employment does not mean that every able

man or woman must have a job, stable prices do not mean average measured inflation is exactly zero, and the third goal is often a consequence of the first two. The mere fact that the governors feel compelled to make their goals clear shows that they have a great deal of discretion in setting the yardsticks by which their own performance is measured.

An active literature has studied the benefits of giving the central bank more precise mandates. Some of the suggestions are to set an objective function that puts a higher weight on inflation relative to other components on social welfare, or that explicitly links the central banker's salary or chances of dismissal to numerical measures of performance (Rogoff, 1985; Walsh, 1995; Svensson, 1997). A well-established consensus argues for central banks to adopt a numerical inflation target, even if there is an active debate on what other goals could also be present and on the strictness and speed at which to reach the target (Bernanke and Mishkin, 1997; Woodford, 2012). Implementing each of these proposals requires that the mandate makes clear what are society's goals and gives some direction on how to weight each one relative to the others.

At the same time, questions about what the optimal inflation rate is, whether to target inflation or the price level, or how aggressively to adjust policy in response to unexpected changes in output, require more technical judgments than disputes on social value. Bureaucrats do not just implement policies, but also shape them, and the central bank may be more effective in technical tasks where ability to incorporate quickly-changing knowledge is more important than effort, and where redistribution is not the most important consideration (Alesina and Tabellini, 2007). If this is the case, some amount of discretion may achieve an outcome that is closer to fulfilling the overall mandate, even if there is a thin line separating the principles handed to the central bank, and the operational targets it sets for itself.

2.2 The choice of long-run goals

Whether across time, or across countries, there is a strikingly high correlation between the change in the monetary base, the nominal interest rate, and the change in the price level over a period of 30 years (e.g., Benati, 2009). As Milton Friedman famously put it, “inflation is always and everywhere a monetary phenomenon.” Since the central bank ultimately controls the amount of banknotes, bank reserves, and the interest rate they pay, and since it seems likely that long-run inflation imposes some social costs, it then follows that price stability is a natural long-run goal for a central bank. Indeed, this is true for all central banks that I am aware of, even though with remarkable frequency, policy gets focused on a succession of urgent short runs and prices end up drifting away, as perhaps happened in the 1970s in the United States (Goodfriend, 2007). Therefore, even if it is consensual, it is worth repeating that the central bank is the agency that is responsible for establishing a stable nominal anchor. This leaves open a series of other questions.

2.2.1 Prices, money or income as alternative nominal anchors

The balance of the current literature suggests that price-level targets bring about less volatile long-run inflation without necessarily higher short-run volatility of output, when compared with measures of either money or nominal income. Monetary aggregates suffer from the important pitfall that financial innovation invariably leads to large deviations between most broad measures of money and the price level. Moreover, while there are strong arguments for why price instability lowers welfare—for instance, because of the opportunity cost it imposes on holders of currency, or because of inefficient relative-price variability if prices are set infrequently—research has struggled to come up with arguments that are both persuasive and quantitatively large for why instability in monetary aggregates is costly per se, independent of price stability (Williamson and Wright, 2010; Woodford, 2010). As for nominal income, the data from outside the United States over the past century shows considerable uncertainty

on the long-run rate of economic growth. The central bank can do little about this rate, yet with a nominal income target, it would lead to an unstable price level.³

2.2.2 Inflation versus the price level

Under an inflation target, bygones are bygones: if inflation exceeds the target in one period, the price level stays higher forever. Instead, with price-level targets, higher-than-planned inflation must be followed by commensurately lower inflation to get back on the target. The literature has identified at least six, quite distinct, theoretical arguments for why price-level targets dominate inflation targets at reducing macroeconomic volatility. First, from the perspective of sticky prices, a price-level target has the virtue that forward-looking price setters will moderate how much they increase their prices following a positive shock today, since they may not be able to change their prices again for while, and the price-level target commits to lower prices into the future. Because they raise their prices by less, the deviation of inflation from target is lower to start with (Woodford, 2003). Second, since price-level targeting commits the central bank to undo any positive deviations of inflation from the announced target, it provides a stronger commitment against the temptation to surprise private agents with inflation and therefore reduces the classic inflation bias (Svensson, 1999; Clarida et al., 1999). Third, if as David Hume put forward, the cost of price variability is that it disrupts people's plans, which they only infrequently or imperfectly update, then it is undesirable to propagate these mistake forever by imparting a unit root into the price level. If the price level is to provide a standard of measurement, much like the meter or the foot, but policymakers cannot prevent deviations in the real counterpart of these units, then they can at least strive to make these deviations short lived (Hall, 1984; Ball et al., 2005). Fourth, with a stationary price level, there is a smaller benefit of indexing contracts to past inflation in order to keep up with past inflation, so prices become more flexible to react

³In the short run, a flexible price-level target that responds to the output gap with a coefficient α is equivalent to a nominal income rule with a coefficient $1 - \alpha$ on the output gap.

to non-monetary shocks (Amano et al., 2007). Fifth, since inflation targeting increases the variance of inflation at longer horizons, it raises the risk premium on nominal assets, raising the cost of capital in the economy (Meh et al., 2010). Sixth, and particularly relevant today, a price-level target is an effective way to guarantee that if a shock pushes the economy into low inflation and zero nominal interest rates, then the central bank automatically commits to higher future inflation escaping from the liquidity trap (Eggertsson and Woodford, 2003).

In spite of all of these theoretical virtues, price-level targets have only very rarely been adopted by actual central banks. One objection is that the central bank would have trouble communicating the ever-changing goal for the inflation rate that comes with a price-level target, to a public that is accustomed nowadays to focusing on 2% inflation every year. Yet, over the last fifty years, people shifted from being used to targets for monetary aggregates, the federal funds rate, and inflation, and in just a few years, they quickly adapted to more frequent speeches, policy announcements about bond purchases, and forward guidance about interest rates. Price-level targets do not seem like such a radical change, in comparison. Another objection is that if agents form expectations of future inflation adaptively as a function of past inflation, price-level targeting will increase instability (Ball, 1999). But this begs the question of why would agents, even if backward looking, use past inflation instead of the past price level to form their expectations in a world with a price-level target.

2.2.3 Measuring long-run inflation

Most measures of inflation are strongly correlated at low frequencies, but they can differ substantially over several years. Having to wait for more than a decade to go by makes it difficult to assess the central bank's performance. Moreover, even if a measure of the cost of living captures social welfare, its year-to-year variation is dominated by relative-price changes that are often due to structural changes that the central bank can do little about. Taking the long-run vertical Phillips curve for a guide, a feasible goal for the central bank

would be a measure of inflation that is by construction uncorrelated with output at low frequencies (Quah and Vahey, 1995). A theoretical ideal is a measure of “pure inflation” that filters out all relative-price movements and so measures only the changes in the unit of account that the central bank can affect (Reis and Watson, 2010).

2.2.4 A real long-run goal?

The almost consensual Friedman-Phelps concept of a long-run Phillips curve argues that the central bank cannot affect output or employment in the long run.⁴ Then, there is no point in asking it to have a long-run real target. Moreover, even if the central bank had one, if we do not understand reasonably well the specifics of the long-run tradeoff between prices and output, it may even be dangerous to have a real long-run target.

