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The Federal Reserve's Framework for Monetary Policy: Recent Changes and New Questions

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The Federal Reserve has made substantial changes to its framework for monetary policy in recent years. On balance, the Federal Reserve has moved closer to the "flexible inflation targeting" used, in some form or another, by many foreign central banks. The Federal Reserve's approach, however, includes a balanced approach to its dual objectives and uses a flexible horizon over which policy aims to foster its objectives. The paper uses a small-scale macro model to help illuminate the Federal Reserve's use of forward guidance. It also examines the case for establishing a different policy objective, such as a higher inflation target or a nominal income target. The paper finds that such changes might be beneficial, but also have potentially significant drawbacks. [JEL 52, 58]
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In recent years, the Federal Reserve has made substantial changes to its framework for monetary policymaking. These changes have included a sequence of improvements in the clarity with which the Federal Open Market Committee (FOMC) has provided information on its policy objectives, starting with the

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introduction of the Summary of Economic Projections (SEP) and proceeding through the publication of the Committee's Statement of Longer-run Goals and Monetary Policy Strategy, which specified a numerical inflation objective for the first time (FOMC, 2012a). This statement also provided information on the Committee's broader policy strategy, indicating that the Committee will take a "balanced approach" to its two objectives of maximum employment and stable prices when they are not complementary. The changes in framework have also encompassed increased communications regarding the Committee's policy intentions—that is, how it intends to use its policy tools to achieve its policy objectives. This information has been conveyed in the Committee's postmeeting statements, in the SEP, and in the Chairman's postmeeting press conferences.

These changes have come about in response to two factors: improved understanding of the value of communications and transparency in helping central banks achieve their goals, and challenges for monetary policy resulting from the financial crisis and the subsequent recession. As noted by Yellen (2012), there has been a revolution in central bank communications in recent decades as it became clear that improved communications and the consequent improved public understanding of policymakers' goals and likely future actions could enhance the effectiveness of monetary policy. In part, this shift reflected the success of inflation-targeting central banks in anchoring inflation expectations and improving economic outcomes.[1]

Changes along these lines were relatively gradual prior to the crisis, but by the end of 2008, with the federal funds rate at its effective lower bound (ELB), the benefits of further changes in the framework became clearer. The Committee began using nontraditional policy tools—specifically, *forward guidance* regarding the path of the federal funds rate and *large-scale asset purchases* (LSAPs)—that required increased communications about the Committee's intentions. Once the federal funds rate is at its ELB, communications about the likely future path of short-term rates can influence longer-term rates and thus influence spending. Moreover, research suggests that it may be desirable to offset the effects of a period at the ELB by maintaining the funds rate at a lower level than would normally be the case given economic conditions once the economy improves—that is, there are benefits to conditional commitments to lower rates (Eggertsson and Woodford, 2003; Woodford, 2012a). We use a small-scale model of the U.S. economy to examine these benefits and to explore possible ways to communicate forward guidance of the kind just described. In particular, the FOMC's use of economic thresholds for the possible timing of the first hike in the federal funds rate can be seen as a way of committing to keep interest rates lower for longer than would otherwise be the case under conventional policy, and thereby improve economic outcomes.

With regard to asset purchases, the effect of a purchase program on the economy depends on the expected quantity of purchases and the length of time that market participants expect the Committee to hold them. As a result, clear communications about the Committee's plans are necessary if the purchases are to have the desired effect. However, asset purchases tend to be carried out over

[1]See Svensson (2011) for a summary of the experience of inflation-targeting central banks.

a period of time, and making commitments with regard to asset purchases is potentially more complicated than in the case of the policy interest rate because, given the limited experience with these nontraditional tools, their effects are more uncertain and their costs are similarly difficult to assess.[2]

The Federal Reserve has not been alone in making changes along these lines. Other major central banks have responded to recent years' developments in similar ways. Both the Bank of England and the Bank of Japan (BOJ) have employed forward guidance and conducted LSAPs. The European Central Bank (ECB) has engaged in long-term refinancing operations, subsequently provided qualitative forward guidance on its policy rates, and more recently has announced plans to purchase significant amounts of private and sovereign assets. Thus, while our analysis focuses on the United States, the results have broader application and there may be important additional lessons in the experiences of those other central banks.

Although central banks have made significant adjustments to their policy frameworks in recent years, the challenges posed by the financial crisis raise additional issues that policymakers need to consider. For example, while most major central banks have provided relatively clear guidance regarding their policy objectives, the protracted period at the ELB may suggest that a higher inflation objective, either on a temporary or permanent basis, could help lessen the constraint (see, for instance, echoing Summers, 1991; Blanchard, Dell'Ariccia, and Mauro, 2010). Alternatively, some have suggested that central banks should aim to target the level of nominal GDP, which would build some history dependence into policy and potentially improve economic outcomes (Woodford, 2012b). We use our small-scale macroeconomic model to examine the possible costs and benefits of such changes. We find that both a higher inflation target and nominal income targeting could contribute to improved macroeconomic outcomes. However, both changes could be misunderstood or could undermine the credibility of the central bank; under such scenarios, macroeconomic outcomes could be significantly worse. Because of the substantial communications and credibility problems that a change in objective could raise, policymakers will need to carefully balance the potential gains against the costs and risks before taking such a step.[3]

[2]Given space constraints, we do not analyze the Federal Reserve's asset purchases; however, the working paper version of this article (English, López-Salido, and Tetlow, 2013) employs a simple, static model to outline the tradeoffs between the efficacy and costs of asset purchases.

[3]The crisis and its aftermath also raised the issue of how central banks' traditional monetary policy objectives can be integrated with their renewed interest in financial stability. The policy response to the crisis and its aftermath demonstrated the potential complementarities between regulatory and supervisory policies—including both prudential supervision and macroprudential policies—and "standard" monetary policy (see Bernanke, 2013c). A section of the working paper version of this article discusses how the tradeoffs between different policy objectives might be made and notes that, regardless of approach, there is a need for improved monitoring of financial markets and institutions to identify and address potential vulnerabilities. The working paper version also briefly discusses issues related to the appropriate institutional structure for the making of monetary policy and financial stability policy.

I. Recent Changes in the Federal Reserve's Monetary Policy Framework

A central bank's monetary policy framework can be thought of as comprising four components. The first component is the central bank's policy goal or goals and the time period over which the central bank aims to achieve them. The second is the instrument or set of tools that the central bank uses to foster those goals. The third is the strategy that the central bank uses when employing its tools. The final component is the range of communications methods that the central bank uses to convey to the public information about its decisions, intentions, and commitments, if any.[4]

The changes the Federal Reserve has made since the middle of the last decade cover all four of these categories. First, the FOMC has significantly clarified its goals, ultimately providing a specific numerical interpretation of its statutory objective of price stability and significant information about its interpretation of its full employment objective. Second, with its traditional policy tool, the target level for the federal funds rate, constrained by its lower bound since late 2008, the Federal Reserve has employed nontraditional policy tools.[5] Specifically, the FOMC has employed an augmented version of forward guidance regarding the future path of the federal funds rate as well as undertaking purchases of longer-term securities in order to put downward pressure on longer-term interest rates. Third, the Committee has made changes to its strategy for implementing policy. In particular, with the federal funds rate constrained near its ELB and the effects of nontraditional policy relatively uncertain, the Committee has moved in the direction of targeting rules by providing information on its desired outcomes for employment and inflation and assurance that it will implement the accommodation needed to achieve those objectives. Finally, the Federal Reserve has greatly expanded its communications with the public. These communications enhancements include increased information provided in postmeeting statements; an explicit statement regarding the Committee's longer-run goals and policy strategy; a quarterly SEP that provides information on FOMC participants' projections of the most important economic variables, their judgments regarding the risks to their projections, and their assessments of the appropriate stance of monetary policy; and finally, the introduction of quarterly postmeeting press conferences by the Chair.

[4]An example may help clarify the various components. In the case of a strict inflation-targeting central bank (which is likely only a caricature of inflation targeting in practice), the goal would be inflation at a particular numerical level at a particular horizon (perhaps 2 percent at a horizon of two years). The tool, at least in normal times, would likely be a target for a specific short-term interest rate, implemented through some standard set of market operations. The strategy for employing the tool might be a specific policy rule, such as the Taylor (1993) rule. Finally, the communications would prominently feature a regular "inflation report," in which the central bank would report on inflation developments, explain any deviation from its target, and show how it planned to use its policy tool to return inflation to its target level over the required horizon.

[5]We assume that the federal funds rate will trade near the target, while in practice actions taken by the Board of Governors and the open market desk are required to ensure that it does so. Henceforth, for brevity we will assume perfect control of the federal funds rate and so treat that rate as an instrument of policy, therefore omitting reference to "targeting" in this context.

These changes to the framework reflect a number of factors. Even prior to the financial crisis, the Committee was working to improve its communications in response to results in monetary economics emphasizing that successful communications could make monetary policy more effective (Yellen, 2012). Then following the crisis, the Federal Reserve developed and implemented nontraditional tools, coupled with enhancements to its communication, in order to provide additional monetary policy accommodation and so help to strengthen the recovery. Some of these changes were continuations of earlier developments, including the introduction of postmeeting statements in 1994, the announcement of the "balance of risks" following FOMC meetings in 2000, and expediting the publication of FOMC minutes from 2006 onward.[6] Other initiatives, such as the asset purchase program, were more distinct breaks from recent practice, although even these had some precedent in "Operation Twist," launched in 1961. In any case, these evolved gradually, as the Committee carefully considered their potential benefits and costs and worked to achieve consensus on particular changes.[7]

Clarifying Policy Objectives, Strategy, and Tools

In recent years, the Committee has taken a sequence of steps to improve public understanding of its policy objectives. Of course, those objectives are ultimately provided by Congress in the Federal Reserve Act, which states that the Federal Reserve's mandate is "to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates" (Federal Reserve Act, Section 2a). In general, the Committee has judged that moderate long-term interest rates would follow if the Federal Reserve achieves its objectives of maximum employment and stable prices; hence, policymakers often refer to the "dual mandate" (Mishkin, 2007a).

Although the dual mandate was assigned specifically to the Federal Reserve by Congress in 1977, until recently, the Committee had not provided more specific guidance regarding its interpretation of either "maximum employment" or "stable prices."[8] With regard to its inflation objective, Chairman Greenspan suggested that the goal should be a situation in which "the expected rate of change of the general level of prices ceases to be a factor in individual and business decision making" (Greenspan, 1988). That goal would presumably be consistent with a low positive level of inflation, but the level of inflation that might be found acceptable was left unstated. With regard to employment, the Committee was even more circumspect, with only scattered quantitative discussion on the part of policymakers of the maximum employment objective (see the discussion in Yellen, 2012). In part, the focus on the inflation objective in the 1980s and 1990s presumably reflected

[6]For a summary of changes in FOMC communications from 1975 to 2002, see Lindsey (2003).

[7]Many of the changes in communications reflected the work of the FOMC's subcommittee on communications, headed by then-Governor Yellen.

[8]Pre-1977, the Employment Act of 1946 established a dual mandate (with price stability defined as "maximum purchasing power") for federal agencies generally.

the fact that the high and volatile inflation in the 1970s remained a fresh memory, and the Committee was focused on bolstering its credibility in order to bring inflation down over time.

However, in early 2007 the Committee again took up the consideration of ways to improve policy communications, and these efforts gained in importance following the start of the financial crisis, during which the risk of very low inflation or even deflation as well as of employment far short of its maximum level pointed to the possible benefits of clearer communication regarding the Committee's goals. Not only would such communication improve Federal Reserve accountability, it could also improve economic outcomes by helping to anchor inflation expectations, thereby helping to avoid an undesirable further decline in inflation and allowing the FOMC to take more aggressive steps to address the crisis. An important step toward greater clarity came with the introduction of the SEP in November 2007. Building on the semiannual summary of projections the Committee had previously supplied to the public, the SEP offered information on the forecasts of all FOMC participants (the seven members of the Board of Governors and the 12 Reserve Bank presidents) under each participant's assessment of "appropriate monetary policy." Initially, the forecasts went out three years, so the November 2007 SEP included forecasts through 2010. The forecasts include four key variables reflecting the Committee's dual mandate: the growth rate of real GDP, the unemployment rate, and overall and core inflation (as measured by the price index for personal consumption expenditures). Although the SEP does not show the individual forecasts, it does provide the range and central tendency of the forecasts, narrative information on the factors that participants expect to shape the outlook, the participants' assessments of the degree of uncertainty around their forecasts, and their judgment of the balance of risks to those forecasts.

An important benefit of the relatively long time horizon for the forecasts in the SEP was that, at least in normal times, they provided considerable information about the Committee's longer-term objectives for unemployment and inflation. Because three years, at least under normal circumstances, is long enough for monetary policy to have significant effects on output and spending, the projections for unemployment and inflation three years ahead would presumably be close to the Committee's longer-run objectives and the projection for real GDP growth in the final year would be close to participants' estimates of the growth of potential GDP. For example, the November 2007 SEP projections had a central tendency for both overall and core inflation of 1.6–1.9 percent in 2010 and a range of 1.5–2.0 percent, suggesting that participants saw the inflation rate most consistent with their dual mandate to be close to or somewhat below 2 percent.[9]

The SEP could also provide indirect information on the Committee's policy strategy. For example, following a shock to the economy that moved inflation and

[9]As discussed in Mishkin (2007b), this mandate-consistent level of inflation is above zero because of measurement issues and the need to take into account the effects of very low inflation on the effective functioning of the economy as a result of the effective bound on nominal interest rates and downward nominal wage rigidity.

unemployment away from their longer-run levels, the projections would show how Committee participants thought it would be appropriate to trade off achievement of the two sides of the dual mandate in returning both variables to desired levels (Bernanke, 2007).[10]

These benefits of the SEP were subsequently enhanced by the addition, in 2009, of "longer-run" projections that were defined as "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." This additional information provided very clear evidence regarding participants' longer-run objectives, evidence that was particularly useful following the financial crisis, when employment and inflation were far from the Committee's desired levels and might be expected to take longer than three years to return to their longer-run values.[11]

The next major step in improving Committee communications regarding its objectives was the publication in January 2012 of the Committee's Statement on Longer-Run Goals and Monetary Policy Strategy.[12] The Statement, for the first time, offered a single, explicit numerical value for the Committee's inflation objective, setting it at 2 percent, as measured by the annual change in the price index for personal consumption expenditures. The establishment of a 2 percent longer-run goal for inflation after many years of discussion in the Committee reflected an assessment of a number of factors (Bernanke, 2012b). Most obviously, an explicit numerical inflation objective would better anchor inflation expectations and improve central bank accountability. The selected objective also needed to balance the welfare costs of inflation over time—see, for example, Fischer (1981)—against the need for an "inflation buffer" to reduce the risks posed by the ELB on nominal interest rates and possible deflation following large shocks (Reifschneider and Williams, 2000).

The Committee was less precise with regard to its longer-run employment objective. As it noted in the Statement, the maximum level of employment is a function of a range of nonmonetary factors—such as demographics, education and training, technology, and labor market structure—that are difficult to quantify and can change over time. Thus, the Committee felt that it would not be appropriate to provide a fixed numerical objective for employment. Nonetheless, the Committee noted that the SEP provided information on the longer-run normal rate of unemployment, and pointed to the central tendency of those values as a way of

[10]Of course, there is bound to be some imprecision in such interpretations because the SEP provides information on the range and central tendency of the individual economic and policy projections but does not link them for each participant. As a result, it may be difficult to interpret the projections in some cases. Moreover, the projections cover all Committee participants, without differentiating the Committee members.

[11]For example, in the January 2009 SEP, the projections for overall inflation in 2011 had a central tendency of 0.9 to 1.7 percent, while the longer-run projections had a central tendency of 1.7 to 2.0 percent.

[12]Hereafter, the "Statement." The Statement has been reaffirmed, without material changes, at subsequent January meetings.

flexibly providing information about its expectations for employment and the labor market.

Finally, the Statement provided information on the way that the Committee would employ policy in the pursuit of its two macroeconomic goals. First, the Committee noted that the goals of maximum employment and stable prices are generally complementary—that is, the establishment of low and stable inflation is beneficial for the attainment of maximum employment, and persistent deviations from maximum employment can make it difficult to attain stable prices. However, for circumstances in which the two goals are not complementary, such as following significant shocks to commodity prices, the Committee stated that it would follow "a balanced approach," taking account of the size of the deviations of employment and inflation from their goals and the time horizons over which they were expected to return to mandate-consistent levels.

