



# Should the Fed Regularly Evaluate Its Monetary Policy Framework?\*

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**Abstract:**

Would a more open and regular evaluation of the monetary policy framework improve policy in the United States? Even when considering a relatively short timeframe that spans the 1960s to the present, it is possible to point to many significant changes to the framework. Some of the changes were precipitated by acute economic conditions, while others were considered and implemented only gradually as a response to long-standing problems with the framework. But the process for evaluating and changing frameworks to date has not always been transparent, and changes have not always been timely. Could a more formal, and open, review improve how well we adhere to our current framework? Could transitions to a new framework be made more effectively? We conclude that such a review might indeed be beneficial, and outline one possible review process.

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From the inception of central banking, policy makers have adjusted their monetary policy frameworks in light of the economics profession's evolving understanding of monetary economics, changes in the structure of the economy, and obvious failures of previously used regimes. The lineaments of the current framework for the Federal Reserve are outlined in the most recent January "Statement on Longer-Run Goals and Monetary Policy Strategy." In addition to specifying the 2 percent numerical inflation objective and the specific price index that the FOMC will target, the document emphasizes the symmetry of the inflation goal, the role that communication plays in anchoring longer-term inflation expectations, and articulates the symmetry of the Committee's loss function with respect to deviations of inflation from target and employment from its assessment of its long-run level, noting also that in circumstances in which these objectives are in conflict, "it follows a balanced approach in promoting them." Finally, and importantly for this paper, the document notes the Committee's intent "to reaffirm these principles and to make adjustments as appropriate in its annual organizational meeting each January." Exploring whether a formal process might help reduce any obstacles to making these adjustments more effective is the aim of this paper.

How often have such adjustments been required? As this paper will illustrate, changes have occurred quite frequently. Almost none of the elements in the current framework existed at the founding of the Federal Reserve System in 1913, and most of these have been codified only very recently. These changes, while sometimes significant, did not require enabling legislation, but just the agreement of the FOMC. In short, the history of the monetary policy framework in the United States is one of nearly continuous changes, both minute and momentous. Broadly over the past 100 years, the monetary framework progressed from the Gold Standard, to the Bretton Woods monetary system, to the Treasury Accord, to goal and instrument independence, to just instrument independence, to formal adoption of an explicit numerical objective for price stability, to the use of balance-sheet policy as an augmentation to conventional policy during the Great Recession, to the

2012 adoption of an explicit framework document that eventually outlined symmetric and equally-weighted emphasis on both aspects of the Fed's Congressionally-given dual mandate.

Thus in reality, the question is not whether the framework can or should change, but what are the appropriate triggers for such changes and what process might best aid the central bank in considering how to change it. As a point of comparison, the Bank of Canada, as part of its founding charter (1991) and in agreement with the Government of Canada, routinely re-examines its monetary policy framework to ensure that the monetary policy framework remains effective even as the economy and the central bank's understanding of it evolve. Every five years they conduct a formal review of the goals of monetary policy as well as alternative approaches to attaining those goals such as either lowering or raising the 2 percent inflation target, whether to target the price level, and the role of financial stability. The process of reevaluation includes staff research on key topics in the years leading up to the decision date, and invites feedback from the public, the government and academics.<sup>1</sup>

Would a more comprehensive and regular evaluation of the framework improve monetary policy in the United States? To answer this question one needs to understand why framework changes have occurred, how and how quickly the shortcomings of earlier frameworks were recognized, and thus whether one can reasonably expect to improve the way in which framework changes are made, and whether a regular review process could be part of that improvement. It is important to recognize that framework reassessment is not entirely episodic and event-driven. Staff and principals within the Federal Reserve System are involved in a continuous reassessment of the framework. And there is also considerable interaction among the Fed, academics, other central banks and other policy institutions, and this interaction provides some opportunity to consider emerging ideas about how to improve the conduct of policy.

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<sup>1</sup> See Murray (2018).