However, it is useful to remember that the empirical evidence for a zero association between the rate of inflation and the rate of economic growth and employment is quite weak. If inflation goes well into the two digits, the data seem to suggest that there is a negative association; for inflation below 10%, the confidence intervals are wide enough that the failure to reject the null hypothesis of no association should not be confused for evidence that the long-run Phillips curve is vertical.⁵

2.3 The potential role of additional short-term goals

There is compelling evidence, using multiple methods, time periods, and data sets, that monetary policy has a large and prolonged effect on real activity (Christiano et al., 1999; Romer and Romer, 2004b, among many others). Steering the economy using nominal interest rates is neither easy nor mechanical, and the debates over the strength and stability of the

⁴For recent theoretical arguments for why the long-run Phillips curve may instead be upward or downward sloping, see Berentsen et al. (2011) and Akerlof et al. (2000), respectively.

⁵See Bruno and Easterly (1998) for the long-run evidence, and Svensson (2013) for a recent empirical argument for a non-vertical Phillips curve in Sweden.

monetary transmission mechanism may at times seem endless (Boivin et al., 2010). Yet, the history of the Federal Reserve suggests that whenever the central bank neglected the effect of its actions on output and employment, the economy suffered (Romer and Romer, 2013). Since social welfare likely depends at least as much on people having a job and food on the table as it does on inflation, there is a strong argument for including some measure of real activity in the objective function of the central bank (Friedman, 2008).

However, this inclusion is only relevant if there is a trade-off between real activity and inflation that is structural and which the central bank can exploit, even if only imperfectly. Moreover, it must be that stabilizing inflation per se does not by itself guarantee that by “divine coincidence”, real activity will be stable as well (Blanchard and Galí, 2007). These issues are still hotly debated today, even if the current state of knowledge leans towards there being structural Phillips curve and a trade-off between price stability and real stability.⁶ Therefore, this research suggests a dual mandate, like the one for the Federal Reserve.

The weight to give to the two targets when they are in conflict is more open for discussion. At one extreme, the central bank can be quite patient at reversing increases in inflation, in order to minimize the potential resulting recession, so that the long-term goal of price stability is reached with a lag of several years. At the other extreme, price stability can receive primacy over economic growth and employment, as in the case of the ECB. Both are examples of flexible price-level targeting, where different societies may choose different extents to which the price level is allowed to deviate from target if there is an output gap, given different weights on the two goals and different opinions on the slope of the Phillips curve (Woodford, 2007; Svensson, 2010).

A more contentious debate is whether to have a tripartite mandate that also includes financial stability. After all, the two largest U.S. recessions in the last century were associated

⁶Mankiw and Reis (2010) offer a modern treatment of the theory behind the Phillips curve and Woodford (2010) of optimal stabilization policy.

with financial crises. As with the discussion on real targets, including financial stability as a separate goal must pass three tests. First, there must be a measurable definition of financial stability. Second, there has to be a convincing case that monetary policy can achieve the target of bringing about a more stable financial system. Third, financial stability must pose a trade-off with the other two goals, so there must be situations where prices and activity are stable but financial instability justifies a change in policy that potentially leads to a recession or causes inflation to exceed its target.

Older approaches to this question did not fulfill these three criteria. Before the Fed was founded, seasonal and random changes in the demand for currency and reserves led to wide fluctuations in interest rates and to occasional bank failures and panics. The Fed was in part founded to supply an “elastic currency”, that is to adjust the supply of high-powered money in order to accommodate these demand shocks. Yet, the volatility of interest rates in these cases almost always comes with volatile inflation and real activity, so it does not seem to merit separate consideration. Moreover, deposit insurance and financial regulation conducted outside of the central bank already address many of the stability concerns related to shifts in the demand for banknotes. Another approach to defining financial stability was in terms of large asset price movements. Yet, at most dates, there seems to be someone crying “bubble” at one financial market or another, and the central bank does not seem particularly well equipped to either spot out the real fires, or to steer equity prices (Blinder and Reis, 2005; Blinder, 2006).

A more promising modern approach is to define stability in terms of the build-up of leverage, the spread between borrowing and lending rates, or the fragility of the funding of financial intermediaries (e.g., Gertler and Kiyotaki, 2010; Cúrdia and Woodford, 2010; Adrian and Song Shin, 2010; Brunnermeier and Sannikov, forthcoming, among many others). This literature has also started gathering evidence that when the central bank changes interest rates, reserves, or the assets it buys, it has a significant effect on the composition of the

balance sheets of financial intermediaries as well as on the risks that they choose to take (Kashyap et al., 2011; Jimenez et al., 2012). Finally, in these models, even for fixed output and prices, changes in the funding structure of banks, in their net worth, or in their perception of tail risk, can create a misallocation of resources that significantly lowers welfare. While it is not quite there yet, this modern approach to financial stability promises to be able to deliver a concrete recommendation for a third mandate that can be quantified and implemented.

2.4 The choice of central banker(s)

Society can give a central bank a clear mandate, but eventually it must appoint individuals to execute it, who will always have some discretion. Choosing the central banker is a complementary way to pick an objective function for the central bank.⁷

Most countries do not pick a single person to have absolute power over the central bank, but prefer to have a committee of several people. The literature has put forward several virtues of having a committee, including the ability to pool information, the gains from having a diversity of views that must be argued for and against, the checks it provides against autocratic power, and the experimental evidence that committees make less volatile decisions (Blinder, 2004). For these potential virtues to be realized requires that the committee members have different perspectives, supported by independent staffs, while sharing a common framework to communicate effectively and to come to agreements.

With a committee making decisions, the objective function has to aggregate their separate preferences. There is a long literature on voting rules that have some desirable properties, and there is little specific to the FOMC (Vandenbussche, 2006). A more interesting question is who should have a vote in the committee, in order to elicit talent and bring together different information. One characteristic that is not part of an optimal arrangement in any

⁷Romer and Romer (2004a) show that different chairs of the FOMC chose very different policies, in spite of an unchanged mandate, mostly due to different views on the role and effects of monetary policy.

existing model is to have central bank governors differ by their place of birth. Related, but actually relevant, is whether to represent different regions in the FOMC.⁸ When it comes to representing regional business interests, there is some evidence that U.S. states share most of their risks (Asdrubali et al., 1996). Therefore, even if governors had only the consumption of people in their region in mind, this would justify focusing on eliminating aggregate risk, ignoring idiosyncratic regional shocks. The next question is whether regional governors bring additional information that originates from or pertains to their region. Looking at the forecast performance for key macroeconomic variables, the members of the FOMC seem to add little value to the forecast produced by the staff at the Board of Governors (Romer and Romer, 2008). Therefore, the case for having regional governors relies more strongly on promoting different perspectives and stimulating original thinking. Geographical distance and separate staffs and budgets may help to cultivate competition in the market for ideas in interpreting the data and arriving at policy proposals (Goodfriend, 1999).