In addition to the SEP and the Statement, the Committee has used its other communications tools to improve public understanding of its goals and policy strategy. In particular, the Committee has increased the length and complexity of its postmeeting statements since the crisis, in order to convey greater information about the economic outlook and the use of nontraditional policy tools. Additionally, in 2011, the Federal Reserve introduced postmeeting press conferences four times a year. The press conferences were intended to "further enhance the clarity and timeliness of the Federal Reserve's monetary policy communication" (Federal Reserve, 2011). Finally, in January 2012, the Committee included in the SEP individual participants' assessments of the path for the target federal funds rate that they viewed as appropriate and compatible with their individual economic projections, as well as qualitative information on the appropriate path for the Federal Reserve's balance sheet. This information can help the public to understand the approach that Committee participants see as appropriate in response to a shock to the economy. All of these changes, as well as more standard communications tools, such as speeches and testimonies, have allowed the Federal Reserve to provide additional detail and nuance regarding its policy intentions and to convey more clearly the range of views across the Committee.

Taken together, these changes to the Federal Reserve's policy framework have moved the Federal Reserve considerably closer to inflation targeting, albeit with some important differences. Most obviously, the Federal Reserve has, by statute, a dual mandate. Of course, inflation-targeting central banks generally employ "flexible inflation targeting" that takes account of the consequences of their actions for the real economy as well as inflation. Nonetheless, their formal accountability and much of their communications are in terms of inflation performance, and that is not the case for the Federal Reserve. A second difference, at least with respect to some inflation-targeting central banks is that the Federal Reserve has considerable flexibility regarding the horizon over which it aims to return inflation to its longer-run goal. Again, as expressed in the Statement, the Committee will take a "balanced approach" in responding to deviations from both of its goals when considering the appropriate policy stance.

Employing Nontraditional Policy Tools

The second set of changes to the Federal Reserve's monetary policy framework was the introduction of nontraditional policy tools and the consequent increase in communications regarding their use. Late in 2008, with the federal funds rate at its ELB, the Committee introduced two nontraditional policy tools—forward guidance regarding the federal funds rate and LSAPs. As noted earlier, both of these tools require communication about the Committee's possible future actions. Our focus in this section is on the effects of forward guidance.

Forward Guidance

Over time, the Committee's communication of its forward guidance regarding the federal funds rate has evolved. Early on, the Committee indicated its expectation that economic conditions were "likely to warrant exceptionally low levels of the federal funds rate for an extended period" (FOMC, 2009). Subsequently, in August 2011, the Committee provided a specific date, through at least which it anticipated that a very low funds rate would be appropriate (FOMC, 2011a). However, the Committee was concerned that such *calendar-based forward guidance*, even when presented as explicitly conditional on economic outcomes, could be misunderstood by the public. Accordingly, in December 2012, the Committee changed its language to make the maintenance of a very low federal funds rate explicitly conditional on economic conditions—that is, *state-based forward guidance*. Specifically, it indicated that the "exceptionally low range for the federal funds rate will be appropriate at least as long as the unemployment rate remains above 6½ percent, inflation between one and two years ahead is projected to be no more than a half percentage point above the Committee's 2-percent longer-run goal, and longer-term inflation expectations continue to be well anchored" (FOMC, 2012b).[13]

In this section we use a small-scale model of the U.S. economy to explore the possible benefits of this sort of threshold-based forward guidance.[14] We start with background on the performance of simple instrument rules in our model, focusing on performance in the situation prevailing in the fall of 2013 of elevated unemployment, below-target inflation, and the funds rate at its ELB. We then proceed to consider outcomes under optimal policy in the model, and then show that augmenting simple rules with thresholds can yield outcomes that are closer to those under the optimal rules than those that can be achieved using the simple rules alone.

Instrument Versus Targeting Rules

Simple instrument rules could be part of a broad-based communications effort, providing a link between the economic outlook and likely path of the short-term

[13]Since the preparation of this paper, the Federal Reserve has made further adjustments to its forward guidance. See Yellen (2014) for a discussion.

[14]See Svensson (2013) for a recent discussion of forward guidance as a monetary policy tool with an application to the Swedish recent experience.

interest rate instrument, and making policy more predictable and more effective.[15] In particular, prior to the recent financial crisis, simple policy rules attracted broad interest because they can provide a clear and easy-to-understand benchmark for adjustments to the short-term interest rate. The parsimony of the Taylor rule and other simple rules, and their focus on only those variables that are central to monetary policy objectives makes it easy to understand how the rule prescriptions respond to changes in economic conditions.[16]

Even so, the extent of uncertainty and disagreement regarding the true structure of the economy makes the robustness of the performance of policy rules across different macroeconomic models a critically important characteristic and the subject of considerable research. The literature on this and other topics related to simple policy rules—recently reviewed by Taylor and Williams (2011)—has suggested that a complicated rule that is optimized to perform best in a particular model may perform very poorly when evaluated in other conventional models. The literature has, however, identified a variety of simple policy rules that are robust in the sense that they perform well across a range of models.

Accordingly, researchers and policymakers have frequently treated the prescriptions of simple rules as useful benchmarks for setting the federal funds rate.[17] The available theory and evidence on simple rules deal most fully with the implications of such rules when the policy rate is far from the lower bound. Unfortunately, as we discuss below, several important considerations suggest that simple rules that are likely to deliver quite successful outcomes in normal times may have less merit under conditions such as those that the U.S. economy has faced in recent years.

The approach called forecast-based targeting deserves consideration as a complement to simple policy rules.[18] In general terms, to perform policy evaluation under this approach, one examines the forecasts of goal variables under various alternative policy rules, and chooses the policy delivering the forecasts that "look best" under the policy objectives (for example, Svensson, 2003). Operationally, the forecast is treated as an intermediate target of monetary policy and the optimal policy has implications for how the forecasted paths of goal variables should evolve—and some of these properties hold robustly across a range of models. For example, if policymaker preferences are symmetric, then it will be best for policy to choose a path for the policy rate such that the medium-term projections of inflation and employment come to lie on opposite sides of their long-run objectives (see, for example, Woodford, 2011).[19]

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[15]For a discussion, see the collected papers in the Taylor (1999a) volume.

[16]This applies to prescriptions from a variety of monetary policy rules, including Taylor's original 1993 rule and a later version he examined in Taylor (1999b).

[17]See, for example, Meyer (2000) and more recently Kohn (2007).

[18]Bernanke (2004) refers to this approach as "forecast-based targeting," Svensson (2003, 2005) instead uses the term "targeting rules." For a critical comparison with instrument rules, see McCallum and Nelson (2005).

[19]That is, when projected employment is lower than its objective, then projected inflation should at some point be (temporarily) above target. It will not, in general, be optimal for both target variables to approach their targets from the same side. To be sure, the particular confluence of shocks that results in employment and inflation differing from their desired levels, together with the specific

One might complement rule-based prescriptions with analysis of whether the implied forecasts of unemployment and inflation satisfy conditions of this variety. In this way, key principles of optimality could be brought to bear as complements to policy benchmarks implied by simple rules. However, recent developments—including decisions to cut the funds rate to its ELB and to use nontraditional policy tools—complicate the interpretation of simple rule prescriptions. When the federal funds rate is at its lower bound, additional stimulus cannot be provided by reducing the funds rate—the usual focus of simple rule prescriptions. As noted above, partly as a result, the FOMC provided considerable forward guidance about the likely future path of the funds rate during the postcrisis period. Simple rules can help inform such guidance, but only if combined with information on the outlook well into the future—something that is subject to considerable uncertainty.

The special features of an economy that has spent an extended period at the ELB may justify deviating from the prescriptions of simple rules—even rules viewed as dependable in normal times. One useful perspective, adopted in our simulations discussed below, applies optimal control theory. This policy is "optimal" in the sense that the path is obtained by minimizing a specific loss function subject to a particular behavioral model of the economy, assuming that the policy is both well understood by the public and is fully credible. A significant drawback of this approach is that the implied rule tends to be very complex and its performance may be quite sensitive to specific features of the modeling environment. Nevertheless, general lessons can be drawn from the considerable body of research on optimal policies in the presence of an explicit effective-lower-bound constraint. These include[20]:

(a) *Exploiting intertemporal tradeoffs*. An optimal rule promises that *future* policy will be more expansionary than usual after the economy no longer faces the ELB constraint, thereby influencing current expectations about future short rates and inflation. Policymakers communicate this promise by indicating to markets that they expect to push output above potential for an extended period after the economy no longer faces a binding lower bound constraint.
(b) *History dependence.* Optimal policy is "history dependent," so that the extent and duration of policy stimulus in the period after the policy rises from its lower bound depends on the evolution of output and prices during the period over which policy was constrained. Intuitively, as an economy facing an ELB constraint becomes mired in a deeper recession, an optimal policy would promise to make up the shortfall with more stimulus in the future in order to reduce longer-term real interest rates commensurately.[21]

features of the model, could result in a period in which employment and inflation are on the same side of their targets, but so long as those shocks do not change the targets themselves, in New Keynesian models under rational expectations, it will be optimal for one of the two variables to overshoot the longer-run objective and approach from the other side. See Svensson (2011) for a detailed discussion.

[20]Eggertsson and Woodford (2003) and Woodford (2011, 2012b) provide excellent discussions of the optimal policy under commitment in the presence of a zero bound constraint.

[21]Nevertheless, at the other extreme, history-dependent strategies have been shown to perform very poorly in models in which expectations regarding interest rates or inflation are purely backward looking, such as in the widely analyzed simple model of Rudebusch and Svensson (1999).

(c) *State dependence during the tightening phase*. Optimal policy sets the timing and size of adjustment in policy rates after they begin to rise depending on the evolution of economic conditions. Thus, if the recovery turns out to be unexpectedly robust, the policy rate could be adjusted upward expeditiously, though to a degree that still leaves an expansionary tilt to policy.
(d) *Credibility and time inconsistency*. Optimal policy relies on credible communication and associated commitments that allow the public to understand and believe the policy strategy. In the absence of such credibility, because the benefits of the optimal policy are front-loaded—that is, they reduce long-term real interest rates—while the costs are paid later—overshooting of the inflation and output objectives—policymakers will have an incentive to renege on their commitments.

Performance of Simple Rules in the Current Environment

In this section we consider the prescriptions and economic implications of simple rules in recent, highly unusual conditions—a situation in which the lessons gained from analyzing rules under "normal" conditions may no longer apply. Toward this end, we carry out simulations of a small, structural New Keynesian (NK) business cycle model, subject to certain baseline economic conditions, and with monetary policy assumed to follow one of a selection of simple monetary policy rules, subject to the ELB on nominal interest rates. The specifications of model, the baseline, and the rule can all have a bearing on the outcomes shown, so we briefly discuss each here, with details left to the appendix.

The model is a small-scale representation of the Board staff's FRB/U.S. model.[22] It features three structural decision rules, one each for output, inflation, and the federal funds rate; a small assortment of equations delineating the target paths of output and inflation toward which the decision rules map out the adjustment, and a dynamic Okun's Law equation. In broad terms, our model, like its larger brethren, can be thought of as a dynamic extension of the basic New Keynesian model in the sense of Woodford (2003) or Galí (2008).[23] In any case, our model contains the critical features that any model tasked to the issues at hand would have; in particular, it places a longer-term interest rate at the center of the monetary policy transmission mechanism, thereby capturing the key role of expected future short-term rates and the Federal Reserve's promises regarding those rates. Moreover, the essential assumptions behind our model, and how we use them, are those it shares with other models of its class: the assumption of

[22]Indeed, this "small FRB/U.S." model was estimated by matching the impulse response properties of the rational expectations version of its larger sibling. See Appendix I and Brayton (2013) for details.

[23]The model embeds a mixture of forward- and backward-looking elements influencing firm and household decisions, including price-setting based on a generalization of the quadratic adjustment-cost model of Rotemberg (1982) called polynomial adjustment costs; see, for example, Brayton and Tinsley (1996). The appendix summarizes the main features of the model including the characteristics of each of the simple rules used in the simulations.

rational expectations, even after the economy has withstood a large, disruptive shock; and the assumption of full credibility.[24] We will have more to say about these important issues below.

The baseline is constructed to be broadly representative of the conditions that the FOMC saw in the autumn of 2012, as reported in the SEP at the time. It features a sizable (negative) output gap that closes only slowly over time, core PCE inflation that had been somewhat below target for some time and was not expected to return to target for some time to come, and (conventional) monetary policy that was constrained by the ELB. Changing the details of the baseline outlook will, of course, affect the results, but most baseline outlooks that embody the features just described will render qualitatively similar outcomes.

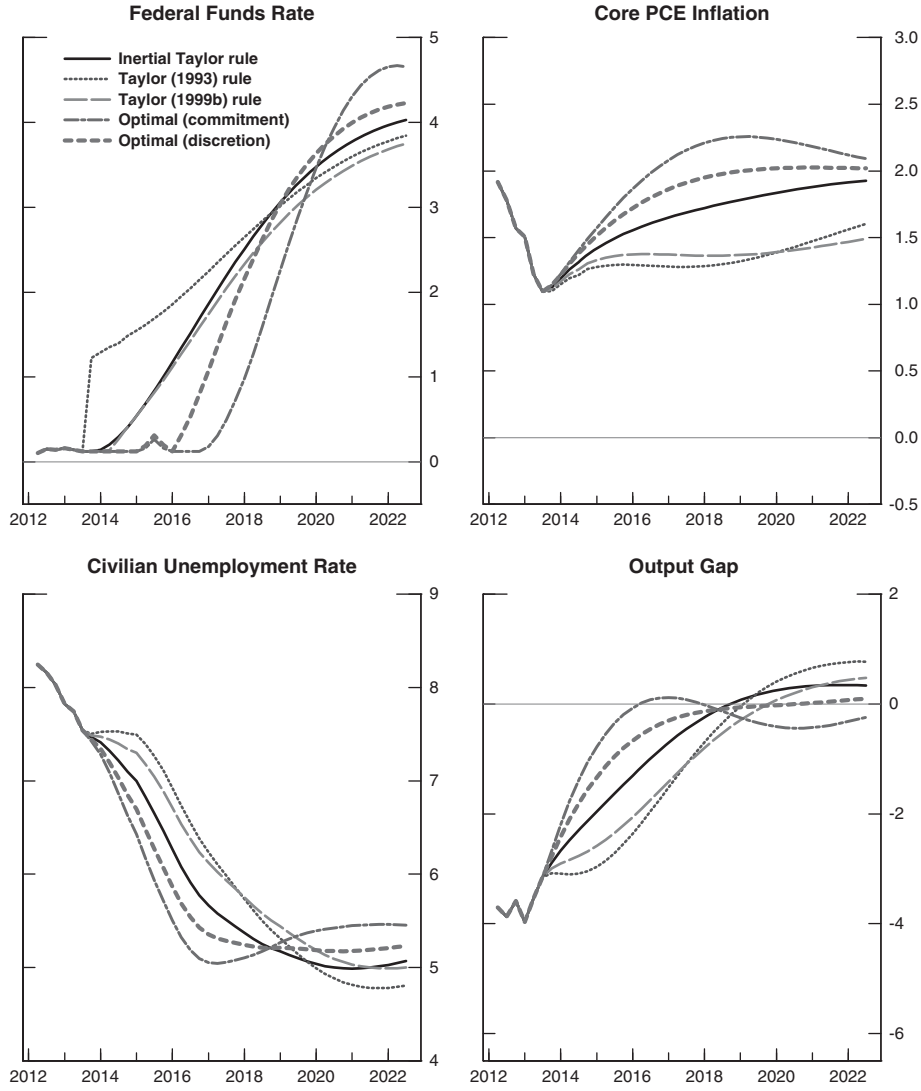
In what follows, we employ some or all of four policy rules, chosen to cover several of the main areas of debate in the literature. In particular, our set includes the canonical Taylor (1993) rule, and two variations on it. The Taylor (1999b) rule is identical to the original Taylor (1993) rule except that the former puts a higher weight (of unity) on the output gap rather than 0.5 as in the original Taylor rule. These two rules are noninertial or "static" rules—that is, the lagged values of the nominal interest rate do not enter into the rule. The inertial Taylor rule takes the 1999 specification and adds a moderate degree of policy-rate inertia by setting the coefficient on the lagged nominal interest rate to 0.85.[25,26] Finally, although the analysis is deferred to later in the paper, we also use a nominal income (level) targeting rule under which policy responds to discrepancies between the (log) level of nominal income and a predetermined path for that variable, subject to some partial adjustment in the federal funds rate. Each of these rules is also subject to the

[24]It is computationally far less costly to use the small model than would have been the case for the large-scale nonlinear rational expectations version of the FRB/U.S. model. That said, for those experiments in which we conducted similar trials with the large-scale model, the conclusions were similar. This should not surprising given that the critical aspects of the monetary transmission mechanism in both—that is, the term structure of interest rates, price determination, and expectations formation—are quite similar.