But U.S. monetary history, certainly including the Great Depression and possibly the Great Inflation of the 1970s and the Great Recession and Financial Crisis of very recent history, might suggest that the existing combination of internal processes and external interactions does not always produce the optimal framework. Would more focused internal analysis at regular intervals be helpful? Would a more formal incorporation of external analysis from academics and others improve Fed performance at key junctures? The paper will tentatively conclude that such a process may help the Fed to more effectively make needed framework changes. Whether the source of any problems is Fed errors or the profession's understanding of monetary economics, a regular re-evaluation process, both external and internal, may help to more efficiently change the framework when needed.

We wish to emphasize that the framework changes we have in mind are not ones that would require amendments to the existing legislation, which would obviously fall under the purview of Congress. Rather, they are largely technical changes meant to improve the conduct of monetary policy to better achieve the Fed's Congressionally-mandated goals.

The paper begins by defining in the next section what is meant by a monetary policy framework. To anticipate, the definition will necessarily entail some "gray areas." In the second section, we consider the history of changes in the monetary policy framework for the U.S. central bank in the modern era. From this review, we hope to get a sense of the frequency of changes, the motivation for changes, and a sense of which measures we might use to gauge the success or failure of the historical frameworks. The third section discusses a host of practical questions about the process for re-evaluating the Fed's monetary policy framework. The fourth section considers whether the Fed might consider a change in framework in given the current circumstances, and the following section concludes.

## I. How Do We Define a Monetary Policy Framework?

Broadly, a monetary policy framework may be defined as the set of tools and processes by which the central bank attempts to define and attain its high-level economic goals. The central bank might be allowed to choose some components of this process, such as the precise inflation target and the transparency of the policy. But some elements of the framework are strongly influenced by other factors outside the central bank's control, such as the structure of the economy and the desires of the public. Given this definition of the framework, it follows that the *changes* in framework that we are most interested in are those that significantly affect the central bank's ability to achieve the public's high-level goals. More specifically, a monetary policy framework will include the following:

- a. **The governance structure of the central bank.** This essay will largely abstract from how the central bank fits into the country's governmental structure—for example, whether it is statutorily instrument independent of the administration and the Treasury. Such considerations have been shown to importantly affect the efficacy of central bank actions, but we will take as given for this essay that the Fed, both legislatively and practically, has a high degree of independence.<sup>2</sup> A related high-level concept is that of accountability: the responsibility delegated to the central bank by Congress to deliver acceptable economic outcomes to the country's citizens. Many of the efforts to improve transparency have been rooted in a desire to provide the public with explanations for why the Fed does what it does, an essential component of accountability.
- b. **A set of ultimate goals for the central bank.** Today, we have a Congressionally-mandated set of goals—the so-called dual mandate, which comprises “stable prices” and “maximum employment”—phrases which have been modified in common usage to “price stability” or

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<sup>2</sup> For issues pertaining to the Federal Reserve's governance, see, among others, Binder and Spindel (2016) and Conti-Brown (2016).

“low and stable inflation” and “maximum *sustainable* employment.”<sup>3</sup> The goals have changed through time. When the Fed was founded in 1913, its goals focused primarily on the stability of the banking system. The Gold Standard demanded fixing the dollar price of gold. Obviously both sets of goals differed dramatically from the Fed’s responsibilities in the current framework. In the long run, even the dual mandate might be altered. For example, recurring bouts of financial instability might prompt the Fed to be more explicit about the role of monetary policy in preventing and offsetting such disruptions.<sup>4</sup>