Monetary policy not only responds to shocks, but can also be a source of aggregate risk that agents cannot insure against and that induces redistributions of wealth.⁹ In a representative democracy, different age cohorts or business sectors may legitimately ask to be represented when these decisions are made. There are two counter-arguments to this request. First, the literature has so far not been able to determine the systematic direction in which monetary policy redistributes wealth. There are few constituencies that are well known to be clearly hurt by the usual decision to raise interest rates. Second, fiscal policy is a more targeted tool when it comes to distributing resources. Even if redistribution is a side effect of monetary policy, other policies can undo its effects on the distribution of income, wealth or consumption.

⁸Of course the Fed needs to interact with and provide services to local communities. But the question is whether to have independent Reserve banks with autonomy and a say in monetary policy, as opposed to local offices of the central bank.

⁹See Bullard and Waller (2004) for some theory applied to central bank design, and Doepke and Schneider (2006), Berriel (2013) and Coibion et al. (2012) for evidence on redistribution.

3 The central bank's resources and policy tools

Like any other economic agent, central banks have limited real resources that constrain their policies (Reis, 2013b). We can divide these policies into three categories: interest-rate policy trying to control one or more interest rates, quantitative policy choosing the size of the Fed's liabilities and its dividends, and credit policy determining the composition of the assets of the central banks. Designing the central bank requires making sure that these actions all respect the resource constraint.

3.1 The role of the central bank as a dependable source of revenue

It is an old adage in monetary policy that the central bank should not monetize fiscal deficits. History teaches that the surest way to produce inflation is to finance government budgets by printing money. At the same time, these statements are not quite correct. All central banks issue reserves to buy government debt as part of their open-market operations. Printing money that pays for deficits is not a taboo, but rather the day-to-day workings of monetary policy. Moreover, when the interest paid on reserves is the same as the short-term return on government bonds, as it is today, then buying bonds with reserves is just exchanging one government liability for another, with likely no direct impact on inflation or anything else.

There is a clearer way to state this important wisdom. As part of its activities, the central bank will generate real resources, which have three properties. First, in present value, they come exclusively from the seignorage arising from money creation. That is, they arise because the central bank pays less-than-market interest on some of its liabilities in exchange for the service that they provide, and earns market interest rates on them (Reis, 2013b). Second, seignorage depends primarily on the level of inflation, and generating substantial revenue requires very high inflation (Hilscher et al., in progress). Third, if the central bank pays out its net income every period, then its budget constraint will be respected regardless of the

monetary policy that is chosen (Hall and Reis, 2013). Governments will always, under fiscal stress, be tempted to demand that the central bank generate more resources and transfer them to the Treasury. Given the three properties just described, these transfers: (i) come from seignorage, (ii) which requires higher inflation, and (iii) the central bank can feasibly do it. This suggests that to keep prices stable in the long run, the central bank design would allow it to not acquiesce to these fiscal demands.

This does not preclude considering the interaction between monetary and fiscal policy in determining inflation (e.g., Sims, 2013). It also does not imply that it is not optimal in some states of the world to generate fiscal revenues via inflation (Sims, 2001; Chari et al., 1991). It simply distinguishes between seignorage revenues, which are small and require high expected inflation, from the fiscal benefits from unexpected inflation by for instance lowering the value of public debt outstanding. This principle removes the first, but allows the latter.

3.2 The importance of fiscal backing for the central bank

In conventional times, the Federal Reserve mostly holds government bonds of short maturities and implements monetary policy by buying and selling them from banks in exchange for reserves (Friedman and Kuttner, 2010). Under this “old-style” central banking, the assets and liabilities of the Fed are close to riskless and they are matched in their maturity, so net income will almost always be positive (Hall and Reis, 2013).

If the central bank pays interest on reserves and, especially, if it holds other assets that create a risk-maturity mismatch with its liabilities, sometimes net income will be negative. Most central banks have a rule, more or less explicit, of handing over their positive net income to the Treasury, but if there is no transfer in the other direction when income is negative, then the budget constraint of the central bank will not hold (Hall and Reis, 2013). Something must give. One plausible consequence is that inflation rises above target so that seignorage is higher and net income does not become negative. Even if this event is rare,

expectations of higher inflation can set in even while net income is positive.

Preventing this outcome require giving fiscal backing to the central bank. One design principle that achieves this backing is to commit the Treasury to transfer resources to the central bank if net income is negative. An alternative is to allow the central bank to build a deferred account against the Treasury when net income is negative, which is then offset against future positive income. These require strict audits of the Fed's accounts, limits to the risks it can take, and an upper bound on this backing, all of which are not easy to specify.

A bolder measure that is simpler to implement would be to completely sever the resource link between the central bank and the Treasury. In that case, instead of sending its net income to the fiscal authority, the central bank would directly fund a public good or a public trust fund. As long as the use of funds does not require a stable stream of income, so that periods of negative net income and held-back dividends are not too disruptive, and if its direct recipients do not have the political power to try to extract more from the central bank, the problems raised above would be eliminated.¹⁰ Under this structure, the central bank would not need the Treasury to provide fiscal backing. The present value of seignorage would become the relevant constraint to cover possible losses and to restrain the risks the central bank takes.

3.3 The set of assets held by the central bank

Usually, the Fed only intervenes directly in the small Federal Funds market for overnight funds, where not even most banks are present. Yet the central bank wants to ultimately affect the spending, pricing and investment decisions of many, or all, economic agents in order to reach its macroeconomic goals. It must therefore rely on investors to, each individually, try to move resources across financial markets given the new federal funds rate, ultimately resulting in financial returns moving in all financial markets, both across types of risk and

¹⁰Funding basic research in the social sciences is a provocative candidate.

across maturities. Profit seeking will transmit monetary policy choices to the relevant interest rates for the agents' marginal decision as long as financial markets function reasonably well, understood as no-arbitrage pricing conditions holding across securities with risk and liquidity premia that are constant or predictable. As long as these conditions hold, even if the central bank could buy other assets, this would make no difference in the effects of policy (Wallace, 1981).

Between 2007 and 2009, the Fed more than doubled its liabilities acquiring a myriad of other assets that had different risks, maturities and counter-parties (Reis, 2009; Bernanke, 2012). While setting interest rates, and choosing or adjusting the size of its assets are necessarily part of monetary policy, credit policies that change the composition of the assets are more controversial (Goodfriend, 1994). In principle, they can be justified if financial markets no longer function well during a crisis from three complementary perspectives. First, if cuts in the interest rate in the Federal Funds market do not lower rates in other financial markets because investors are constrained in their ability to borrow to arbitrage changes. In this case, the monetary transmission mechanism is broken, and purchasing other assets is a way to bypass it. Second, if markets are all so illiquid that even the relatively small-scale purchases by central banks can significantly raise security prices and lower their yields (Krishnamurthy and Vissing-Jorgensen, 2011). And third, if the combination of illiquidity and limits to arbitrage suggests that relative prices of financial assets may be distorted leading to a misallocation of resources that the central bank may be able to correct. Therefore, a financial crisis gives a need, a means, and an ambition for the central bank to do more.