[25]The inertia might suggest that either policymakers prefer to avoid large changes and reversals in the policy rate, as a manifestation of committee dynamics (as in, for example, Riboni and Ruge-Murcia, 2008) or as something of a hedge against uncertainty and the policy errors that a less gradualist policy response might uncover. Inertial policy rules also have the feature that they are more reliably learnable than are static rules; see, for example, Bullard and Mitra (2002) and Tetlow and von zur Muehlen (2009). Alternatively, inertial rules might arise if the Committee were actually setting policy in a noninertial manner but responding to some persistent variable that was omitted from the rule. Rudebusch (2006) presents arguments and evidence against true inertia as the primary explanation. English, Nelson, and Sack (2003) argue that both inertia and other causes seem to be at work. Woodford (2003) emphasizes that inertia would be consistent with optimal policy in many models. Evidence suggests that each story plays some role, but we do not take a strong position on the source of this historical phenomenon.

[26]The longer, working paper version of this article includes a fairly extensive analysis of the performance characteristics of a fourth rule, the first-difference rule. That rule does not depend on the *level* of the output gap or the *level* of the long-run real interest rate, but instead responds to the *change* in the gap and the inflation rate. The absence of level conditions in rules like the first-difference rule has been noted as a potentially attractive feature for reasons of robustness (see, for example, Orphanides, 2003). These results are omitted from this version for brevity.

Figure 1. Performance of Optimal Policies and Simple Policy Rules



ELB on nominal interest rates. In a later subsection, we consider augmenting these simple rules with thresholds governing *forbearance* from following the prescriptions of the policy rules for raising the federal funds rate.

Except where otherwise indicated, it is assumed in our simulations that private agents fully understand the future economic implications of each rule and that the central bank enjoys complete credibility. Figure 1 shows the policy prescriptions and economic outcomes for a selection of policies, including our first three policy rules. We will come back to the results for optimal policies (the dot-dashed and the dashed line) below. As can be seen, the first date of policy firming for the simple

rules ranges from the onset of the simulation in 2013:Q3, in the case of the Taylor (1993) rule; to 2014:Q3, in the case of the Taylor (1999b) rule and inertial Taylor rule. All else equal, a rule that calls for keeping the federal funds rate relatively low for a longer time yields a faster decline in the unemployment rate and an inflation rate closer to the Committee's 2 percent objective. Rules that incorporate greater history dependence in the form of interest-rate smoothing, or rules that respond strongly to the level of resource utilization tend to involve a longer period over which the federal funds rate is kept at its lower bound. However, the behavior of the policy rule once the tightening begins also has a material effect on economic outcomes. This is amply illustrated by comparing the Taylor (1999b) and the inertial Taylor rule, which differ only in the lagged endogenous variable in the latter. As we already noted, the two rules prescribe lift off at the same date, and produce broadly similar paths for the funds rate, at least for a time, but imply notably different paths for inflation and real activity.

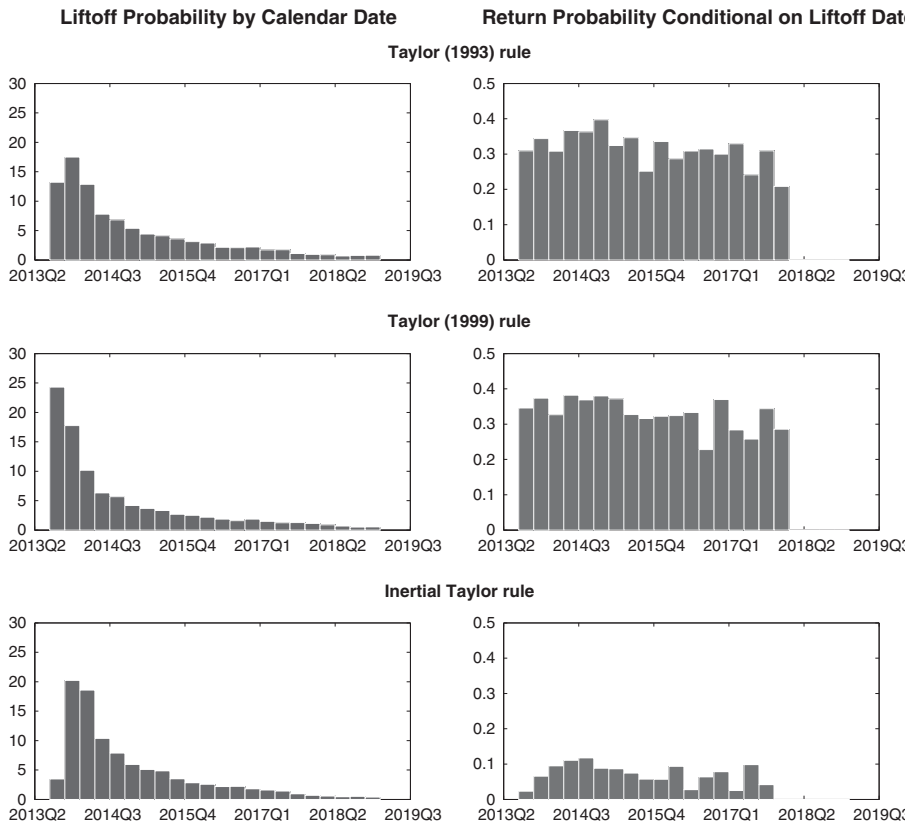
Private, rational agents are taken as having a full understanding of the rule and complete confidence in the policymakers; hence they anticipate that rate setting will continue to follow the prescription of the inertial Taylor rule going forward. As a result, inflation under that rule is higher, and thus real rates are lower, thereby driving down the unemployment rate faster, than under the Taylor (1999b) rule. That said, the fact that current policy prescriptions vary considerably across rules illustrates a more general phenomenon: If the Committee strictly adhered to the prescriptions of these or most other simple rules, the projected timing and pace of policy firming would likely be quite sensitive to modest differences in views about the outlook, to modest changes over time in projections of real activity and inflation, and to the details of the rule.

To get a sense of the probability distribution of the date of first firming under different simple policy rules, we performed a set of stochastic simulations of the model, with policy governed by the same three policy rules we used in the construction of Figure 1.[27] The three panels that form the left-hand column of Figure 2 show the distribution of dates of the first increase in the federal funds rate as implied by stochastic simulations of the model assuming that the policymaker strictly follows the rule. The results suggest two general conclusions: First, the policy rules attach considerable likelihood to an early departure from the ELB.[28] We will have something to say about the advisability of early departure a bit later. Second, the first point notwithstanding, there is considerable uncertainty both across policy rules and within the context of a single rule, on the likely date of departure from the ELB. As can be seen, regardless of the rule, the distribution

[27]The stochastic simulations use 5,000 bootstrapped draws from the model's historical shocks drawn over a period from 1984:Q1 to 2012:Q4, subject to the same baseline as described in the text. The model is subjected to shocks for the period from 2013:Q3 to 2018:Q4, and simulated, under rational expectations, once for each of the 22 shocked dates to complete a draw. We assume that policy is implemented beginning in 2013:Q3, subject to the effective lower bound.

[28]It is interesting and noteworthy that the rule that calls for the earliest departure under baseline conditions, the Taylor (1993) rule, is the one that has the smallest mass for departure for early dates. This is a manifestation of the rule's low sensitivity to economic conditions, which means that it takes a less likely configuration of net positive real shocks to reduce the shadow price on the effective bound constraint to zero than is the case for, say, the Taylor (1999b) rule.

Figure 2. Probabilities of Liftoff from the ELB and Return within Four Quarters
(Stochastic simulations, selected simple monetary policy rules)



indicates considerable odds that conditions could evolve in a manner that would have called for raising the federal funds rate well into 2014 or later. This uncertainty presents some obvious challenges for forward guidance in monetary policy, particularly when that forward guidance is articulated in terms of predictions of particular dates for policy firming—that is, *calendar-based forward guidance*. Shifting views of the economic outlook, changes in perception of the monetary policy transmission mechanism, or merely the ebb and flow of policy Committee internal dynamics, could alter the predicted date of firming in ways that could be difficult to communicate to the public and might undermine the credibility of the central bank.

Our stochastic analysis showed a considerable likelihood of an early prescribed departure from the ELB. However, whether such an early departure is advisable is an open question. One way of assessing this question is to consider the distributions of economic performance conditional on an early departure from the ELB. We will consider this metric a bit later when we examine threshold-based strategies because such strategies provide a natural basis for comparison. Another

criterion for judgment, closer to the theme of the communications challenges surrounding forward guidance, is the probability, once departure has occurred, that the policy rule will prescribe an early return to the ELB. Clearly, forward guidance that centers on departure dates will be less reliable and less effective if that departure could well turn out to be fleeting. The right-hand column of Figure 2 shows the probability of return to the ELB conditional on the date of departure, marked on the horizontal axis, for the three policy rules. Three key points can be gleaned from the figure. First, depending on the policy rule, there is a substantial probability that forward guidance on the departure date, even if is initially accurate, will eventually be met with "regret" in the sense that a return to the ELB is likely. Second, the probability of return to the ELB varies widely across policy rules, with high likelihood for the static policy rules—the Taylor (1993) and (1999b) rules—and much lower probabilities for the inertial Taylor rule. Third, there is some evidence that the likelihood of regret, in this sense of the term, declines as the date of the first federal funds rate increase is deferred by economic circumstances.[29,30]

Simple Rules and Optimal Policy in the Current Environment

As discussed above, given the ELB, policymakers face constraints when considering strategies to provide additional stimulus. "Optimal" policy simulations of macroeconomic models can provide some insight into strategies that may be desirable. To compute the optimal policy, we assume that policymakers place equal weight on penalizing squared deviations of PCE inflation from its target of 2 percent; on keeping the unemployment rate close to the natural rate of unemployment, which is taken currently to be 5½ percent, albeit declining gradually over time to eventually reach 5¼ percent; and on minimizing changes in the federal funds rate.[31] Under *commitment*, the Committee is willing and able to credibly commit (conditional on economic outcomes) to future policies that are generally more expansionary than usual in order to stimulate activity today, despite the temptation to tighten policy early that arises in such cases. In the *discretion* case, the Committee still sets an optimal policy, but on a period-by-period basis. That is, the Committee cannot bind future Committees to act in a particular way.

Under the commitment strategy, optimal policy, shown by the dot-dashed line in Figure 1, the nominal federal funds rate is held near its lower bound well into a period

[29]The working paper version of this article notes a high incidence of prescribed early departures from the ELB for the first-difference rule and a very high probability of return to the ELB, conditional on those early liftoffs. See English, López-Salido, and Tetlow (2013) for details.

[30]Care needs to be taken in assessing the probability of return to the ELB for departure dates that are late in the period shown because the number of departures covered under these circumstances can be small, as indicated by the bars in the left-hand column of Figure 2.

[31]Per-period losses are discounted with a quarterly discount factor of 0.99. As noted in Note 25, the presence of a penalty on the change in the federal funds rate can be justified on the grounds of a desire for robustness or simply as a preference of policymakers. In stochastic simulations of the FRB/U.S. model, the weight on this factor in the loss function produces variability in the funds rate that approximates the historical record, once one corrects for the low-frequency historical drift and volatility of inflation.

of economic expansion. Of course, this commitment implies that the unemployment rate eventually falls below its natural rate for a time and inflation rises slightly above its long-run target. It is the promise to remain accommodative and not prevent future above-target inflation and below-target unemployment that lowers current long-term interest rates and thereby stimulates activity today. In contrast, the discretionary policy, which does not constrain future actions, prescribes a considerably more rapid pace of tightening as the economy recovers, as shown by the dashed line in the same figure; this trajectory ensures that inflation does not rise above the 2 percent target rate and that unemployment does not fall appreciably below its natural rate, but also results in substantially poorer economic performance, on average, over the next decade.

Both of these policies involve later departures from the ELB than do simple rules, including the inertial Taylor rule. Outcomes under this simple rule are substantially worse than those under the optimal policies.[32] There are two important differences between the inertial Taylor rule and optimal policy. First, the inertial Taylor rule is somewhat less responsive to resource utilization, which appears to account for the difference between this rule and the discretion strategy. Thus, the inertial Taylor rule involves raising the federal funds rate earlier, and keeping it above the path implied under discretion after the firming date. Second, the commitment strategy involves managing expectations regarding future policy actions and remaining accommodative for a substantially longer period. These conditional commitments lead to much better performance, on average, with only moderate overshooting of the 2 percent inflation target and undershooting of unemployment in relation to the natural rate.[33] Of course, whether optimal policies are feasible, even in some approximate sense, remains an open question.

The merits, relative to the simple rules considered here, of optimal policies are magnified in environments in which aggregate demand is even weaker than in Figure 1. This should not be surprising because simple rules in general are designed for typical conditions, local to the steady state of the economy whereas optimal commitment strategies, by definition, are tuned to the conditions at hand.[34]

Using Forward Guidance to Implement Targeting Rules

A potential difficulty with commitment-based strategies is that their effectiveness depends on influencing the public's beliefs about the policy as many as five years

[32]Measured by the same loss function used to construct the optimal policies, the rankings of policy rules under the baseline scenario, over the period from 2013:Q3 to 2018:Q4, from best to worst are as follows: commitment > discretion > inertial Taylor rule > Taylor (1999b) rule > Taylor (1993) rule.

[33]The logic also underlies the proposal of Reifschneider and Williams (2000). These authors argued that in the aftermath of a prolonged period when the short-term nominal interest rate has been constrained by the ELB, the policy rate should be held lower for longer than would otherwise be suggested by the conventional rule in order to make up for past shortfalls in conventional monetary policy. By committing to such an approach, the central bank can provide additional accommodation while the funds rate is at its ELB.

[34]See the longer, working paper version of this article, English, López-Salido, and Tetlow (2013), for a discussion of the performance of selected Taylor-type rules and the optimal commitment policy in an environment with a significantly larger, negative output gap.

or more ahead. Moreover, as we noted above, the optimal commitment strategy involves adhering to low settings of the federal funds rate well after the point at which the unemployment rate has returned to a level consistent with full employment. Thus, the benefits of these strategies are frontloaded while the costs are incurred later, providing an incentive to renege—that is, such policies are dynamically time inconsistent in the absence of a commitment technology or reliable reputation effects. It is understandable that the public may entertain doubts about such long-horizon commitments.

The discussion in the previous section suggests that, given the current outlook, strategies to provide additional stimulus would be consistent with achieving outcomes better aligned with the assumed long-run policy goals. Nevertheless, such optimal policies might be viewed as theoretical references of limited usefulness in Committee communications because they are both complex and model dependent and because they do not reveal how the Committee would respond to changes in the economic outlook.