- c. **A loss function.** An articulation of goals is not sufficient. Unless the framework entails a single rigidly-defined goal, the framework needs to include a loss function (or the equivalent) that describes how the central bank weights its (sometimes competing) goals.<sup>5</sup> For example, the Fed needs to say whether it considers losses on either side of the target inflation or employment goals symmetrically, how it weights deviations of inflation from its goal versus deviations of employment from its goal, whether it chooses a point target for inflation or a band, whether it allows the operational inflation goal to move somewhat over time, over what horizon it intends to bring inflation back to its goal, and so on. As an institution accountable to the public, the Fed might also explain where the targets come from, and what determines their values. Such an explication would also help illuminate why the framework might change through time.
- d. **The instrument or set of instruments that the central bank directly controls** in attempting to achieve its key goals. Over time, instruments have included the dollar price of gold, the volume of different monetary and reserve aggregates, the level of short-term

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<sup>3</sup> Federal Reserve Act, as amended, Section 2A, [12 USC 225a. As added by act of November 16, 1977 (91 Stat. 1387) and amended by acts of October 27, 1978 (92 Stat. 1897); Aug. 23, 1988 (102 Stat. 1375); and Dec. 27, 2000 (114 Stat. 3028).]

<sup>4</sup> See Peek, Rosengren, and Tootell (2015).

<sup>5</sup> In some cases, a model’s explicit microeconomic foundations allow one to derive a model-consistent loss function (see Rotemberg and Woodford 1997, Woodford 2002), and could inform the central bank’s choice of a specific loss function.

interest rates and the size and composition of our balance sheet. Multiple instruments can and have been part of the same framework: For example, during the financial crisis, the Fed used the federal funds rate until it fell to its effective lower bound, at which point the Fed pursued balance sheet policies in an attempt to better achieve its mandated goals.

- e. **The operational “target” (or targets) that the central bank sets** to achieve its primary goals. In some cases, these can overlap completely with the central bank’s ultimate goals. A central bank that is a pure inflation-targeter can use inflation both as its ultimate and its operational target. However, a central bank with both inflation and output as ultimate goals could choose to use, for example, nominal GDP as the operational target to achieve its goals. Nominal GDP targeting imposes specific weights on deviations of prices from the desired price-level path and deviations of real output from potential, the ultimate goals of monetary policy.<sup>6</sup>
- f. **Transparency** is often an important part of the framework, especially when it is enhanced to improve the efficacy of policy actions. Transparency is also an important element of the framework since it improves central bank accountability to the public. One goal of transparency is to make monetary policy more predictable. For example, releasing Committee or staff forecasts, sending signals about future policy, and publishing alternative scenarios could (at least in theory) help the public to understand the current and expected setting of policy, which might lead to a more predictable and efficient transmission of policy actions into other asset prices. In fact, one motivation for revisiting the monetary policy regime every few years is to ensure the regime’s clarity to the public. The costs of opacity can be high. For example, the profession has struggled with understanding the poor

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<sup>6</sup> The desire to use nominal GDP as an operational target might arise from equal weights on price and output deviations in the loss function, or from other practical considerations that suggest it would deliver desirable outcomes relative to other operational targets.

performance of the U.S. economy in the 1970s and early 1980s (and this article is no exception), in part because of this lack of clarity about the policy framework. In the extreme the Fed may want to set expectations with clear forward guidance. The ability of the central bank to affect expectations is a topic of active discussion, and much has been written about the wisdom of attempting it, as well as the efficacy of historical attempts (see, for example, King, Lu, and Pastén 2008).

- g. **Rules and discretion: the systematic component of monetary policy.** Given a set of goals, an articulation of the loss function, a set of instruments, and (perhaps) an intermediate target, a central bank should generally aim to conduct monetary policy in a systematic (and thus predictable) fashion. As a consequence, even if transparency is minimal, one may be able to infer with some accuracy the policy rule implications of a framework. That rule will not capture all features of the framework—in particular, a simple rule would fail to capture asymmetries in the uncertainty about the outlook—but it can reflect in a compact way many aspects of the framework. To the extent that a central bank’s behavior can be well-described by a policy rule, whether that rule is articulated by the central bank or can be accurately inferred by the public from the central bank’s actions, policy predictability will be enhanced, and the transmission channel more effective. At the same time, truly optimal policy may deviate noticeably from simple rules under certain conditions, and thus discretion may be an important component of the monetary policy framework.