Nevertheless, there are many powerful objections to engaging in credit policies. A pressing one is the risk that the central bank realizes significant losses, which is greatly magnified with credit policies. Furthermore, if the markets are illiquid enough for the central bank's purchases to make a difference, they are potentially likewise illiquid enough for it to have trouble selling when it wants to without incurring large losses. Moreover, even when the

central bank lends against strong collateral to failed banks, it increases the potential losses that deposit insurance may have to bear (Goodfriend, 2011). It is also tempting for the central bank to become over-confident about its ability to detect and correct financial market mispricings, and jeopardize the focus on its macroeconomic objectives.

Another objection is precisely that credit policy, if it is effective, will necessarily affect the allocation of resources across financial markets. The central bank may find itself supporting the survival of some markets and firms that have become uncompetitive. Moreover, when economists detect inefficiencies in market prices, the common prescription is not to buy or sell the good to bring prices back in line, but rather to tax or subsidize it. Correcting market distortions is the domain of tax and regulatory policy, not of central banking.

A final objection is that aggressive credit policy exposes the central bank to legitimate political questions of why some firms, markets or securities were chosen for support and not others. While conventional buying and selling of government bonds does not clearly benefit one firm or sector, credit policies have clear redistributive effects. At the same time, they also expose the central bank to lobbying pressure from financial market participants. Both will likely get in the way of the central bank's goals (Reis, 2013a). A different type of pressure and temptation may come from within the central bank. Without a clear rule forbidding policy from bailing out systemic institutions, it will be ex post optimal to always do so to avoid a crisis, but this may create ex ante incentives for banks to become larger, take on more risk, and correlate their exposure to become systemic (Goodfriend, 1994; Stern and Feldman, 2004; Farhi and Tirole, 2012; Chari and Kehoe, 2013).

Given so many objections to credit policy, central bank design likely puts some restrictions on the assets that the central bank can buy. At one extreme, the policy could be the one that the Fed faced in 2007, of having to justify unconventional policies to Congress as being due to "unusual and exigent circumstances". At the other extreme, if we judge that there is too much of a temptation for the central bank to ex post always find a way to get around the rules,

then a “Treasury only” strict rule may be the answer (Goodfriend, 2011). Even in this case, the central bank would still be able to shift between short-term and long-term government bonds. These “quantitative easing” policies expose it to maturity risk—when policy becomes contractionary and markets start expecting an upward-sloping path for short-term interest rates, long-term bond prices will fall inducing capital losses on the Fed’s portfolio—but most empirical estimates of this risk come up with relatively small losses in worst-case scenarios that could easily be written off against a few future years of positive earnings (Hall and Reis, 2013; Carpenter et al., 2013; Greenlaw et al., 2013).

In between these two extremes, there are many plausible alternatives. One concrete restriction would be to prevent the central bank from taking part in ad hoc interventions targeted at specific institutions. The central bank would have to stick to a general policy that is applied uniformly at arms-length with the entire financial sector. This would prevent the Fed from being able to resolve a particular financial institution, as happened in the bailouts of Bear Stearns and AIG. A tighter restriction would require the central bank to only purchase securities for which there is a market price, with enough market participants that compete for the central bank’s funds. A stronger version of this rule would prevent the Federal Reserve from intervening in any over-the-counter financial markets. A weaker version could draw from the experience in industrial organization and require the central bank to run a reverse auction with even a small set of institutions designed to ensure that its purchases are allocated efficiently.

3.4 The payment of interest on reserves

Paying interest on reserves allows for quantitative policy to satisfy the liquidity needs of the economy: by choosing both the interest on reserves and the federal funds rate, the central bank can at the same time set the short-term interest rate that will determine inflation, as well as affect the amount of liquidity held in the banking sector (Kashyap and Stein, 2012).

Separately from its interest-rate policy, the Fed can have a large balance sheet, like today, if society wants to keep a larger share of their wealth in money-like investments, or the balance sheet can quickly shrink to the pre-crisis levels, all without consequences or dangers for the rate of inflation. Most central banks have the authority to pay interest on reserves, and the Fed joined them in October of 2008.

One could go one step further (Hall, 1986). The Friedman rule states that since the social marginal cost of producing an extra unit of reserves is zero, then economic efficiency requires that the private opportunity cost of holding these reserves is also zero. This robust principle has been re-affirmed repeatedly in a wide variety of models of the demand for money (Lucas, 2000; Chari and Kehoe, 1999; Lagos and Wright, 2005). Applied to reserves, the rule dictates the central bank to pay an interest rate on overnight reserves equal to the overnight federal funds rate, satiating the market with as many reserves as it wants. This “floor policy” would make the interest rate on reserves the primary instrument of monetary policy and, unlike the federal funds rate, it is perfectly set and controlled by the central bank (Goodfriend, 2002; Woodford, 2003). The literature makes a case for requiring the central bank to not just pay interest on reserves, but also to always follow the Friedman rule.

4 Transparency, commitments and accountability

Central bank announcements can be valuable to economic agents because of the information about the economy that they provide, and because they can justify current policy and reveal likely future policies. In some circumstances, like the liquidity trap, forward guidance about future policy is one of the few effective tools left for the central bank (Eggertsson and Woodford, 2003). Designing the central bank is in part choosing the rules of the game that it will play with private agents, which includes what the central bank will reveal, what it will commit to do, and how it will be held accountable to its promises and goals.

4.1 The importance of announcements and commitments

While many policymakers may be benevolent in their intentions, the history of government includes many mistakes and blunders because of incompetence, shortsightedness, hubris, false models, or bad ideas. Milton Friedman (1968) strongly argued that rules for monetary policy are an effective way to prevent mismanagement. The difficulty with most strict instrument rules, such as Friedman's proposal for a constant growth rate of the money supply, is that our understanding of economics is far from complete. Knowledge is still evolving quickly, our data is imperfect, and our theories have uncovered few policy-invariant relations. Therefore, any rule quickly becomes not slightly, but grossly, sub-optimal, and there is still a significant role for what, for lack of a better word, may be called judgment.

Yet, a remarkable result in economics shows that even if policymakers have the same goals and information as private agents, if they exercise their judgment to do what seems best, we may end up with clearly inferior outcomes (Kydland and Prescott, 1977). Even if ex ante the policymaker has no desire to mislead private agents, after they have made their choices, the policymaker's incentives change, and it may implement a different policy from the one that was announced. If agents anticipate this, society may end up worse off. Designing the central bank to tie the hands of policymakers along same dimensions may then improve welfare.

There is a long literature investigating different forms to implement this commitment.¹¹ One simple design principle is that if there is a temptation, for instance to generate excess inflation to maintain positive output gaps forever, then removing the temptation in the first place, if possible, eliminates the source of the time inconsistency (Blinder, 1999). One design that has been adopted all over the world with some success gives governors a long non-renewable term of office and limits the ability of politicians to remove them or exert

¹¹For complementary perspectives see Stokey (2003) and the accompanying discussions by Peter Ireland and Lars Svensson, or Alesina and Stella (2010).

pressure to temporarily lower unemployment to win elections (Crowe and Meade, 2007).