In this section, we consider strategies that the policymaker could potentially implement to augment simple policy rules. In particular, we study threshold policies by which the monetary authority commits itself not to depart from the ELB, notwithstanding the prescriptions of its simple monetary policy rule, *at least* until a threshold condition is satisfied, namely *either* the unemployment rate drops below a certain level *or* the projection for inflation rises above a certain level. Threshold strategies of this nature may provide one or both of two possible benefits. The first is the clarification and reinforcement of the intentions of monetary policy as encompassed within the simple rule. In circumstances in which knowledge of the extant policy rule cannot be taken as given, and hence the benefits of rational expectations are not assured, the use of the *enhanced forward guidance* we discuss here could be sizable, even if they are hard to quantify. In this sense, threshold strategies provide much of the same benefits that calendar-based forward guidance does, except that because threshold policies are state-based forward guidance, in principle, they need not be adjusted continuously as the economy evolves over time. Instead, private agents can adjust their beliefs regarding the likely date of policy firming for themselves as the economy gets closer to (or further from) crossing a threshold value. To the extent that such forward guidance improves investors' understanding of the Committee's reaction function, such guidance can make it more likely that investors' responses to incoming data will move medium- and longer-term rates in a way that is consistent with the Committee's thinking about the likely future path of short-term rates. Second, to the extent that the stating of thresholds can serve as a commitment device, properly designed threshold strategies can provide additional stimulus that comes from the "lower for longer" *conditional commitment* to maintain accommodative policy for longer than policymakers might in a discretionary equilibrium. This forbearance from the prescriptions of the accompanying simple rule may capture aspects of the "history dependent" strategies that characterize the optimal policy under commitment. According to this argument, if the Committee were to announce, say, its intention to keep short-term interest rates near zero until certain economic conditions were met (that is, introducing thresholds), private agents would be confident that the Committee would indeed do so on the expectation that the

Committee would be unwilling to suffer the loss in reputation associated with a failure to follow through on its pledge. As a result, the stated policy would be more likely to shift the public's expectations for short-term interest rates, inflation, and other factors in the desired directions.

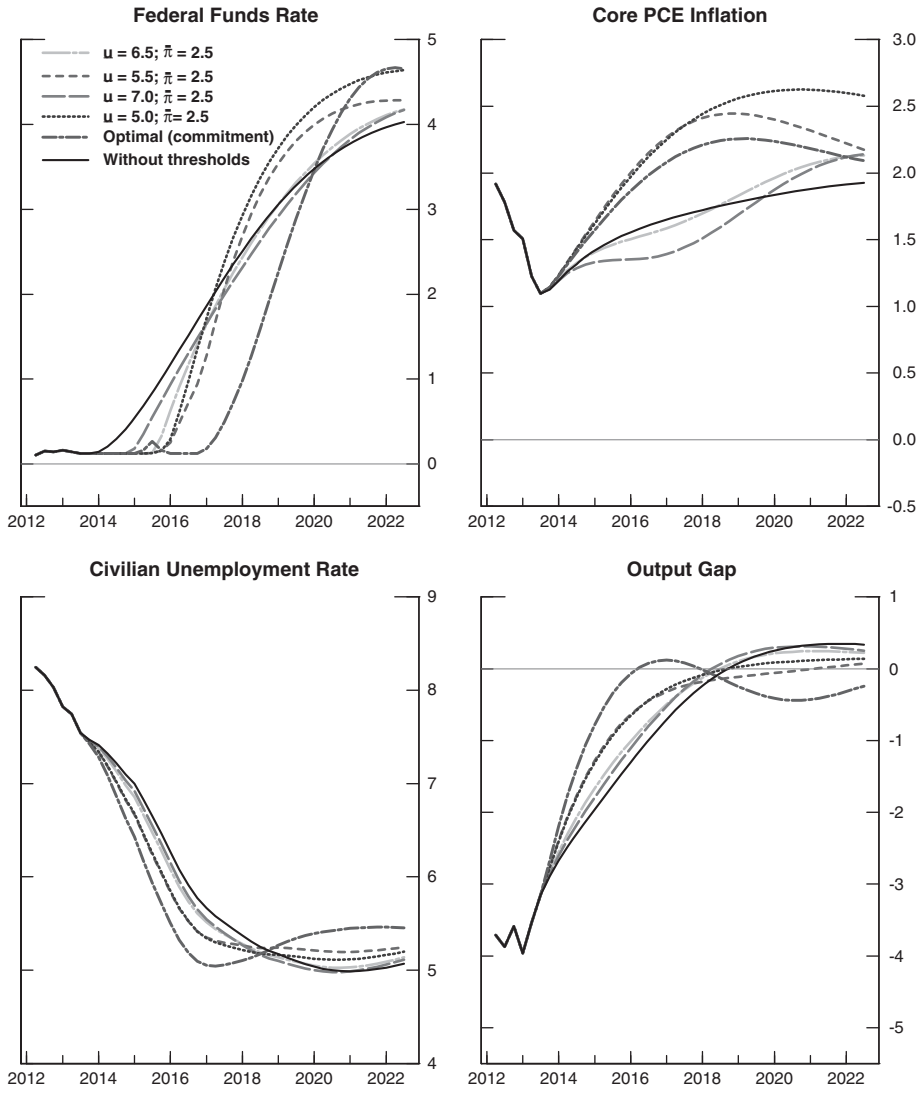
Following this strategy, the policymaker might choose to specify thresholds for the inflation rate and unemployment rate to clarify conditions governing the onset of tightening. In addition, forward guidance could be used to clarify the strategy the central bank intends to follow after it initiates tightening. In this vein, the policymaker might emphasize that its intended exit strategy embeds key features of the optimal policy; hence, such guidance could be interpreted as consistent with "flexible inflation targeting under commitment." Specifically, the policymaker could indicate that it would permit inflation to rise modestly, but temporarily, above its 2 percent mandate on the grounds that a period of higher inflation, in conditions of a short-term nominal interest rate fixed at the ELB, would imply a reduction in real interest rates and hence stimulate demand.

We now explore the potential macroeconomic effects of adopting a threshold strategy using simulations of our model. We consider both the macroeconomic implications of setting thresholds at different levels and the importance of what monetary policy does after a threshold is crossed. In light of the highly uncertain outlook for real activity and inflation, we next investigate the likely performance of a threshold strategy in the face of unexpected economic developments, based on the sort of shocks that have hit the economy over the past 40 years. Both the choice of a threshold pair and the associated choice of the post-crossing policy rule may have an important bearing on expectations formation and economic performance. For example, if the Committee were to choose a relatively low threshold for the unemployment rate and a high threshold for inflation, it would, in effect, be signaling an intention to be persistently more accommodative than would be suggested by historical experience or by most simple policy rules.

Our analysis starts with the assumption that the public currently expects the economy to evolve along the lines shown in the solid line of Figure 3 which corresponds to the outcomes obtained under the inertial Taylor rule. We then consider the consequences of an announcement that the FOMC intends to follow a threshold strategy. For example, the yellow dot-dashed line shows one particular threshold pairing in which the federal funds rate is held near zero at least until *either* the unemployment rate falls below 6.5 percent, *or* core PCE inflation over the medium term is projected to exceed 2.5 percent.[35] We employ a projection-based inflation threshold in order to reduce the possibility that transitory fluctuations in inflation related to energy or other shocks could lead to the threshold being crossed. In addition, the simulations assume that once either threshold condition is crossed, the federal funds rate then follows the prescriptions of the inertial Taylor rule. It is important to understand that the switch in policy

[35]Specifically, the inflation threshold is defined in terms of the eight-quarter-ahead projection of the trailing four- quarter rate of core PCE price inflation as forecast by the model. In the absence of future shocks, the inflation forecast will equal the actual future rate of inflation generated in the simulation and will be consistent with the current and projected future path for policy.

Figure 3. Implications of Alternative Unemployment Threshold Values
(Inertial Taylor rule)



upon crossing a threshold does not imply an immediate increase in the federal funds rate; rather a crossing merely implies that forbearance regarding the policy rule's prescriptions comes to an end.[36] Importantly, the public is assumed to understand the announced change in policy and to view it as fully credible.

Under the 6.5/2.5 percent threshold pair, the federal funds rate begins to rise from its ELB six quarters after the prescription without thresholds, gradually

[36]Other assumptions are possible, of course. One could assume that policy reverts to the simple rule gradually over time, for example. The approach taken here has the advantage of simplicity.

climbs to 3 percent by 2018, and after that eventually rises above the trajectory without thresholds. In other words, the threshold strategy moves monetary policy away from that of the unadorned inertial Taylor rule—the solid line—some distance toward the optimal commitment policy—the dot-dashed line). As might be expected, this threshold pair gives better economic outcomes than the rule without thresholds but falls considerably short of the performance of the (possibly infeasible) commitment strategy. The remaining lines in the figure show the policy prescriptions and economic effects of other threshold pairings, where each pair holds the inflation threshold constant at 2.5 percent and varies the unemployment threshold. Summarizing these results for this baseline model, and simple policy rule, reducing the unemployment threshold improves measured economic performance until the unemployment threshold reaches 5.5 percent: A further reduction in the threshold to 5.0 percent, however, reduces welfare, as the control of inflation becomes notably less precise.

Figure 3 also illustrates the potential implications of altering market expectations regarding the behavior of the funds rate *after* firming begins, again conditional on the baseline outlook for real activity and inflation. As the figure shows, late departures in the federal funds rate that occur with lower unemployment thresholds are associated with steeper subsequent climbs in the federal funds rate. Because current economic conditions are determined in large part by expectations of the entire future path of the real federal funds rate, these sharp climbs offset, to some degree, some of the stimulative effects of deferred firming. A post-lower-bound policy that is more gradual would produce a larger initial boost in aggregate demand, albeit possibly at some cost. This result highlights the potential importance of guidance about the Committee's intentions for the stance of monetary policy after the onset of tightening.

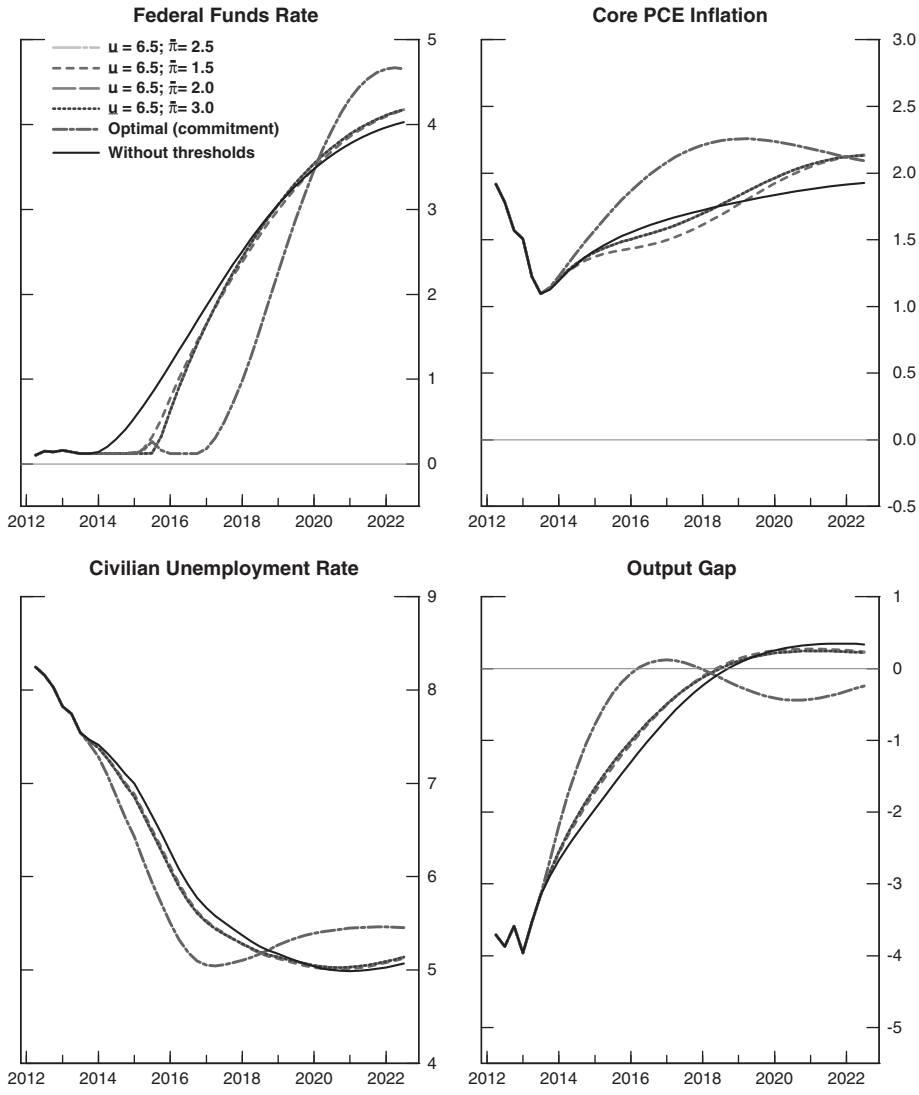
Figure 4 repeats the exercise of Figure 3, except that this time it is the unemployment threshold that is held constant, at 6.5 percent, and the inflation threshold is varied from 1.5 to 3.0 percent. In this instance, varying the inflation threshold has comparatively small implications—and indeed over some range, no material implications—for economic outcomes.[37,38]

Our analysis to this point has examined how threshold strategies influence real activity, inflation, and interest rates under baseline conditions. We now broaden the analysis by evaluating macroeconomic performance under threshold strategies in response to a wide range of economic disturbances. To do this, we run stochastic simulations of the model, an approach that allows us to construct probability

[37]We warn the reader that this result is not general. There are combinations of models, baselines, and policy rules for which the adjustment of the inflation threshold would have a material effect on measured losses.

[38]Measured using the same loss function as was used to construct the optimal policies, the rankings of the various threshold policies, with the inertial Taylor rule, for the baseline scenario as of 2018:Q4 are, from lowest loss to highest: commitment > discretion >5.5/2.5>5.0/2.5>6.0/2.5>6.5/2.5 = 6.5/2.0 = 6.5/3.0>6.5/1.5> no thresholds, where the first number in a pair is the unemployment threshold and the second is the inflation threshold.

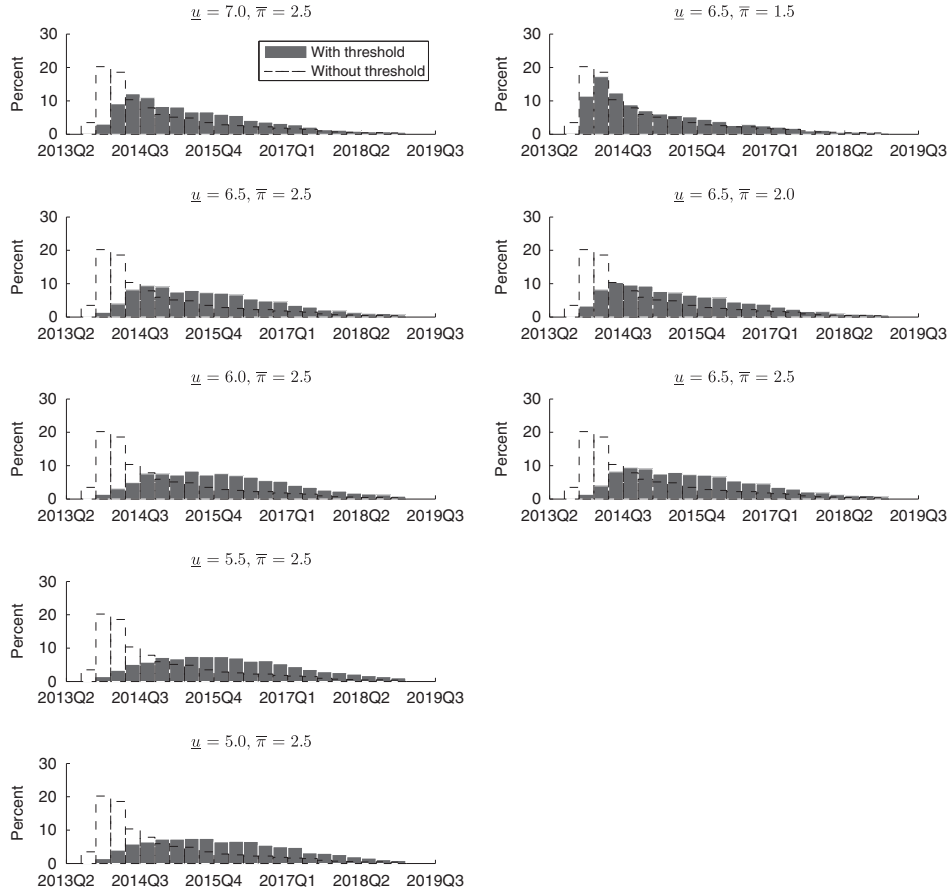
Figure 4. Implications of Alternative Inflation Threshold Values
(Inertial Taylor rule)



distributions for future economic conditions. To save space, we focus on results for the inertial Taylor rule.