One important element of discretion concerns risk management. Most of the discussion to this point has abstracted away from how the evaluation of and response to risk might fit into the monetary policy framework. This is not a trivial omission: indeed, Chairman Greenspan often described the business of monetary policy as in large part a kind of risk management (Greenspan 2004 and 2005). The evaluation of risk—or more specifically the



consideration of asymmetry in the distribution of policy-relevant outcomes, as well as the possibility of abnormally large tail risks—has clearly played a role in FOMC deliberations over the years. Most notably, financial stability risks have risen in prominence in Committee discussions. Providing a precise analytical framework for the Fed’s or any other central bank’s systematic response to such risks is beyond the scope of this paper. But in attempting a definition of the monetary policy framework, the response to and management of risk is a non-trivial element.

- h. **The central bank’s depiction of the economy (“the model”)**. The model, broadly speaking, that the central bank uses to describe the evolution of the economy and the interactions between policy and the real and financial economies, can both constrain and influence the regime chosen by the central bank.<sup>7</sup> In a committee such as the FOMC, different members can base their policy recommendations on different models while still sharing the same elements of the framework we have already outlined. Nevertheless, there are common features across models that are crucial inputs to the policy process—the equilibrium real rate of interest, the natural rate of unemployment, the slope of the Phillips curve. Post-war U.S. history appears to have experienced quite persistent and significant fluctuations in most if not all of these key parameters, as illustrated in section II below. Such changes in economic structure can also spur modifications to the monetary policy framework, although not all changes will require a shift in framework. For example, when changes in economic structure *constrain* the framework—such as when a drop in the equilibrium rate makes it more likely that the effective lower bound will bind—then a framework change may be needed.

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<sup>7</sup> For a given economic structure or model, one can entertain any number of monetary policy frameworks that might work within it. In that sense, the model is not part of the framework, although it can clearly influence the choice and efficacy of frameworks.

In addition, the current instantiation of a central bank's economic model reflects current economic wisdom as accepted (and perhaps modified) by the central bank. One can take for granted in the present circumstances the importance of explicit expectations; of macroeconomic behavior that is grounded to some extent in microeconomic behaviors; of the importance of accounting identities, budget constraints and adding-up constraints; or of the absence of a long-run trade-off between unemployment and inflation, as most modern models reflect such concepts to varying degrees. But these have not always been features of the models used by central banks in the conduct of monetary policy, and several of them have changed the way central banks think about conducting monetary policy, and thus about what are viewed as better and worse frameworks.

There is no widely agreed-upon definition of what constitutes a monetary policy framework, but the elements described above should be useful as guideposts as we consider both the history of the U.S. monetary policy framework and its possible evolution going forward. Again, it is important to recognize that while these elements appear as distinct components in the description above, in practice there will be both gray areas around the definitions, and overlap among the components as these are used in any specific framework.

## **II. A Review of Monetary Policy Frameworks Since the 1960s**

We now provide our assessment of framework changes over time using the previous section's taxonomy. Many of the changes we identify are discussed in Meltzer's history of the Federal Reserve (2002, 2010, and 2014) and by Romer and Romer (2002 and 2013). These works are based on a thorough reading and interpretation of the minutes of the FOMC meetings. Here, we complement some empirical evidence with a word count of specific phrases at FOMC meetings that may indicate a change in focus on key elements of the policy regimes at the time. When a given framework is operative, one would expect certain words related to that framework to arise more frequently. Our

analysis is also organized around some specific elements of the framework. As such, it is not necessarily exhaustive, but it is meant to highlight the fundamental issues and provide some explanations for the reasons and processes that led to or hindered changes.