This does not make the deeper problem disappear: sometimes, it will be ex post socially optimal for inflation to be above what agents expect. Moreover, if this generates a temptation for the central bank to renege on previous commitments to private agents, it likewise generates a temptation for the government to dismiss a conservative central banker or to alter the terms of the contract it offered the banker. The literature has suggested that if the central bank makes a public commitment and cares about its reputation in keeping to this commitment, it may be able to bring about a favorable equilibrium (Barro and Gordon, 1983; Backus and Driffill, 1985). Several countries have done so by adopting targeting rules, and none has so far abandoned them. These rules have come under the form of inflation targeting, but it is not the particular target that is most important, rather the commitment by the central bank to announce its projections for the variables in its objective function as transparently as possible.¹² Publishing periodic inflation reports, like the Bank of England or the Norges Bank do, is a way for the central bank to justify its actions and commit to forecasts of its targets. Ex ante, agents can infer whether policy is sticking to its objectives or trying to mislead them. Ex post, they can compare outcomes with announcements and adjust their future actions and expectations to potentially punish policymakers that are perceived to be reneging on their commitment.

4.2 Choosing the extent of transparency

While it still does not publish an inflation report, the FOMC releases a statement and holds a press conference right after it makes decisions, and with varying but increasingly short delays, it makes available the votes, forecasts and arguments made by each governor,

¹²Chari and Kehoe (2006) associate the adoption of clear rules with addressing the time-inconsistency problem, Svensson (2003) explains targeting rules, Giannoni and Woodford (2010) provide a very general theoretical treatment, and Bernanke and Mishkin (1997) early on defined inflation targeting as a broad framework where communication and transparency are central.

releasing all transcripts after 5 years. How far can transparency go? Once it has been internally produced, revealing information has a cost that is close to zero on one side of the scale, and positive benefits on the other side of the scale arising from commitment, from improving public information about the economy, and from providing forward guidance about future monetary policy (Woodford, 2005; Blinder et al., 2008). Moreover, there is a *prima facie* argument for public institutions to be open in order to be democratically legitimate. The question can therefore be put backwards: is there any strong argument for the central bank to not reveal everything it knows?

It is arguably appropriate for the central bank to keep to itself the private information it receives from banks it regulates. It may also lead to a more productive internal discussion to not reveal every step of the deliberative process too soon after monetary policy decisions. But both of these points are minor exceptions to the general rule of openness, and there is as much risk of them being violated as there is of them being over-stretched.

Of greater concern is whether central bank announcements foster confusion rather than better understanding. A small literature uses models where agents have cognitive or informational limitations that can make them misinterpret public information. If the central bank reveals signals about the state variables that agents use to make decisions that are too noisy, or if it announces them too soon before they become relevant, or if it focuses on variables that are too far from the policy targets, then it is possible to lower the precision of private actions and achieve worst outcomes (Reis, 2011; Eusepi and Preston, 2010; Gaballo, 2013). Moreover, public signals may lead agents to collect less private information, making the price system less efficient and inducing an over-reaction of expectations to noisy public signals (Morris and Shin, 2002, 2005; Amador and Weill, 2010). But while the literature has developed theoretical arguments for why less information *may* raise welfare in a model, it has not convincingly shown that these effects are likely to be present (Roca, 2006), quantitatively important (Svensson, 2006), or empirically significant (Crowe, 2010) in reality.

Moreover, in these models, what is better than revealing less information is to optimize the form and timing of announcements. The work of national statistical agencies is subject to the same caveats and they respond by working harder at being informative and clear, not by embracing obscurantism.

4.3 Picking the channel(s) of communication

The Federal Reserve has a particular decentralized structure, with 7 governors in the center and 12 Federal Reserve Bank presidents as independent poles. Having these many actors in monetary policy poses challenges for making public announcements.

First, it makes it difficult to have model-based monetary policy. There is a model in Washington DC that is used to make staff forecasts, but the district presidents have no input into it, and in turn, each of them has his or her own model and set of predictions. It is hard to explain monetary policy decisions, and especially to announce and commit to future policy and targets, when there are so many decision-makers partially revealing their views and plans (Ehrmann and Fratzscher, 2007). Second, many voices raise the danger of confusing disagreement with uncertainty, in spite of the two being conceptually distinct and empirically only weakly related (Mankiw et al., 2004; Zarnowitz and Lambros, 1987). Third, it makes it harder for agents to coordinate on the public signals provided by policy. Some research has suggested that to aid coordination, the central bank could have fewer speeches, which are more precise and targeted at different groups in the population (Morris and Shin, 2007; Chahrour, 2013).

While none of these problems can be completely solved, all of them are ameliorated with more information, including requiring each governor to justify its views and report distributions with its forecasts. The literature offers few objections against giving the central bank a general mandate to be as transparent as possible, and leaving policymakers with some discretion on how to implement it.

4.4 The accountability of the central bank

Transparency is a, or perhaps *the*, way of achieving accountability. If the central bank is open about its objectives, its procedure, and its views of the future, that will go almost all the way towards being accountable in its missions to society as a whole (Blinder, 2004).

Hand in hand with accountability is political oversight. The 7 governors of the Federal Reserve are appointed by the President, confirmed by Senate, and periodically answer to Congress. Therefore, both the executive and legislative powers, and the public that elected them, are represented. The overlapping terms for the governors ensure that different waves of those holding political power have an influence, which research has suggested reduces the likelihood of the central bank becoming captured by partisan governors (Waller, 1989, 2000).

The regional structure of the Federal Reserve makes power more diffuse, so it is in principle harder for the central bank's actions to be taken over by one particular interest group (Friedman and Schwartz, 1963). The 12 presidents of the Reserve banks answer to a board of nine members, three appointed by the Board of Governors, three from the local community, and three from the banks in their district, but after the Dodd-Frank Act of 2010, banks no longer have a vote appointing the president. An interesting open question is whether banks should be singled out, either in terms of having three reserved seats in the board, or in terms of having no vote. The main consideration in making this choice is the role of the Fed in regulating banks.

5 Conclusion

This paper covered twelve principles in central bank design using multiple sections of the economics literature. Three issues were pervasive throughout. The first was central bank independence. While many have defended the virtues of central bank independence in general, looking at more specific questions led to a more mixed message. Even if there is a

case for central banks to independently conduct the operations of monetary policy, basic democratic principles would imply that society would still choose the goals. Committing to a stable long-run nominal anchor may reduce the costs of price uncertainty, but that is not the same as having a fanatic central banker committed to 2% inflation at all times, and research shows that a flexible price-level target may be able to lower the variance of inflation and real activity. In turn, releasing the central bank from the duty to raise seignorage to make transfers to fiscal authorities does not imply that the central bank can assume large risks through bold credit policies. Moreover, even if central bankers are appointed to long terms that are independent from political pressure in order to attenuate the problem of time inconsistency, this goal will only be accomplished if the policymakers are politically accountable and transparent.

The second topic was the level of decentralization of the central bank, and in particular of the Federal Reserve. There are reasons to be skeptical of the regional structure's ability to reconcile different business interests or to produce new information, and having so many voices raises difficulties for effective communication. At the same time, it makes different actors accountable and fosters the competition of ideas and perspectives. Whether there is a better structure to maximize advantages and minimize disadvantages is an open question.