The hollow bars in the various panels of Figure 5 repeat what we showed in one panel of Figure 2, namely the distribution of the dates of the first increase in the funds rate for the inertial Taylor rule without thresholds. The blue solid bars, lying on top of the hollow bars, show how the distribution is shifted by the implementation of the threshold strategy. The left-hand column shows the effects of varying the unemployment threshold, holding constant the inflation threshold at

Figure 5. Probability of Liftoff from the Effective Lower Bound by Calendar Date
(Stochastic simulations under inertial Taylor (1999b) rule, with and without thresholds)



its baseline value of 2.5 percent; the right-hand column varies the inflation threshold, holding the unemployment threshold at its baseline value of 6.5 percent. The values of the unemployment threshold have an important bearing on the date that the federal funds rate departs from the ELB, as all of the thresholds shown lead to a substantial deferral of first tightening. At the same time, it is worth noting that while the strategy quells some possible apprehension on the part of private agents regarding what could be an inappropriately early firming, the cost of this is a general reduction in the predictability of firming dates and an associated decline in the effectiveness of calendar-based forward guidance that might serve as a complement to threshold strategies.

The effects of varying the inflation threshold are less impressive but still noteworthy. Even a very low threshold rate of 1.5 percent for inflation shifts the distribution noticeably. Indeed, the fact that the choice of the inflation threshold does

Table 1. Influence of Threshold Settings on the Expected Timing of Threshold Crossing and Related Factors (Stochastic Simulations of a Small FRB/U.S. Model)

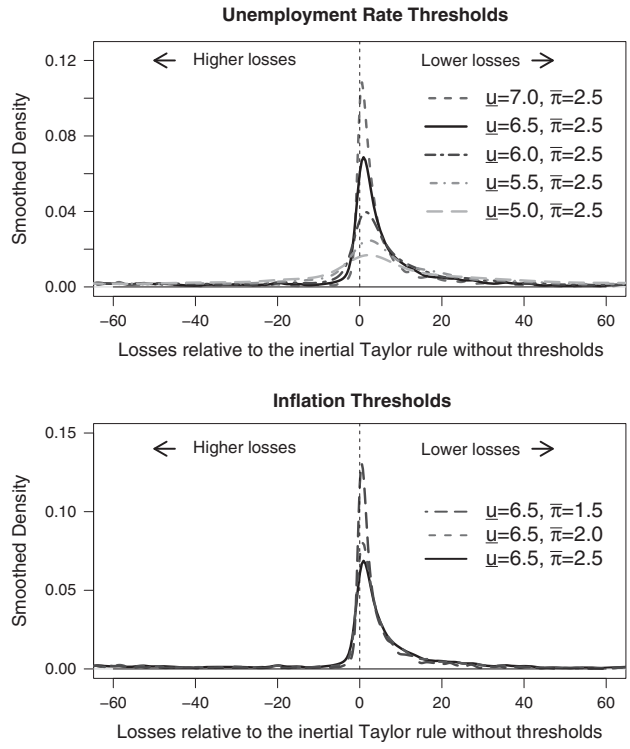
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
	Median Date of First Time		Percentage of Crossings Caused by Reaching the:		Policymaker Loss		
	Crossing	Initial tightening	Unemployment threshold	Inflation threshold	Mean	Median	Loss improvement share
Inertial Taylor rule	NA	2014:Q2	NA	NA	116.48	96.46	NA
$u = 5.0; \pi = 2.5$	2015:Q3	2015:Q4	59.62	42.99	97.92	78.2	81.42
$u = 5.5; \pi = 2.5$	2015:Q3	2015:Q4	66.49	36.33	102.38	82.7	85.08
$u = 6.0; \pi = 2.5$	2015:Q2	2015:Q4	73.24	29.69	105.85	85.71	87.92
$u = 6.5; \pi = 1.5$	2014:Q2	2014:Q4	50.88	53.5	111.3	92.09	94.71
$u = 6.5; \pi = 2.0$	2014:Q4	2015:Q2	68.7	34.72	109.17	89.91	92.84
$u = 6.5; \pi = 2.5$	2014:Q4	2015:Q3	79.69	22.88	108.45	89.21	91.26
$u = 7.0; \pi = 2.5$	2014:Q2	2015:Q1	86.67	15.44	110.5	91.31	94.05

affect the likely date of firming in a stochastic environment, whereas under the baseline scenario it had little to no effect, stands as an important reminder that monetary policy design, broadly conceived, needs to consider a range of economic outlooks.

Table 1 presents some statistics on our stochastic simulation runs. Comparing columns [1] and [2] shows that there can be a substantial delay between the date a threshold is crossed and the date of initial tightening. Columns [3] and [4] note how changes in the threshold pairings alter the likelihood that one threshold or another will be crossed, in ways that one might expect. This clearly shows that thresholds are effective in shifting the date of firming; however, it says nothing about whether they deliver favorable economic outcomes. The remaining columns address this question by providing some estimates of economic performance. In particular, column [7] shows the proportion of stochastic draws for which the use of the threshold policy gives better economic performance than does the policy rule without thresholds, as measured by the same loss function we used in constructing the optimal policies above. As can be seen, the proportion of draws that feature improvements in welfare is high to very high, regardless of the threshold pair. In short, thresholds work. At the same time, there is some evidence of tradeoffs between performance on average and performance in the tail cases as can be seen in comparing losses for the 5.0/2.5 thresholds with those with the other threshold pairs. The 5.0/2.5 pair, shown in the second line of the table, renders the lowest loss, on average and at the median, but the share of draws for which welfare is improved is notably lower than for other pairs. This finding hints at certain fragility in expected improvements in welfare as policy forbearance becomes more aggressive.[39]

[39]The key result that welfare is improved by the use of thresholds in a high to very high proportion of draws holds up almost as well when the model is simulated assuming that agents form

Figure 6. Effects of Threshold Policies on Economic Performance
(Losses relative to the inertial Taylor rule without thresholds)



A bit more evidence on economic performance under threshold policies and policymakers' choices in this regard is contained in Figure 6. The figure shows the (smoothed) density of changes in loss from using a given threshold pair, relative to a no-threshold base case, as computed from the same stochastic simulations that are described in Table 1. Mass to the right of the gray vertical line at zero represent draws that feature improvements in economic outcomes. As can be seen, aggressive threshold pairs, like the 5.5/2.5 pair, present greater opportunity for economically meaningful improvements in performance; however, they also present a more substantial likelihood of a deterioration in performance than do less aggressive pairs like the 7.0/2.5 pair.

Although thresholds work on average, performance can vary significantly depending on conditions. Examining those draws for which marked improvements in economic performance are realized with thresholds and comparing those with the identical scenario without thresholds is instructive.

expectations using a small-scale VAR model, rather than model-consistent expectations. Details of these simulations are available from the authors upon request.

Draws for which the effects of the 6.5/2.5 threshold pair are salutary tend to have relatively high realized inflation in the early going of the scenario—such that policy rules without thresholds have a tendency to prescribe that the federal funds rate be raised above the ELB—but not so high and not so persistent that the projection-based inflation threshold is crossed. Thus, the thresholds in these draws tend to produce a substantial degree of policy forbearance as measured by the length of time for which the first funds rate increase is deferred. Particularly large improvements also arise when a sequence of real-side shocks brings about an increase in the unemployment rate, in contrast to the downward trend in the baseline, as these are the circumstances in which "staying lower for longer" is particularly beneficial. Not surprisingly these draws often feature regret in the sense of a return to the ELB within four quarters in the version without thresholds.[40]

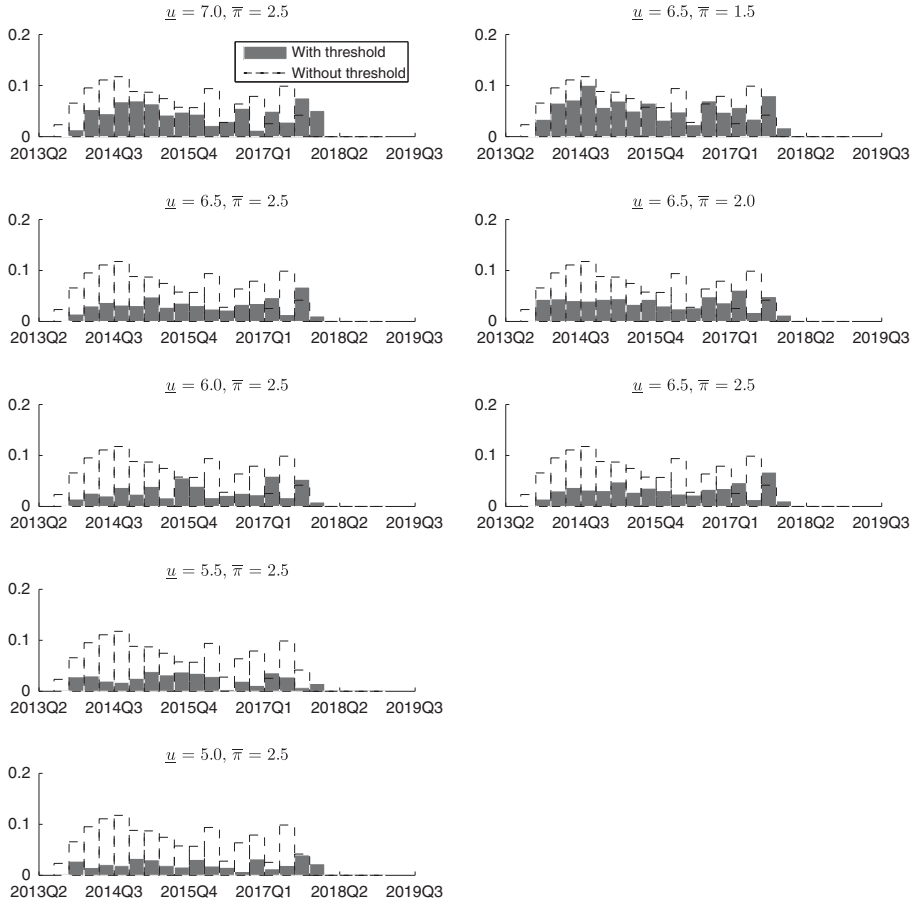
Finally, in Figure 7, we reconsider the probability of return to the ELB, following initial departure, this time for our threshold strategies. Just as we saw that even mildly restrictive thresholds may have a material effect on probabilities of leaving the lower bound, so too do they have an effect on the likelihood of returning to the lower bound. As the figure shows, the introduction of thresholds reduces the sensitivity of the inertial Taylor rule to modest changes in economic conditions because it is less likely that the rule will respond to what turns out to be a purely transitory improvement in real activity or in inflation and calls for policy to begin to tighten, only to find that the policy rate needs to return to the ELB shortly thereafter.[41]

The likelihood of regret and the associated difficulty in predicting firming dates underscores the communication challenges associated with the use of threshold strategies. Ideally, thresholds would be cast in terms of readily verifiable and easily understandable measures. The variables that matter, however, in economic models—such as output gaps and unemployment gaps—are harder for the public to understand and, in any case, are often only narrow proxies for broader concepts of "excess demand" in the minds of policymakers. The probability that a threshold pair would need to be recalibrated because of shifts in, say, labor market conditions that are not well captured solely by fluctuations in the unemployment rate—driven by movements in the labor force participation rate, for example—is not something that can be safely ignored. Broadly similar communications challenges arise as a result of the use of *projected* inflation in place of realized inflation because of the volatility of the latter, buffeted as it is by significant but transitory shocks.

[40]It seems reasonable to expect that a baseline in which the proportion of threshold crossings that arise from crossing the inflation threshold is higher would produce more draws where thresholds produce large gains. We have not formally tested this proposition, however.

[41]The effect of thresholds is more substantial in terms of both the deferral of policy firming and the likelihood of returning to the zero lower bound for static policy rules like the Taylor (1993) and Taylor (1999b) rules because, as we have already shown, these rules tend to produce early firming and these often turn out to be deleterious for economic performance. For example, the 6.5/2.5 threshold pair improves welfare in 95 percent of draws for the Taylor (1999b) rule.

Figure 7. Probability of Returning to the ELB within Four Quarters of Liftoff
(Stochastic simulations under inertial Taylor (1999b) rule, with and without thresholds)



Summary

Our examination of the possible benefits of employing threshold-based forward guidance suggests that thresholds, if understood and seen as credible, can significantly improve economic outcomes. Of course, such guidance could also be delivered by providing the expected date of the first increase in the federal funds rate conditional on the economic outlook. However, as we saw, that approach would likely require a number of changes in the date as the outlook evolved, which could be confusing to the public and undermine the credibility of the forward guidance. The analysis also suggests that guidance regarding the federal funds rate after it is first increased from its ELB can also improve performance. Indeed, the FOMC arguably included such guidance, albeit qualitatively, in some of its postmeeting statements, which indicated that "when the Committee decides to begin

to remove policy accommodation, it will take a balanced approach consistent with its longer-run goals of maximum employment and inflation of 2 percent."[42]

Communications and Unconventional Policies at Foreign Central Banks

Although the discussion thus far has focused on the recent experience of the Federal Reserve, a number of foreign central banks have faced policy challenges similar to those faced by the Federal Reserve. As was the case in the United States, in many instances the nontraditional tools adopted by foreign central banks were an outgrowth of extant policies regarding central bank communications.[43]

In Japan, the BOJ has provided greater clarity on its goals and intentions over time. The BOJ's mandate, like that of the Federal Reserve, does not provide a numerical inflation objective, but rather calls for the BOJ to aim policy at "achieving price stability, thereby contributing to the sound development of the national economy" (Bank of Japan Act, Article 2). In the face of ongoing deflation, the Bank indicated in 2006 that it intended to "realize price stability over the medium to long term" and that the Policy Board members understood price stability to be a year-over-year change in the consumer price index (CPI) of between 0 and 2 percent (Bank of Japan (2006)). This framework set the stage for the BOJ to launch, in October 2010, an "Asset Purchase Program" (APP) whose size reached ¥101 trillion (more than 20 percent of GDP) by December 2012.[44] Alongside the launch of its APP, the BOJ declared its intention to maintain zero interest rates until it judged that price stability was in sight on the basis of its "medium- to long-term understanding of price stability (i.e. 1 percent)."

In 2012, the Policy Board introduced a "price stability goal in the medium to long term" of a positive range of 2 percent or lower in the year-over-year change in the CPI, and further noted that within this range it set a goal of "1 percent for the time being" (Bank of Japan, 2012). More recently, the Policy Board has set a "price stability target" of 2 percent by the same measure (Bank of Japan, 2013a). At the same time, the Policy Board provided information on its policy strategy, indicating that monetary policy would be aimed at sustainable growth and price stability "over the next two years or so" and also at longer-term risks, particularly financial imbalances. This strategy was further elaborated in April, with the

[42]As noted above, the Committee has made further changes to its forward guidance after the preparation of this paper. Those changes included the inclusion of additional guidance regarding the path of the federal funds rate after liftoff. In particular, the statement indicates that "The Committee currently anticipates that, even after employment and inflation are near mandate-consistent levels, economic conditions may, for some time, warrant keeping the target federal funds rate below levels the Committee views as normal in the longer run" (see FOMC, 2014).

[43]The working paper version of this paper includes a table summarizing unconventional monetary policies implemented by major foreign central banks to provide extra support to economic activity after reaching the effective lower bound on short-term policy rates. Additional unconventional policies have been announced since that paper was prepared.

[44]The APP program covered a wide range of both public and private securities; purchases were unsterilized and concentrated in relatively short-term securities.

introduction of "Quantitative and Qualitative Monetary Easing," under which the Policy Board announced steps to achieve its price stability target at the earliest possible time, "with a time horizon of about two years" (Bank of Japan, 2013b). This forward guidance was buttressed by the BOJ's replacement of the APP by a new, more aggressive "Quantitative and Qualitative Easing" program that was slated to significantly extend the average remaining maturity of Japanese government bonds purchased and to double the BOJ's balance sheet to about 60 percent of GDP by late 2014, which should exert downward pressure on longer-term rates.