The final topic was the use of unconventional policy. During a financial crisis, possibly including being stuck in a liquidity trap, the literature has put forward arguments that support price-level targets, forward guidance in setting interest rates, paying interest on reserves, allowing the Fed's balance sheet to grow, or changing the maturity of the Fed's holdings of government securities. Yet, there are strong objections to letting the Fed hold some types of assets, and with fiscal backing from the Treasury must come limits on the risk to the central bank's net income. More generally, institutional design rules that do not cover exceptional times are incomplete, and the analysis above suggested principles that apply during crises and normal times.

There are many other design issues that were not addressed, especially concerning financial regulation, a topic that is covered in another paper in this symposium and elsewhere (Gorton and Metrick, 2013; Blinder, 2010). The broader message of this paper is that designing a central bank is not just a worthwhile research question, but also one that can be answered *scientifically*. There is much research that can be brought to bear on the topic, so we need not resort to hunches, old aphorisms, or vague platitudes. Diverse tools and models, drawn from different branches of economics, can come together in informing this particular application of mechanism design.

References

- ADRIAN, T. AND H. SONG SHIN (2010): “Financial Intermediaries and Monetary Economics,” in *Handbook of Monetary Economics*, ed. by B. M. Friedman and M. Woodford, Elsevier, vol. 3 of *Handbook of Monetary Economics*, chap. 12, 601–650.
- AKERLOF, G. A., W. T. DICKENS, AND G. L. PERRY (2000): “Near-Rational Wage and Price Setting and the Long-Run Phillips Curve,” *Brookings Papers on Economic Activity*, 31, 1–60.
- ALESINA, A. AND A. STELLA (2010): “The Politics of Monetary Policy,” in *Handbook of Monetary Economics*, ed. by B. M. Friedman and M. Woodford, Elsevier, vol. 3 of *Handbook of Monetary Economics*, chap. 18, 1001–1054.
- ALESINA, A. AND G. TABELLINI (2007): “Bureaucrats or Politicians? Part I: A Single Policy Task,” *American Economic Review*, 97, 169–179.
- AMADOR, M. AND P.-O. WEILL (2010): “Learning from Prices: Public Communication and Welfare,” *Journal of Political Economy*, 118, 866 – 907.
- AMANO, R., S. AMBLER, AND P. IRELAND (2007): “Price-Level Targeting, Wage Indexation and Welfare,” Bank of Canada manuscript.
- ASDRUBALI, P., B. E. SORENSEN, AND O. YOSHA (1996): “Channels of Interstate Risk Sharing: United States 1963-1990,” *The Quarterly Journal of Economics*, 111, 1081–1110.
- BACKUS, D. AND J. DRIFFILL (1985): “Inflation and Reputation,” *American Economic Review*, 75, 530–38.
- BALL, L. (1999): “Efficient Rules for Monetary Policy,” *International Finance*, 2, 63–83.
- BALL, L., N. G. MANKIW, AND R. REIS (2005): “Monetary Policy for Inattentive Economies,” *Journal of Monetary Economics*, 52, 703–725.
- BARRO, R. J. AND D. B. GORDON (1983): “Rules, discretion and reputation in a model of monetary policy,” *Journal of Monetary Economics*, 12, 101–121.
- BENATI, L. (2009): “Long Run Evidence on Money Growth and Inflation,” European Central Bank Working Paper 1027.
- BERENTSEN, A., G. MENZIO, AND R. WRIGHT (2011): “Inflation and Unemployment in the Long Run,” *American Economic Review*, 101, 371–98.
- BERNANKE, B. S. (2012): “The Federal Reserve and the Financial Crisis,” Lectures delivered at George Washington University.
- BERNANKE, B. S. AND F. S. MISHKIN (1997): “Inflation Targeting: A New Framework for Monetary Policy?” *Journal of Economic Perspectives*, 11, 97–116.
- BERRIEL, T. C. (2013): “Nominal Portfolio Choice and the Redistribution Effects of Inflation Surprises,” FGV-EPGE Rio de Janeiro.
- BLANCHARD, O. AND J. GALÍ (2007): “Real Wage Rigidities and the New Keynesian Model,” *Journal of Money, Credit and Banking*, 39, 35–65.
- BLINDER, A. S. (1999): *Central Banking in Theory and Practice*, vol. 1 of *MIT Press Books*, The MIT Press.
- (2004): *The Quiet Revolution: Central Banking Goes Modern*, The Arthur M. Okun memorial lecture series, Yale University Press.
- (2006): “Monetary Policy Today: Sixteen Questions and about Twelve Answers,”

- Princeton University, Department of Economics, Center for Economic Policy Studies Working Paper 73.
- (2010): “How Central Should the Central Bank Be?” *Journal of Economic Literature*, 48, 123–133.
- BLINDER, A. S., M. EHRMANN, M. FRATZSCHER, J. D. HAAN, AND D.-J. JANSEN (2008): “Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence,” *Journal of Economic Literature*, 46, 910–45.
- BLINDER, A. S. AND R. REIS (2005): “Understanding the Greenspan standard,” in *The Greenspan Era: Lessons for the Future*, Jackson Hole Symposium: Federal Reserve Bank of Kansas City, 11–96.
- BOIVIN, J., M. T. KILEY, AND F. S. MISHKIN (2010): “How Has the Monetary Transmission Mechanism Evolved Over Time?” in *Handbook of Monetary Economics*, ed. by B. M. Friedman and M. Woodford, Elsevier, vol. 3 of *Handbook of Monetary Economics*, chap. 8, 369–422.
- BRUNNERMEIER, M. K. AND Y. SANNIKOV (forthcoming): “Redistributive Monetary Policy,” in *Jackson Hole Symposium*, Federal Reserve Bank of Kansas City.
- BRUNO, M. AND W. EASTERLY (1998): “Inflation Crises and Long-Run Growth,” *Journal of Monetary Economics*, 41, 3–26.
- BULLARD, J. AND C. J. WALLER (2004): “Central Bank Design in General Equilibrium,” *Journal of Money, Credit and Banking*, 36, 95–113.
- CARPENTER, S. B., J. E. IHRIG, E. C. KLEE, D. W. QUINN, AND A. H. BOOTE (2013): “The Federal Reserve’s Balance Sheet and Earnings: A Primer and Projections,” Finance and Economics Discussion Series 2013-03.
- CHAHROUR, R. (2013): “Public Communication and Information Acquisition,” Boston College manuscript.
- CHARI, V. V., L. J. CHRISTIANO, AND P. J. KEHOE (1991): “Optimal Fiscal and Monetary Policy: Some Recent Results,” *Journal of Money, Credit and Banking*, 23, 519–39.
- CHARI, V. V. AND P. J. KEHOE (1999): “Optimal Fiscal and Monetary Policy,” in *Handbook of Macroeconomics*, ed. by J. B. Taylor and M. Woodford, Elsevier, vol. 1, chap. 26, 1671–1745.
- (2006): “Modern Macroeconomics in Practice: How Theory Is Shaping Policy,” *Journal of Economic Perspectives*, 20, 3–28.
- (2013): “Bailouts, Time Inconsistency, and Optimal Regulation,” FRB Minneapolis Staff Report 481.
- CHRISTIANO, L. J., M. EICHENBAUM, AND C. L. EVANS (1999): “Monetary Policy Shocks: What Have We Learned and to What End?” in *Handbook of Macroeconomics*, ed. by J. B. Taylor and M. Woodford, Elsevier, vol. 1.
- CLARIDA, R., J. GALI, AND M. GERTLER (1999): “The Science of Monetary Policy: A New Keynesian Perspective,” *Journal of Economic Literature*, 37, 1661–1707.
- COIBION, O., Y. GORODNICHENKO, L. KUENG, AND J. SILVIA (2012): “Innocent Bystanders? Monetary Policy and Inequality in the U.S.” NBER Working Paper 18710.
- CROWE, C. (2010): “Testing the Transparency Benefits of Inflation Targeting: Evidence