The Bank of England has also steadily increased the clarity of its communications in recent years. As of 2003, the remit of the Monetary Policy Committee was to secure an inflation rate of 2 percent and, conditional on that, to support the economic policy of the government, including its objectives for growth and employment (HM Treasury, 2003). In 2013, however, with inflation running above the 2 percent target in part because of increases in administered and regulated prices as well as changes in exchange rates, both the Monetary Policy Committee and the U.K. Treasury indicated that they saw it as appropriate to "look through" even fairly protracted periods of above-target inflation rather than "risk derailing the recovery by attempting to return inflation to target sooner" (Bank of England, 2013; HM Treasury, 2013). More broadly, the U.K. Government's March 2013 remit to the Monetary Policy Committee spelled out in greater detail the approach to be taken to monetary policy decisions in the context of a primary objective of medium-term price stability. In particular, the Treasury called for "an appropriately balanced approach" to the Committee's objectives, including to the tradeoffs between the inflation objective and the Committee's goals with regard to the variability of output and financial stability, as well as for greater transparency regarding the Monetary Policy Committee's decisions with regard to such tradeoffs (HM Treasury, 2013). Thus, despite what might sound like a lexicographic mandate, the BOE effectively became a "flexible inflation targeter."

In March 2013, the U.K. Treasury authorized the BOE to assess the merits of using intermediate activity and inflation thresholds. Subsequently, the BOE announced on August 7, 2013, its intention "not to raise Bank Rate from its current level of 0.5 percent at least until the Labour Force Survey headline measure of the unemployment rate has fallen to a threshold of 7 percent." The guidance was subject to three "knockout conditions": first, that the Monetary Policy Committee expects inflation to exceed its 2 percent target by more than 0.5 percent 18-24 months ahead; second, that market participants' medium-term inflation expectations are no longer sufficiently well anchored; and third, that the Financial Policy Committee judges that the stance of monetary policy poses a significant threat to financial stability.[45] In this

[45]Importantly, the Bank of England stated that there is "no presumption that breaching any of these knockouts would lead to an immediate increase in the Bank Rate or sale of assets." Thus the knockout conditions are thresholds, not triggers.

respect, the approach taken by the BOE was similar to that taken by the Federal Reserve.[46]

The ECB has not provided as much additional information on its objectives or policy approach in recent years as have some other central banks. The ECB's objective for monetary policy is set by treaty to be price stability, and, "without prejudice to that objective, support of the general economic policies of the European Union" (ECB, 2011). In 1998, the ECB defined price stability to be a year-over-year increase in the Harmonized Index of Consumer Prices for the euro area of below 2 percent over the medium term. This broad definition was subsequently clarified in 2003, when the Governing Council of the ECB indicated that it would aim to keep euro area inflation "below, but close to" 2 percent over the medium term. The treaties of the European Union provide no additional guidance on how the ECB might, for example, balance the time period over which it aims to achieve its price stability objective against other objectives such as growth or financial stability. Nevertheless, in the wake of the euro crisis and the recession it spawned, the Governing Council stated in 2013 that policy rates will remain at current or lower levels for "an extended period of time" given the "subdued outlook for inflation …, the broad-based weakness in the economy and subdued monetary dynamics" (ECB, 2013a). Further support to real activity and financial stability was provided through programs of outright asset purchases. Under the "Securities Market Programme," the ECB bought €208.7 billion in peripheral euro area securities. The program operated from May 2010 to August 2012 before being replaced by the Outright Monetary Transactions (OMTs) program. OMTs, although they have yet to be activated, would allow the ECB to purchase shorter-term sovereign debt of euro area countries conditional on the countries' participation in a European Financial Stability Facility/European Stability Mechanism macroeconomic adjustment program. The mere announcement of the OMT program appeared to have a noteworthy salutary effect on the euro area economies.[47]

With regard to forward guidance, the ECB has also been less active than other major central banks. That said, on July 4, 2013, the ECB adopted a qualitative form of forward guidance by adding the following language to the statement that follows its monetary policy decisions: "The Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time. This expectation is based on the overall subdued outlook for inflation extending

[46]Even earlier, in June 2013, the Monetary Policy Committee used forward guidance to talk down longer-term U.K. interest rates that were coming under upward pressure in response to increases in U.S. yields following the June 2013 FOMC meeting, stating that "the implied rise in the expected future path of Bank Rate was not warranted by the recent developments in the domestic economy."

[47]Although refinancing operations are not identical to large-scale asset purchase programs, the two sets of policy actions have strong parallels, and the ECB's massive and unsterilized LTROs have been credited for some of the same positive effects on financial markets, notably a reduction in peripheral-country interest rates (Rogers, Scotti, and Wright, 2013). The ECB also ran two covered bond programs between mid-2009 and late 2012, with cumulative purchases of €76 billion (¾ percent of GDP). More recently, the ECB has announced plans to purchase large amounts of private assets (ECB, 2014). Since the preparation of this paper, the ECB has also announced plans to purchase sovereign assets.

into the medium term, given the broad-based weakness in the real economy and subdued monetary dynamics."

Other Notable Actions

In addition to forward guidance and asset purchases, some central banks have pursued programs intended to bolster lending to the private sector. For example, the BOE and U.K. Treasury announced a "Funding for Lending Scheme" in June 2012 that was designed to provide an incentive for banks to boost their lending to the nonfinancial sector. Under the program, participants can swap a wide range of assets for Treasury Bills. Using the Bills as collateral improves their liquidity positions and should help them borrow in private funding markets at lower rates than they would otherwise be able to obtain.

Similarly, since June 2010, the BOJ has implemented a series of initiatives to support lending to the real sector through a ¥5.5 trillion (1¼ percent of GDP) "Loan Support Program." The largest initiative, the "Growth-Supporting Funding Facility," is fully operated by the BOJ, with its staff reviewing the eligibility of individual loans and monitoring their progress.

II. Questions Regarding Monetary Policy Frameworks Raised by the Financial Crisis and its Aftermath

Not surprisingly, the financial crisis and the ensuing, severe recession have raised additional questions about the most appropriate framework for monetary policy. In this section, we consider whether policymakers could improve economic performance by changing their objectives. In particular, it has been suggested that introducing a higher (permanent) target rate of inflation could provide more of a buffer against the ELB constraint on nominal interest rates and so allow for improved economic outcomes (Blanchard, Dell'Ariccia, and Mauro, 2010). Alternatively, as we discussed above, given the benefits that can be achieved when the nominal interest rate is at its lower bound from a policy that is history-dependent, some have suggested that central banks should target a path for the level of nominal GDP (Woodford, 2012b).

Possible Benefits of a Change in Objective

As we will discuss below, a key issue regarding a possible change in the central bank's objective is the importance of credibility for any change in regime to be successful, especially during a period when short-term rates are constrained by the lower bound and so conventional policy instruments are constrained. Achieving such credibility could be difficult, and a change in objective might be seen by financial market participants and wage and price setters as either confusing or not credible, raising significant communications issues that could undermine the economic benefits of the change.[48]

[48]Indeed, to the best of our knowledge, only once has an inflation-targeting country raised its target without also changing the targeted variable. That was New Zealand in 1997 when it widened its inflation band from 0-to-2 percent to 0-to-3 percent.

An additional, related complication is that there is remarkably little experience with either price-level targeting or nominal income targeting. The one clear-cut historical precedent for price-level targeting is when Sweden abandoned the gold standard in 1931 and attempted instead to maintain the September 1931 price level (Fregert and Jonung, 1999). The policy was associated with Sweden's avoidance of the deflation that plagued countries still operating under the gold standard, but whether there is much to take from this for modern times is questionable. No country has centered its monetary policy strategy on a nominal income target.

A Permanent Increase in the Target Rate of Inflation

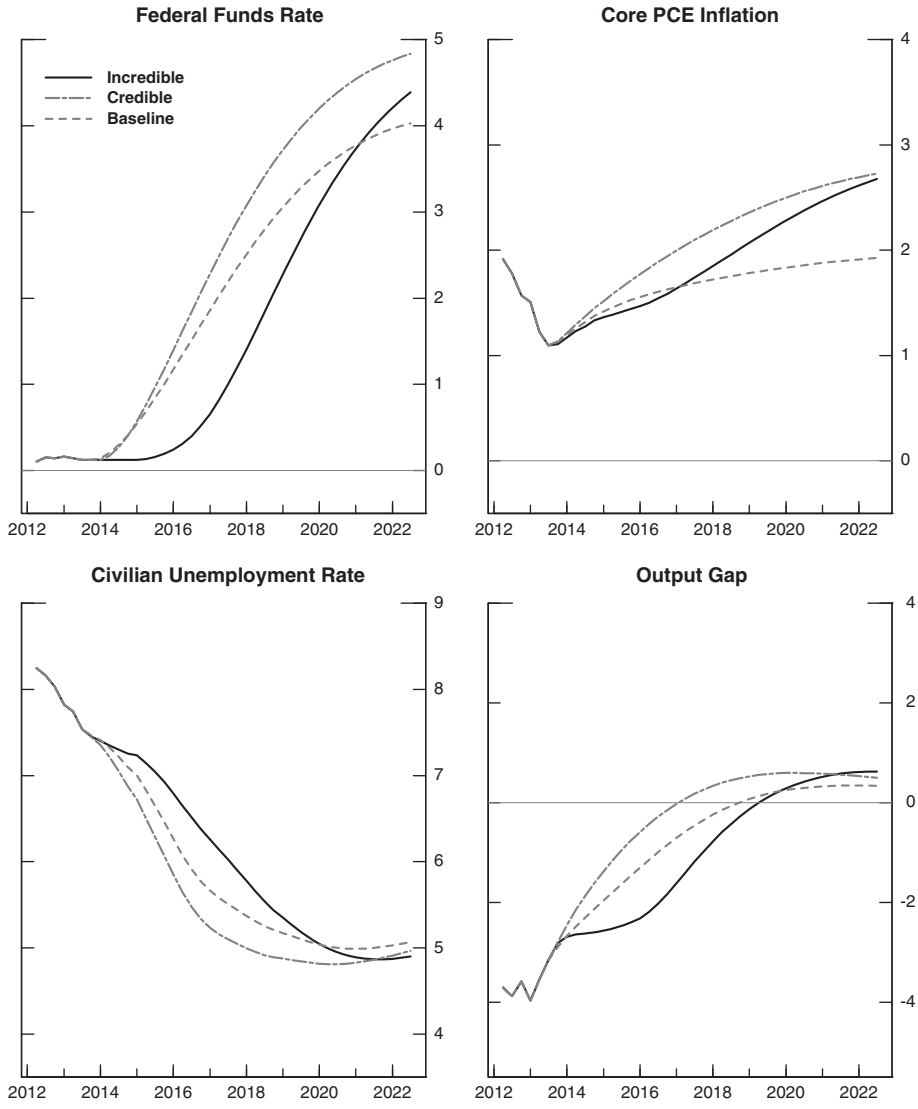
There is a substantial literature on the costs of inflation, one that is too large (and too well known) for us to survey here. We take it for granted that prior to the crisis the case for defining "price stability" as steady-state inflation near 2 percent for broad indices of prices was a compelling one, in part because of the effects of the ELB on interest rates.[49] A more interesting issue, from our point of view, is whether a case can be made for engineering a permanent increase in the inflation rate under current conditions in which the ELB is binding, inflation is below its current target, and the economy is likely in excess supply.

In the stylized world of textbook rational expectations models, the question almost answers itself: A credible increase in the target rate of inflation would reduce real interest rates, relax the ELB constraint, and thereby help conventional monetary policy to regain its effectiveness. Moreover, it would also reduce the asymmetric effects of negative shocks on the economy. But reality introduces a number of practical concerns. After all, if policy were as credible as textbooks assume, inflation would arguably already be at its (current) target. Indeed, the question of how agents can be expected to arrive at rational expectations—especially in an environment of imperfect policy credibility—is a valid one. The literature shows that a rational expectations equilibrium can arise out of a process of learning, provided that a given policy is in place long enough for private agents to learn it (see, for example, Evans and Honkapohja, 2001). Whether agents can be expected to come to understand a change in a policy rule, such as a change in the target rate of inflation, and form a rational expectation of the implications of that rule without experiencing the regime beforehand, is an open question.

Figure 8 provides one illustration bearing on the above issues. The dot-dashed line shows the effects of a credible, once-and-for-all increase in the target rate of inflation to 3 percent, under the inertial Taylor rule. Compared with the baseline case introduced in Figure 1 and shown here as the dashed line, where the target remains at 2 percent, the higher path for inflation induces a more rapid increase in the nominal federal funds rate. Real interest rates, however, are lower than in the baseline, so the unemployment rate falls considerably more rapidly than in the baseline, as shown in the lower-left panel.

[49]Recently, Coibion, Gorodnichenko, and Wieland (2012) explicitly study, in the context of a modern macroeconomic New Keynesian model, the effect of the ELB on the optimal inflation rate, and they find that, for plausible calibrations, an inflation target around 2 percent is robustly optimal.

Figure 8. Increase in Inflation Target with and Without Policy Credibility
(Inertial Taylor rule)



However, this result depends on rational expectations and the credibility of the change in objective. In an alternative simulation, shown by the solid lines, we assume that while expectations in financial markets continue to be rational in the usual sense of that word, the expectations of agents in nonfinancial markets are formed using a small-scale VAR model.[50] This assumption means that the

[50]Indeed, VAR-based expectations are a standard assumption for simulations of the FRB/U.S. model, although rational expectations are also commonly assumed. See Brayton and Tinsley (1996) for a discussion.

"free lunch" of a credible increase in the *perceived* target rate of inflation from the mere announcement of a higher target is not available. In this instance, part of the increase in nominal bond rates observed by nonfinancial agents is perceived as an increase in real rates, leading to a reduction in expenditures and prices in the short run. The monetary authority responds to these "headwinds" by deferring departure from the ELB. The deferral in tightening notwithstanding, the improvement in the real economy proceeds at pace that is initially even slower than in the baseline and inflation is lower than in the baseline for a time, as the lower panels show.

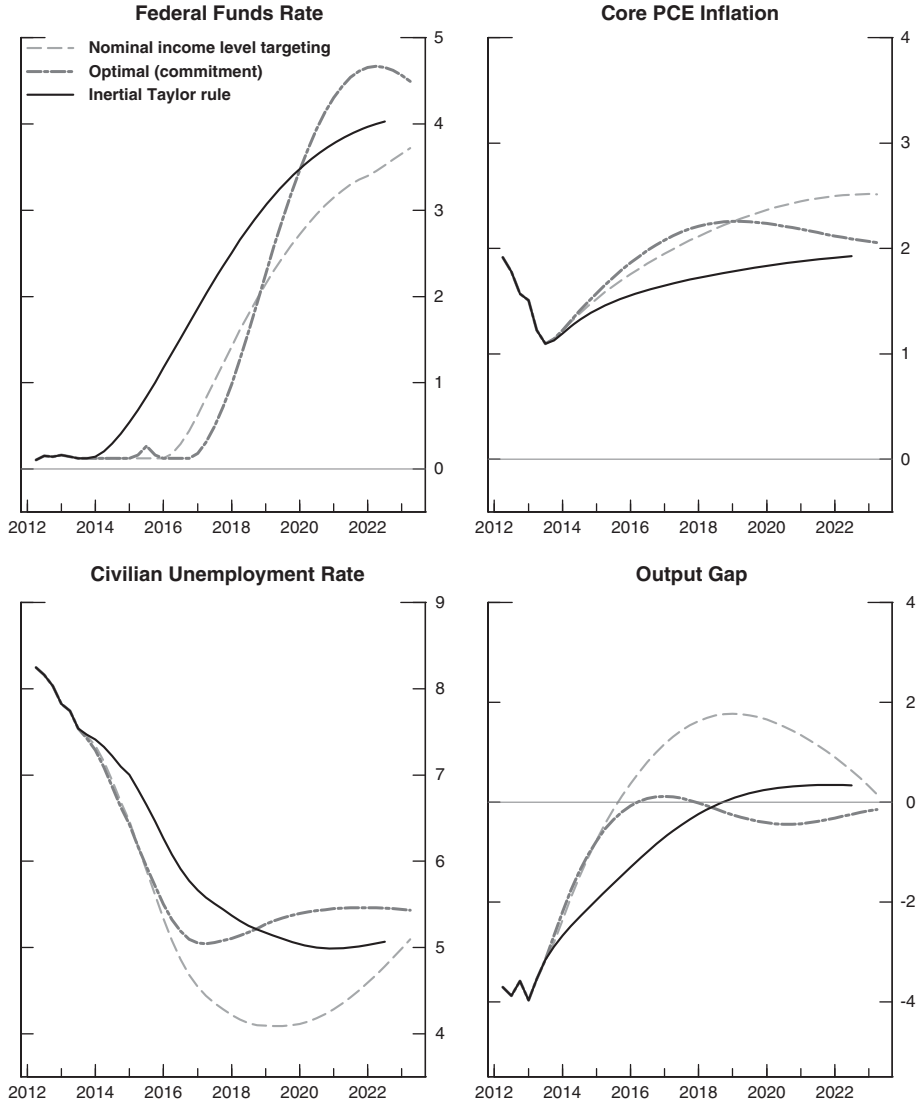
There is nothing to say that the pessimistic scenario portrayed by the solid line is more likely than the credible rational expectations scenario. And other possibilities come easily to mind, including ones in which the perceived target rate of inflation exceeds the central bank's actual target, obliging a subsequent costly contraction. What these scenarios do effectively highlight, however, is how critical expectations formation is for the efficacy of policy at the ELB.[51]

Nominal Income Targeting

In an earlier section we discussed the features of optimal policies at the ELB, in particular their propensity to promise "lower for longer" as a funds rate prescription and to generate a modest overshooting of inflation of its long-run target. However, such optimal policies are of limited usefulness, partly because they are complex and model dependent, but also because they do not reveal how the Committee would respond to changes in the economic outlook. We also discussed how simple policy rules could be augmented with thresholds in order to go at least part of the way toward optimal commitment policies and thereby generate results closer to policymakers' goals. In this section, we consider another strategy, the adoption of an intermediate target for nominal income. As recently reemphasized by Woodford (2012b), pursuing a nominal income *level* target implicitly aims to reverse past inflation shortfalls rather than let bygones be bygones, thereby inducing a form of history dependence that moves policy a step closer to the optimal policy with commitment under the ELB in the context of New Keynesian models. Under this approach, the Committee would choose a target path for nominal income, y_N^*, and commit to using available instruments to minimize the gap between nominal income and this target (or a forecast of the gap) over time. It is useful to decompose the nominal income target into a price-level component and an activity component (that is, $y_N^* = p^* y^*$, where p^* is the price-level target, and y^* is the real output target). Importantly, nominal income targeting does not necessarily require agreement on an estimate of the output gap, as different views on the output gap would simply correspond to different implied paths for the price level over the medium term to achieve a given nominal income target. Once the nominal income gap is closed, however, such a strategy would imply similar outlooks for inflation and economic growth in the longer run as would be the case with price level targeting, assuming

[51] Ascari and Sbordone (2013) provide a theoretical discussion of similar issues and emphasize that a permanently higher inflation rate will be associated with a more unstable economy and will tend to destabilize inflation expectations.

Figure 9. Nominal Income Level Targeting



broadly similar views regarding the growth rate of potential GDP going forward. Just as the choice of a target path is a major ingredient of price-level targeting, the choice of a target path for nominal income is important for nominal income targeting. A simple extrapolation of the price component of the target at a 2 percent rate is a natural choice; with regard to the target path for output, a reasonable course would be to base the path for y^* on current estimates and forecasts of the economy's potential output, and then to update the projections on a periodic basis.

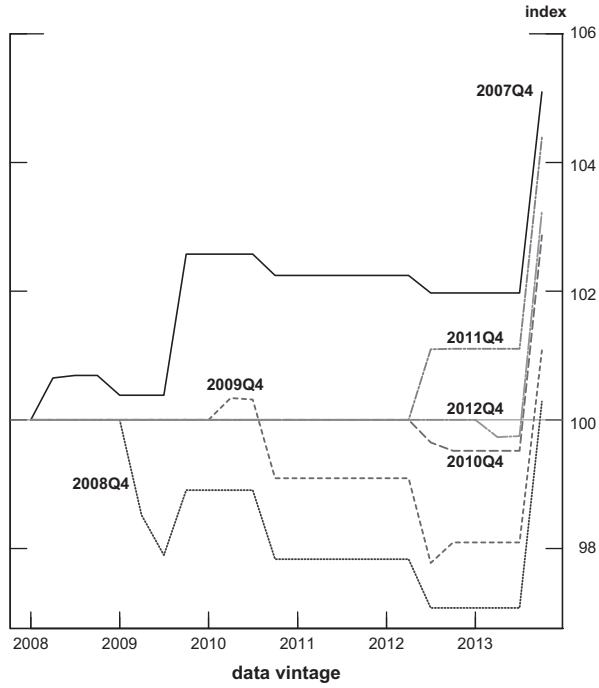
One appealing feature of a nominal income target in the U.S. setting is that it explicitly recognizes both sides of the dual mandate. Indeed, the equal weights on

the price-level gap and output gap would be consistent with a similar degree of concern for both objectives. A nominal income target could also provide effective forward guidance to reinforce market perceptions about the strength of the Committee's desire to keep interest rates low for an extended period, given that the gap between nominal income and target could initially be quite large. Of course, the Committee would need to make it clear to the public that the nominal income targeting framework is not simply a cover for engineering a temporary or perhaps permanent rise in the inflation target; to this end, the Committee would want to demonstrate that the implicit gap in resource utilization underlying the initial nominal income gap was reasonable.

Figure 9 illustrates how nominal income targeting might move policy a step closer, compared with the inertial Taylor strategy, to the optimal policy under our baseline scenario. The delayed firming from the ELB under nominal income targeting—the dashed lines in the figure—like the commitment strategy, leads to a sharper reduction in the unemployment rate than under the inertial Taylor rule. This rapid real-side improvement is facilitated by a moderate overshooting of inflation of its target, which reduces the real rate despite no movement, initially, in the nominal funds rate. There is a cost, however: Nominal income targeting engenders a period of excess demand toward the end of the decade, something that the commitment strategy, if it were feasible, would not produce. The beneficial effects of nominal income targeting arise because of its self-correcting nature: As the shortfall in activity lowers nominal income both directly and through lower prices, policy is expected to remain accommodative for longer (top left panel), thereby providing additional stimulus by causing the unemployment rate to substantially undershoot its equilibrium level and inflation to move higher.

The demands on the public's attention and comprehension imposed by nominal income targeting are arguably more severe than they are for other rule-based regimes. The implications of revisions to the data are a pertinent example. Any monetary policy regime that depends, at least in part, on an informed public runs the risk of sowing confusion and error when the data that underlie prior communications are revised. However, whereas a revision, say, to historical inflation is unlikely to change either the objective or, in any serious way, the tactics of an inflation-targeting central bank, this is not necessarily the case for a central bank that targets the level of nominal income. The efficacy of such a regime requires that the private sector knows what the initial discrepancy is between the level of nominal income and its target level; without such knowledge, the benefits of the public's expectation that the gap will be closed over time will not be realized. But this initial gap is subject to revision in the source data for nominal income. Figure 10 shows the pattern of revisions to the reported level of nominal income for selected vintages over the period since the deepening of the financial crisis in 2008. Therefore, for example, the solid line, labeled "2007:Q4," shows how estimates of the level nominal income *for 2007:Q4* changed with each vintage of the data, indexed by the horizontal axis. In each case shown, we index the initial level of nominal income to 100 for ease of comparison. As can be seen, the level of nominal income has been subject to significant revision, generally of 2 to 4 percent and sometimes more, often with

Figure 10. The Level of Nominal Income by Data Vintage
(Selected dates and selected vintages)

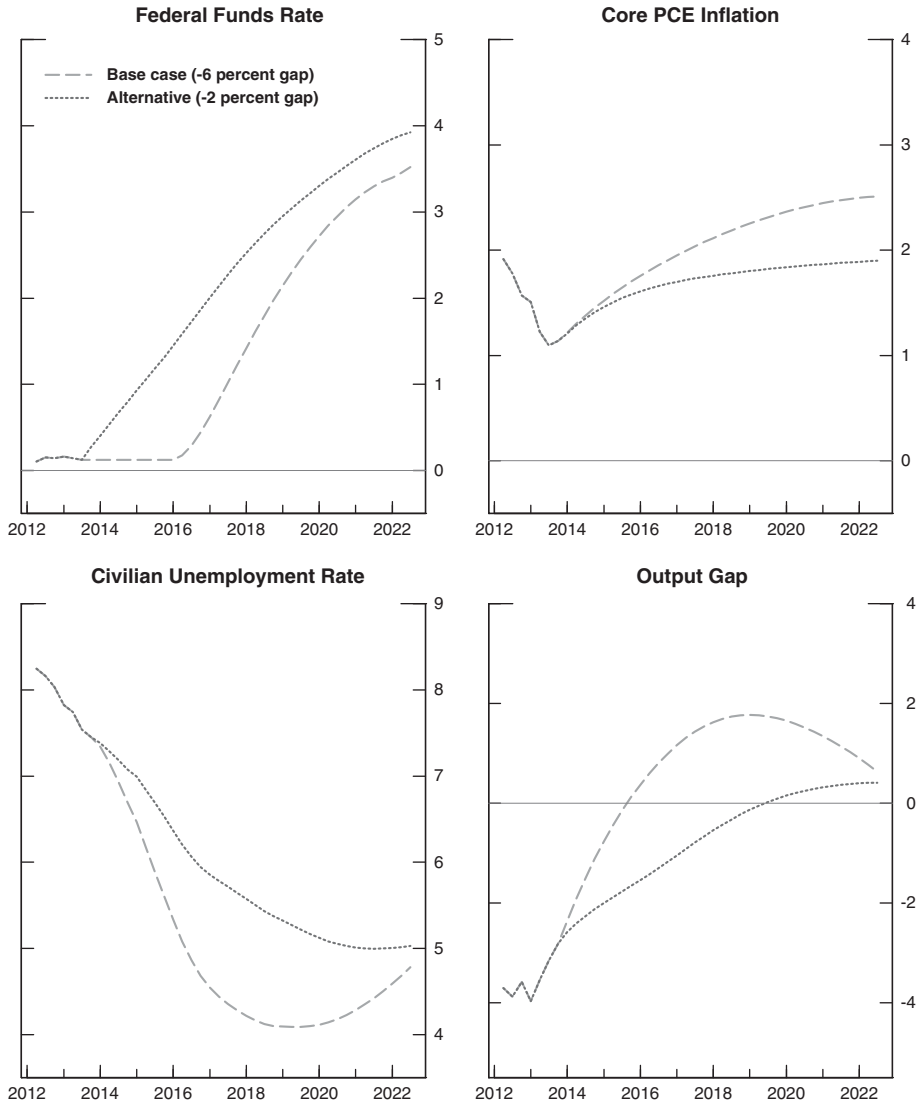


changes in the sign over time.[52] That such revisions can have substantial implications is demonstrated in Figure 11. The dashed line is our nominal income targeting scenario, repeated from Figure 9; that scenario is conditional on an initial nominal income-level gap of about −6 percent. The dotted line shows a similar scenario, but with an initial gap that is 4 percentage points smaller, roughly in line with the pattern of historical revisions. As can be seen, the policy implications of such a revision are substantial. Of course, one could, at least in principle, simply revise the target path for nominal income to offset the upward revision in the data. But while it may well be beneficial to do so, the demands on private agents' attention span and comprehension of such changes should not be taken lightly.

To illustrate further the dependence of nominal income level targeting on expectations formation, we consider in Figure 12 a case in which expectations of future prices and output are taken to be boundedly rational. In particular, we assume that agents, instead of having rational expectations, form expectations of future events using a small-scale VAR. As the dotted line in the figure shows, VAR-based expectations allow a protracted period in which inflation

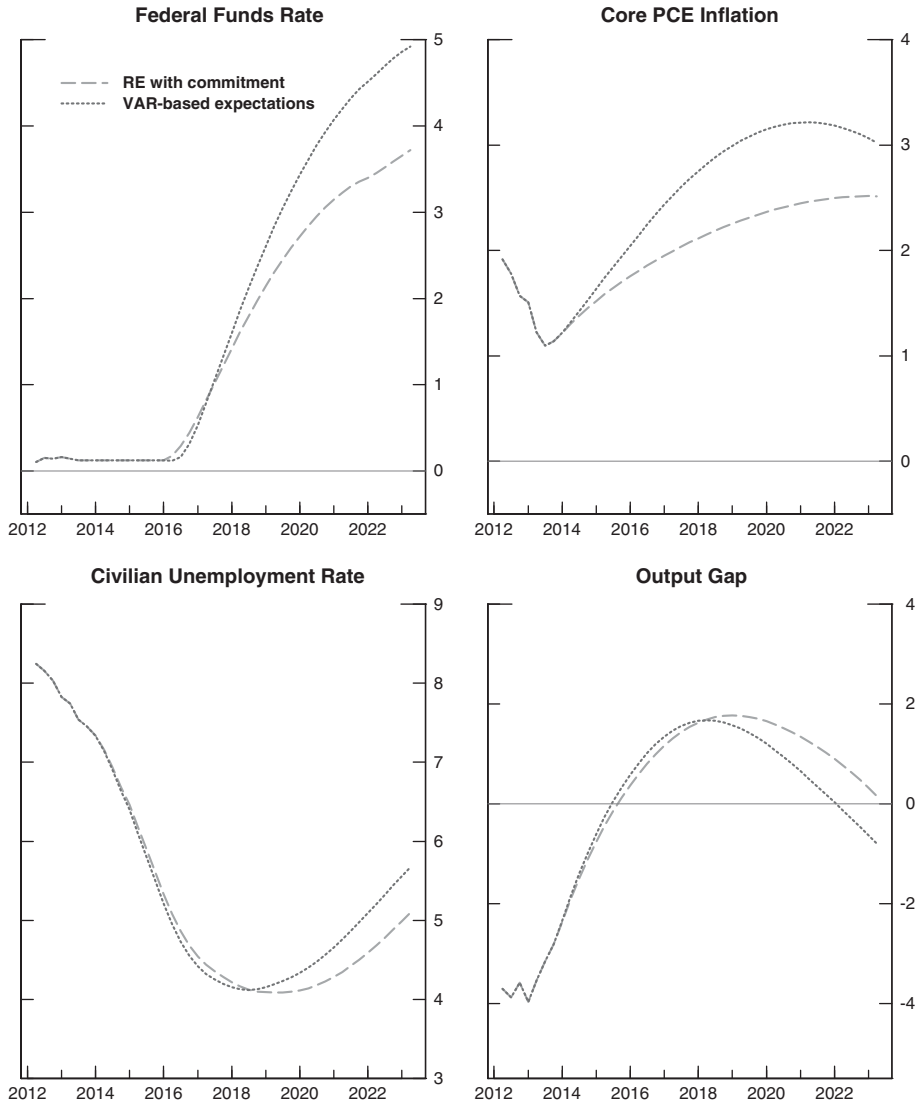
[52]Revisions to nominal income were even larger in the late 1990s.

Figure 11. Effects of Different Initial Nominal-Income-Level Gaps
(Nominal income level targeting)



overshoots its long-run objective because of the introduction of an extrapolative element in expectations by this departure from model-consistent expectations. In this instance, expectations are not "well anchored" as is generally the case under rational expectations, so that a period of persistently high inflation induces households, firms, and investors to mark up their expectations of inflation, touching off what amounts to a wage-price spiral. Monetary policymakers cope with this spiral by tightening more than is called for in the baseline toward the end of the period shown.

Figure 12. Effects of Expectations on Policy Outcomes
(Nominal income level targeting with and without complete information)



Communications Challenges

In short, both a higher inflation objective and nominal income targeting could, if communicated clearly and found to be credible, improve economic outcomes. But a number of communications challenges make such changes in framework less likely to be successful in practice.

Most important, the effectiveness of such changes depends on influencing the public's beliefs about the policy strategy likely to prevail as much as five years or

more ahead. Accordingly, the ability of policymakers to influence expectations hinges on the public's belief that the strategy will be followed for many years, including well after the point at which the unemployment rate has returned to a level consistent with full employment. But the public may be skeptical about such long-horizon commitments. As noted earlier, the benefits of such strategies are frontloaded while the costs are incurred later, providing an incentive to renege. Moreover, the adoption of one of these strategies might not be seen as credible because the Committee cannot really bind its successors.