- from Private Sector Forecasts,” *Journal of Monetary Economics*, 57, 226–232.
- CROWE, C. AND E. E. MEADE (2007): “The Evolution of Central Bank Governance around the World,” *Journal of Economic Perspectives*, 21, 69–90.
- CÚRDIA, V. AND M. WOODFORD (2010): “Credit Spreads and Monetary Policy,” *Journal of Money, Credit and Banking*, 42, 3–35.
- DOEPKE, M. AND M. SCHNEIDER (2006): “Inflation and the Redistribution of Nominal Wealth,” *Journal of Political Economy*, 114, 1069–1097.
- EGGERTSSON, G. B. AND M. WOODFORD (2003): “The Zero Bound on Interest Rates and Optimal Monetary Policy,” *Brookings Papers on Economic Activity*, 34, 139–235.
- EHRMANN, M. AND M. FRATZSCHER (2007): “Communication by Central Bank Committee Members: Different Strategies, Same Effectiveness?” *Journal of Money, Credit and Banking*, 39, 509–541.
- EUSEPI, S. AND B. PRESTON (2010): “Central Bank Communication and Expectations Stabilization,” *American Economic Journal: Macroeconomics*, 2, 235–71.
- FARHI, E. AND J. TIROLE (2012): “Collective Moral Hazard, Maturity Mismatch, and Systemic Bailouts,” *American Economic Review*, 102, 60–93.
- FOOTE, C., W. BLOCK, K. CRANE, AND S. GRAY (2004): “Economic Policy and Prospects in Iraq,” *Journal of Economic Perspectives*, 18, 47–70.
- FRIEDMAN, B. M. (2008): “What Objectives for Monetary Policy?” in *Central Banks as Economic Institutions*, ed. by Touffut, Cheltenham: Edward Elgar.
- FRIEDMAN, B. M. AND K. N. KUTTNER (2010): “Implementation of Monetary Policy: How Do Central Banks Set Interest Rates?” in *Handbook of Monetary Economics*, ed. by B. M. Friedman and M. Woodford, Elsevier, vol. 3 of *Handbook of Monetary Economics*, chap. 24, 1345–1438.
- FRIEDMAN, M. (1968): “The Role of Monetary Policy,” *American Economic Review*, 58, 1–17.
- FRIEDMAN, M. AND A. J. SCHWARTZ (1963): *A Monetary History of the United States, 1867-1960*, National Bureau of Economic Research, Inc.
- GABALLO, G. (2013): “Rational Inattention to News: The Perils of Forward Guidance,” Banque de France working paper 416.
- GERTLER, M. AND N. KIYOTAKI (2010): “Financial Intermediation and Credit Policy in Business Cycle Analysis,” in *Handbook of Monetary Economics*, ed. by B. M. Friedman and M. Woodford, Elsevier, vol. 3 of *Handbook of Monetary Economics*, chap. 11, 547–599.
- GIANNONI, M. P. AND M. WOODFORD (2010): “Optimal Target Criteria for Stabilization Policy,” NBER Working Paper 15757.
- GOODFRIEND, M. (1994): “Why We Need an Accord for Federal Reserve Credit Policy: A Note,” *Journal of Money, Credit and Banking*, 26, 572–80.
- (1999): “The Role of a Regional Bank in a System of Central Banks,” *Carnegie-Rochester Conference Series on Public Policy*, 51, 51–71.
- (2002): “Interest on Reserves and Monetary Policy,” *Federal Reserve Bank of New York Economic Policy Review*, 8, 77 – 84.
- (2007): “How the World Achieved Consensus on Monetary Policy,” *Journal of Eco-*

- nomics Perspectives*, 21, 47–68.
- (2011): “Central Banking in the Credit Turmoil: An Assessment of Federal Reserve Practice,” *Journal of Monetary Economics*, 58, 1–12.
- GORTON, G. AND A. METRICK (2013): “The Federal Reserve and Financial Regulation: The First Hundred Years,” Yale University and NBER.
- GREENLAW, D., J. D. HAMILTON, P. HOOPER, AND F. S. MISHKIN (2013): “Crunch Times: Fiscal Crises and the Role of Monetary Policy,” Columbia University and UC San Diego.
- HALL, R. E. (1984): “Monetary Strategy with an Elastic Price Standard,” in *Price Stability and Public Policy: A Symposium Sponsored by the Federal Reserve Bank of Kansas City*.
- (1986): “Optimal Monetary Institutions and Policy,” in *Alternative Monetary Regimes*, ed. by C. Campbell and W. Dougan, Baltimore: Johns Hopkins University Press, 224–239.
- HALL, R. E. AND R. REIS (2013): “Maintaining Central-Bank Solvency under New-Style Central Banking,” Hoover Institution, Stanford University, and Columbia University.
- HILSCHER, J., A. RAVIV, AND R. REIS (in progress): “Measuring the Market Value of Central Bank Capital,” Brandeis University and Columbia University.
- JIMENEZ, G., S. ONGENA, J.-L. PEYDRO, AND J. SAURINA (2012): “Credit Supply and Monetary Policy: Identifying the Bank Balance-Sheet Channel with Loan Applications,” *American Economic Review*, 102, 2301–26.
- KASHYAP, A. K., R. BERNER, AND C. A. E. GOODHART (2011): “The Macroprudential Toolkit,” *IMF Economic Review*, 59, 145–161.
- KASHYAP, A. K. AND J. C. STEIN (2012): “The Optimal Conduct of Monetary Policy with Interest on Reserves,” *American Economic Journal: Macroeconomics*, 4, 266–82.
- KRISHNAMURTHY, A. AND A. VISSING-JORGENSEN (2011): “The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy,” *Brookings Papers on Economic Activity*, 43, 215–287.
- KYDLAND, F. E. AND E. C. PRESCOTT (1977): “Rules Rather than Discretion: the Inconsistency of Optimal Plans,” *Journal of Political Economy*, 85, 473.
- LAGOS, R. AND R. WRIGHT (2005): “A Unified Framework for Monetary Theory and Policy Analysis,” *Journal of Political Economy*, 113, 463–484.
- LUCAS, R. E. (2000): “Inflation and Welfare,” *Econometrica*, 68, 247–274.
- MANKIW, N. G. AND R. REIS (2010): “Imperfect Information and Aggregate Supply,” in *Handbook of Monetary Economics*, ed. by B. Friedman and M. Woodford, Elsevier: North Holland, vol. 3A, chap. 5, 183–230.
- MANKIW, N. G., R. REIS, AND J. WOLFERS (2004): “Disagreement about Inflation Expectations,” *NBER Macroeconomics Annual*, 18, 209–248.
- MEH, C. A., J.-V. ROS-RULL, AND Y. TERAJIMA (2010): “Aggregate and welfare effects of redistribution of wealth under inflation and price-level targeting,” *Journal of Monetary Economics*, 57, 637–652.
- MELTZER, A. H. (2003): *A History of the Federal Reserve, Volume 1: 1913-1951*, University of Chicago Press.