More broadly, the public may not understand the change in policy framework and so may be confused about the central bank's intentions. The change could well be seen as a case in which policymakers back away from their commitment to low and stable inflation, thereby unanchoring inflation expectations and so limiting the ability of policymakers to use policy to counter adverse aggregate demand shocks without causing a sharp run-up in inflation expectations to levels that policymakers would find unacceptable.

These communication challenges might be particularly formidable in the case of adopting an intermediate target, such as nominal income. The public would be unfamiliar with this approach, and so might find it particularly hard to understand fully. Moreover, to guard against potential losses in credibility, the Committee would have to consider how to deal with issues such as periodic revisions to the data without leaving private agents with the impression that the FOMC is trying to evade its commitments. In principle, the Committee may also wish to consider "escape clauses" that adjust target variables for the effects of certain events, such as increases in indirect taxes and/or commodity prices. But, even if these contingencies are specified in advance, they might be perceived as being opportunistically invoked as they occur. Additionally, too many escape clauses could weaken public confidence in the commitment to the target, and thereby, limit the necessary building up of reputation that this policy requires over time.

A more general caveat is that the policy analysis we carry out in this paper is always conditional on the model used and, as we noted previously, on the baseline. No model contains the myriad channels through which a major change in strategy might affect the economy. For example, the financial system could evolve endogenously in response to changes in monetary policy, expectations may adjust differently than we have assumed, and agents may have become more resistant to bearing risk than models, based as they are on the historical experience, suggest. Moreover, the benefits of temporary increases in inflation in terms of additional stimulus will decline as the fraction of agents that are unable to respond to changes in expected future real interest rates rises, because those nonresponding agents, who simply consume their wage income, will find their purchasing power eroded by unexpected price inflation. Finally, the primacy of expectations formation must be emphasized. The effects of the nontraditional policies could differ substantially if increases in inflation put upward pressure on term premiums that counteract, in part or in full, the intended stimulus.

Given these challenges and uncertainties, it is hard to be confident of the outcome of a change in the central bank's objective. That is not to say that

the outcome will necessarily be adverse; one can imagine a range of possible outcomes depending on how the change is interpreted by the public. Indeed, Romer (2013) argues that a wider-ranging change in policy framework could help make the new approach clear to the public and, by marking a change in regime, could make the change in approach more credible and so more likely to be successful. What our scenarios do effectively highlight, however, is how critical expectations formation is for the efficacy of policy at the ELB. No central bank has successfully shifted from inflation targeting to nominal income targeting or used an increase in the inflation target as a stimulus tool—although of course the BOJ is in the midst of just such an attempt and there is some reason for optimism. Expecting the unexpected thus would seem to be in order, and policymakers may well conclude that the potential benefits of a change in objective are not sufficient to outweigh the potential risks and costs that could result.[53]

III. Concluding Remarks

This paper has reviewed changes in the Federal Reserve's monetary policy framework that have been undertaken over the past several years. In part, these changes reflected improvements in economists' understanding of effective monetary policy, including lessons from the experience of inflation-targeting central banks worldwide and their demonstration of the merits of explicit long-run targets for monetary policy and increased communications regarding economic prospects. However, the changes also reflected the challenges posed by the financial crisis, the ensuing severe recession and the lengthy period in which the federal funds rate has been at the ELB, which led the Federal Reserve to employ unconventional tools to foster its dual mandate.

We began by documenting the recent changes to the Federal Reserve's framework for monetary policymaking. These changes included a sequence of improvements in the clarity with which the FOMC provided information on its policy objectives, starting with the introduction of the SEP and proceeding through the publication of the Committee's Statement of Longer-run Goals and Monetary Policy Strategy, which specified a specific numerical inflation objective for the first time. The changes in framework have also encompassed increased communications regarding the Committee's policy intentions.

The paper has provided some of the analytical substance behind several of the features of the Federal Reserve's framework. We employed a small New Keynesian model to calculate optimal control policies under rational expectations and full policy credibility. We also examined the performance of some commonly referenced simple policy rules as potential stand-ins for the likely infeasible optimal commitment strategy. And finally we assessed the possible benefits of thresholds policies—that is, conditional commitments to remain at the ELB at

[53]Indeed, when the FOMC discussed nominal income targeting at its November 2011 meeting, participants agreed that such a change was not advisable at that time because of the "significant challenges associated with the adoption of such frameworks" (FOMC, 2011b).

least until some economic state is realized—as a method for moving closer to the commitment solution. We found that, in the economic environment experienced in 2013, unadorned simple rules failed to deliver sufficient stimulus to satisfy the Federal Reserve's dual mandate in a reasonable period of time and that augmenting such rules with thresholds could generate significant and reliable improvements in macroeconomic outcomes.

We then turned to some further questions regarding the monetary policy framework posed by the financial crisis and its aftermath. In particular, we considered two possible departures from the current framework that have been discussed in the research literature and in policy circles, namely, a permanent increase in the inflation target and a shift to a nominal income level target. We found that in our model these proposals could improve economic outcomes if the change in framework is well understood by the public and is seen as credible. These are, however, strong maintained hypotheses, and we noted that both proposals push very hard the assumptions of rational expectations, full credibility and absence of doubt about the model, in order to deliver their promised benefits. Although there may be some situations in which such changes would be appropriate, given that they involve significant communications challenges we argued that a cautious approach was appropriate, and that central banks should carefully consider the potential risks and costs of these approaches as well as their possible benefits.

With many countries' central banks operating in unfamiliar territory, monetary policy frameworks will undoubtedly continue to evolve, with central banks adapting to their own experiences as well as learning from the experiences of others. Indeed, we noted that recently several foreign central banks have adopted versions of some of the framework modifications described in this paper. Moreover, new economic developments and challenges may call for new tools and changes in communications to make those tools more effective. Although they cannot always anticipate such challenges, central banks should remain flexible over time to ensure that their frameworks are changed appropriately in order to best support the success of their economies.

APPENDIX I

The "Small FRB/U.S." Model

The model employed in this paper is a small-scale version of the Board staff's FRB/U.S. model. As documented in a sequence of papers,[54] FRB/U.S. can be described as an elaborate, large-scale version of a New Keynesian model. The larger model contains structures designed to allow the model to consider a wide range of economic phenomena, consistent with its role as the central domestic-economy model in much Federal Reserve Board staff analysis. However, for the class of experiments of interest in this paper—experiments that center on the monetary transmission mechanism in general and expectations formation in particular—a much simpler model can capture the essence of the FRB/U.S. model.

[54]See, for example, Brayton and Tinsley (1996).

As in the original model, agents in what we might call "small FRB/U.S." formulate decision rules by choosing a target path for the decision variable of interest, subject to an adjustment cost function. Small FRB/U.S. condenses the decisions of a variety of agents into a single decision maker who can be thought of as choosing a target path for consumption, to minimize an adjustment cost function. The order of adjustment costs is a generalization of the well-known quadratic-adjustment cost model as exemplified by Rotemberg (1982) for the case of monopolistically competitive price-setting agents. The order of adjustment costs could be as high as three; however, the key behavioral equations of the FRB/U.S. model and hence, of small FRB/U.S., involve second-order adjustment costs, which means that it is costly to adjust the growth rate of the decision variable. For a generic variable, x_t the (second-order) cost function is as follows:

$$L = \min \sum_{i=0}^{\infty} \beta^i \left\{ \left(x_{t+i} - x^*_{t+i}\right)^2 + b_1 (\Delta x_{t+i})^2 + b_2 (\Delta x_{t+i} - \Delta x^*_{t+i})^2 \right\}, \tag{A.1}$$

where β is the discount factor, b_1, b_2 are adjustment cost parameters, and an asterisk indicates a desired or target level of a variable. The solution to the above problem results in a decision rule, which can be written in extended error-correction form:

$$\Delta x_t = \lambda_1 \left(x^*_{t-1} - x_{t-1}\right) + \lambda_2 \Delta x_{t-1} + z_t + \varepsilon_t, \tag{A.2}$$

where z_t is the weighted sum of expected future changes in the target variable along the desired path toward steady-state equilibrium. Without the z-variable, Equation (A.2) is a straightforward error-correction equation; it captures all the forward-looking aspects of the agent's decision making. As befits their structural nature, the z-variable embeds cross-equation restrictions from the adjustment cost technology, and is written in this second-order adjustment-cost case as:

$$z_t = \lambda_1 \Delta x^*_t - \lambda_1 \lambda_2 \beta^2 \Delta x^*_{t+1} + (1 - \lambda_1 + \lambda_2)\beta E_t z_{t+1} - \lambda_2 \beta^2 E_t z_{t+2}. \tag{A.3}$$

Note that first-order adjustment costs obtains as a special case when $\lambda_2 = 0$ in which case z_{t+2} and Δx^*_{t+1} drop out.

For small FRB/U.S., we can think of the two decision variables covered by this formulation as consumption and the consumption price level; monetary policy is taken as being governed by any of the several Taylor-type rules described in Appendix III, or by an optimal control policy.

Let us take x to be the output gap (*gap* in what follows), with target, *gap**. The target paths—that is, the z-variables—that enter the dynamic adjustment equations for the output gap equation are as follows:

$$gap^*_t = \lambda_3 \left(rrl_t - rrl^{\infty}_t\right) + \lambda_4 gap^{pv}_t + (1 - \lambda_4) gap_t, \tag{A.4}$$

$$rrl_t = \lambda_5 rrl_{t+1} + (1 - \lambda_5)(R_t - \pi_t + \lambda_6 gap_t), \tag{A.5}$$

$$gap^{pv}_t = \lambda_7 gap^{pv}_{t+1} + (1 - \lambda_7) gap_t. \tag{A.6}$$

Equation (A.4) shows that the desired output gap, conditional on adjustment costs, is a function of the deviation of the target level of the long-term real interest rate, rrl_t, from its equilibrium level, and a weighted average of the current output gap and a geometric sum of future output gaps, gap^{pv} where the *pv* superscript indicates a present value of, in this case, expected future output gaps. This present-value calculation is specified in Equation (A.6). Equation (A.5) models the long-term real interest rate as a geometric sum of short-term real interest rates plus an output gap term; the latter captures the relationship between term premiums and the state of the economy. The presence of the gap^{pv} reflects the role of permanent income in

consumption, while $rrl - rrl^{\infty}$ captures the wealth and substitution effects of interest rates on desired consumption; see, Brayton (2013) for further details.

The model's price equation resembles a standard hybrid New Keynesian specification with a coefficient on lagged inflation and unity minus that coefficient on lagged inflation, plus a term in the output gap. The only nonstandard element to it is that a term in the change in the (long-term) real interest rate appears as a proxy for (temporary) exchange-rate effects on domestic prices operating through uncovered interest parity with the foreign interest rate taken as exogenous. This term plays no significant role in what is studied in this paper.

Finally, we add an expression linking the unemployment gap to the output gap, that is, a dynamic Okun's Law equation:

$$u_t = u_t^* + a_1\left(u_{t-1} - u_{t-1}^*\right) + a_2\Delta\left(u_{t-1} - u_{t-1}^*\right) - a_3 gap_t - a_4\Delta gap_t. \tag{A.7}$$

Here is the complete model (except for the monetary policy rule) with numerical values for the coefficients. Expectations operators and constant terms are suppressed.

$$\pi_t = 0.5 \cdot \pi_{t-1}^4 + (1-0.5) \cdot \pi_{t+1} + 0.02667 \cdot gap_{t-1} + 0.11268 \cdot \Delta rrl_t, \tag{A.8}$$

$$\Delta gap_t = (1 - 1.1906 + 0.3067) \cdot \left(gap_{t-1}^* - gap_{t-1}\right) + 0.3067 \cdot \Delta gap_{t-1} + zgap_t, \tag{A.9}$$

$$gap_t^* = -1.7602 \cdot rrl_t + 0.62 \cdot gap_t^{pv} + (1-0.62) \cdot gap_t, \tag{A.10}$$

$$rrl_t = 0.967 \cdot rrl_{t+1} + (1-0.967) \cdot (R_t - \pi_t - 0.6 \cdot gap_t), \tag{A.11}$$

$$\begin{aligned} zgap_t = {} & (1 - 1.1906 + 0.3067) \cdot \Delta gap_t^* - 0.3067 \cdot (1 - 1.1906 + 0.3067) \cdot 0.98^2 \\ & \cdot \left(gap_{t+1}^* - gap_t^*\right) + 1.1906 \cdot 0.98 \cdot zgap_{t+1} - 0.3067 \cdot 0.98^2 \cdot zgap_{t+2}, \end{aligned} \tag{A.12}$$

$$gap_t^{pv} = 0.93 \cdot gap_{t+1}^{pv} + (1-0.93) \cdot gap_t, \tag{A.13}$$

$$\pi_t^4 = 0.25 \cdot (\pi_t + \pi_{t-1} + \pi_{t-2} + \pi_{t-3}), \tag{A.14}$$

$$\begin{aligned} u_t = {} & u_t^* + 0.888 \cdot \left(u_{t-1} - u_{t-1}^*\right) + 0.526 \cdot \Delta\left(u_{t-1} - u_{t-1}^*\right) - 0.068 \cdot gap_t \\ & - 0.131 \cdot \Delta gap_t. \end{aligned} \tag{A.15}$$

APPENDIX II

The Baseline

As noted in the main text, the quantitative results described in this paper will exhibit some sensitivity to the particular features of the baseline owing, among other things, to the implications of the ELB. Accordingly, in this brief appendix, we describe in words the central features of the baseline. It should be noted that the qualitative results will not differ substantially for alternative baselines that are in the neighborhood of one described here.

The construction of the baseline begins with the National Income and Product Accounts for 2013:Q2, as they were seen in July 2013, together with a characterization of the state of resource utilization that is consistent with those accounts. All of the scenarios described in this paper begin in 2013:Q3. In our baseline, we assume that the output gap is −2.8 percent as of that date, and the unemployment rate is 7.5 percent, which with a natural rate of unemployment of 5½

percent corresponds to an unemployment gap of 2 percentage points. The output gap is assumed to close slowly over time, reaching zero at the end of 2018; the labor market gap closes at about the same date. Inflation as measured by the four-quarter rate of change in core PCE prices is 1.1 percent in 2013:Q3 and climbs slowly to reach the target rate of inflation of 2 percent in 2020. The path for the federal funds rate that supports this outlook remains at the effective lower bound until the first quarter of 2016 after which it climbs moderately quickly, reaching 4 percent in 2021.

APPENDIX III

The Simple Monetary Policy Rules

The table below gives the expressions for the policy rules used in this paper. In the table, R_t denotes the nominal federal funds rate for quarter t, while the right-hand-side variables include the model's projection of trailing four-quarter core PCE inflation for the current quarter and three quarters ahead (π_t and $\pi_{t+3|t}$, respectively), the output gap estimate for the current period as well as its one-quarter-ahead forecast (gap_t and $gap_{t+1|t}$), and the forecast of the three-quarter-ahead annual change in the output gap ($\Delta^4 gap_{t+3|t}$). The value of policymakers' long-run inflation objective, denoted π^*, is 2 percent. The nominal income targeting rule responds to the nominal income gap four quarters ahead, which is defined as the difference between nominal income yn_t (100 times the log of the level of nominal GDP) and a target value yn_t^* (100 times the log of target nominal GDP). Target nominal GDP in 2007:Q4 is set equal to actual nominal GDP in that quarter and then projected forward at a rate of 2 percentage points per year faster than conventional estimates of potential GDP, about 2½ percent per year.

Taylor (1993) rule	$R_t = rr^* + \pi_t + 0.5(\pi_t - \pi^*) + 0.5 gap_t$
Taylor (1999b) rule	$R_t = rr^* + \pi_t + 0.5(\pi_t - \pi^*) + gap_t$
Inertial Taylor (1999b) rule	$R_t = 0.85R_{t-1} + 0.15(rr^* + \pi_t + 0.5(\pi_t - \pi^*) + gap_t)$
Nominal income targeting rule	$R_t = 0.75R_{t-1} + 0.25(rr^* + \pi_t + yn_{t+4|t} - yn^*_{t+4})$

The first two of the selected rules were studied by Taylor (1993, 1999a and 1999b). The inertial Taylor (1999a and 1999b) rule is a straightforward extension of the Taylor (1999a and 1999b) rule. The long-run real interest rates appearing in the Taylor (1993, 1999a and 1999b) rules and the inertial Taylor (1999a and 1999b) rule are set a bit over 2 percent.

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