- (2010a): *A History of the Federal Reserve, Volume 2, Book 1, 1951-1969*, University of Chicago Press.
- (2010b): *A History of the Federal Reserve, Volume 2, Book 2, 1970-1986*, University of Chicago Press.
- MORRIS, S. AND H. S. SHIN (2002): “Social Value of Public Information,” *American Economic Review*, 92, 1521–1534.
- (2005): “Central Bank Transparency and the Signal Value of Prices,” *Brookings Papers on Economic Activity*, 36, 1–66.
- (2007): “Optimal Communication,” *Journal of the European Economic Association*, 5, 594–602.
- QUAH, D. AND S. P. VAHEY (1995): “Measuring Core Inflation?” *Economic Journal*, 105, 1130–44.
- REIS, R. (2009): “Interpreting the Unconventional U.S. Monetary Policy of 2007-09,” *Brookings Papers on Economic Activity*, 40, 119–165.
- (2011): “When Should Policymakers Make Announcements?” Columbia University.
- (2013a): “Exit Strategies and the Federal Reserve,” in *No Way Out: Government Responses to the Financial Crisis*, ed. by V. Reinhart, American Enterprise Institute Press.
- (2013b): “The Mystique Surrounding the Central Bank’s Balance Sheet, Applied to the European Crisis,” *American Economics Review Papers and Proceedings*, 103, 135–140.
- REIS, R. AND M. W. WATSON (2010): “Relative Goods’ Prices, Pure Inflation and the Phillips Correlation,” *American Economic Journal: Macroeconomics*, 2, 128–157.
- ROCA, M. (2006): “Transparency and Monetary Policy with Imperfect Common Knowledge,” Columbia University manuscript.
- ROGOFF, K. (1985): “The Optimal Degree of Commitment to an Intermediate Monetary Target,” *The Quarterly Journal of Economics*, 100, 1169–89.
- ROMER, C. D. AND D. H. ROMER (1997): “Institutions for Monetary Stability,” in *Reducing Inflation: Motivation and Strategy*, National Bureau of Economic Research, Inc, NBER Chapters, 307–334.
- (2004a): “Choosing the Federal Reserve Chair: Lessons from History,” *Journal of Economic Perspectives*, 18, 129–162.
- (2004b): “A New Measure of Monetary Shocks: Derivation and Implications,” *American Economic Review*, 94, 1055–1084.
- (2008): “The FOMC versus the Staff: Where Can Monetary Policymakers Add Value?” *American Economic Review*, 98, 230–35.
- (2013): “The Most Dangerous Idea in Federal Reserve History: Monetary Policy Doesn’t Matter,” *American Economics Review Papers & Proceedings*, 103, forthcoming.
- SIMS, C. A. (2001): “Fiscal Consequences for Mexico of Adopting the Dollar,” *Journal of Money, Credit and Banking*, 33, 597–616.
- (2013): “Paper Money,” *American Economic Review*, 103, 563–84.
- STERN, G. AND R. FELDMAN (2004): *Too Big to Fail: The Hazards of Bank Bailouts*, Brookings Institution Press.
- STOKEY, N. L. (2003): ““Rules vs. Discretion” After Twenty-Five Years,” *NBER Macroe-*

- conomics Annual*, 17, 9–64.
- SVENSSON, L. E. (2010): “Inflation Targeting,” in *Handbook of Monetary Economics*, ed. by B. M. Friedman and M. Woodford, Elsevier, vol. 3 of *Handbook of Monetary Economics*, chap. 22, 1237–1302.
- SVENSSON, L. E. O. (1997): “Optimal Inflation Targets, Conservative Central Banks, and Linear Inflation Contracts,” *American Economic Review*, 87, 98–114.
- (1999): “Price Level Targeting vs. Inflation Targeting: A Free Lunch?” *Journal of Money, Credit and Banking*, 31, 277–295.
- (2003): “What Is Wrong with Taylor Rules? Using Judgment in Monetary Policy through Targeting Rules,” *Journal of Economic Literature*, 41, 426–477.
- (2006): “Social Value of Public Information: Comment: Morris and Shin (2002) Is Actually Pro-Transparency, Not Con,” *American Economic Review*, 96, 448–452.
- (2013): “The Possible Unemployment Cost of Average Inflation below a Credible Target,” Stockholm University manuscript.
- VANDENBUSSCHE, J. (2006): “Elements of Optimal Monetary Policy Committee Design,” IMF Working Paper 06/277.
- VON HAGEN, J. (1997): “Monetary Policy and Institutions in the EMU,” *Swedish Economic Policy Review*, 4, 51–116.
- WALLACE, N. (1981): “A Modigliani-Miller Theorem for Open-Market Operations,” *American Economic Review*, 71, 267–74.
- WALLER, C. J. (1989): “Monetary Policy Games and Central Bank Politics,” *Journal of Money, Credit and Banking*, 21, pp. 422–431.
- (2000): “Policy Boards and Policy Smoothing,” *The Quarterly Journal of Economics*, 115, 305–339.
- WALSH, C. E. (1995): “Optimal Contracts for Central Bankers,” *American Economic Review*, 85, 150–67.
- WILLIAMSON, S. AND R. WRIGHT (2010): “New Monetarist Economics: Models,” in *Handbook of Monetary Economics*, ed. by B. M. Friedman and M. Woodford, Elsevier, vol. 3 of *Handbook of Monetary Economics*, chap. 2, 25–96.
- WOODFORD, M. (2003): *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton University Press.
- (2005): “Central bank Communication and Policy Effectiveness,” in *The Greenspan Era: Lessons for the Future*, Federal Reserve Bank of Kansas City, 399–474.
- (2007): “The Case for Forecast Targeting as a Monetary Policy Strategy,” *Journal of Economic Perspectives*, 21, 3–24.
- (2010): “Optimal Monetary Stabilization Policy,” in *Handbook of Monetary Economics*, ed. by B. M. Friedman and M. Woodford, Elsevier, vol. 3 of *Handbook of Monetary Economics*, chap. 14, 723–828.
- (2012): “Inflation Targeting and Financial Stability,” NBER Working Paper 17967.
- ZARNOWITZ, V. AND L. A. LAMBROS (1987): “Consensus and Uncertainty in Economic Prediction,” *Journal of Political Economy*, 95, 591–621.