As Fed insiders, we also wish to emphasize that the framework is to some extent always under discussion and debate. The staff at the Board and the regional banks is constantly working on memos and papers that examine possible changes to the framework. Another element of the work conducted at the Board and the banks concerns potential technical changes in key parameters of the economy. Such work is ongoing in the system and might need less coverage at a regularly scheduled public meeting such as the one under consideration here. The deeper issues that correspond with the framework debates may be more appropriate for such gatherings.

It is useful to frame the discussion first in terms of realized outcomes and the policy frameworks in which these occurred. Figure 1 presents our version of the frameworks that have existed since the 1960s. The regimes are drawn in Figure 1 with a very broad brush. Still, we attempt to show some of the finer strands of the tapestry of monetary policy that run throughout the past 60 years, such as independence and transparency. It is important to note that, for the most part, previous lessons were not forgotten over this time period, so in many ways the regime changes are really an accumulation of knowledge. The regime names attempt to emphasize the added pieces to the puzzle acquired over a given period.

The realized outcomes are also presented in Figure 1 by means of a quadratic loss function that weights inflation and unemployment equally. These losses could capture the costs of using the wrong framework, as well as adverse shocks not related to monetary policy. Inflation and unemployment are taken as deviations from an estimate of the inflation target (when the target was

not explicit),<sup>8</sup> and the CBO estimate of the natural rate of unemployment, respectively. The largest losses appear in the second half of the 1960s, the 1970s and early 1980s, and with the recent Great Recession.<sup>9</sup> The Volcker disinflation occurred after about 15 years of large welfare losses, and required a very costly recession to alter the course of inflation and inflation expectations. While not all of the large economic losses represented in the figure were the direct consequences of FOMC policies, it is relevant to ask whether a more systematic evaluation of the framework might reduce such losses, whether these resulted from delayed actions, adherence to a broken framework, misperception of key aspects of the economy's structure, or discretionary deviations from an otherwise well-functioning framework.

### *II.A. Model and Targets: Regimes Without and With Targets*

With the demise of Bretton Woods, and the demands of financing the Vietnam War, the Fed's mandate became less clear. To examine this issue, this subsection explores the Fed's inflation model. In so doing, we also comment on recent developments that have a bearing on the framework. The Fed grapples constantly with its model of inflation. Here, we infer the evolution of the FOMC's views about inflation from the inflation predictions made by the Staff of the Federal Reserve Board and published in the Greenbook/Tealbook (GB/TB). This analysis is related to and extends work in Romer and Romer (2002). The GB/TB inflation forecast for a particular quarter is modeled as a function of lagged inflation and the unemployment rate:

$$(1) \quad E_t \pi_{t+i} = \beta_{0,t} + \beta_{1,t} E_t \pi_{t+i-1}^4 + \beta_{2,t} E_t u_{t+i-1} + v_{i,t} \quad i = 1, 2, 3$$

where  $\pi_{t+i}$  denotes the annualized rate of inflation in quarter  $t+i$ ,  $\pi_{t+i-1}^4$  is the average of inflation

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<sup>8</sup> We measure inflation with the latest vintage of the Q4/Q4 change in the core PCE deflator. Details about the estimation of the time-varying inflation target are provided in section II of the paper.

<sup>9</sup> A time-varying target for inflation reduces the loss during the 1970s and early 1980s, but the qualitative results in the figure continue to hold even with an inflation target fixed at 2 percent.

prevailing over the four quarters from  $t+i-1$  to  $t+i-4$ , and  $u_{t+i-1}$  is the level of the unemployment rate at  $t+i-1$ . The operator  $E_t$  denotes a forecast made in quarter  $t$ . We consider forecasts of inflation one, two and three quarters out, as indexed by  $i$ . At each of the three forecast horizons, the relationship is augmented by an error term  $v_{i,t}$ , which captures factors that influence the inflation forecast other than past inflation and the unemployment rate. For our purposes, an important feature of (1) is time variation in the  $\beta$  coefficients, which is assumed to occur as a random walk.

Details about the data and estimation are provided in the Appendix. Figure 2 reports the unsmoothed time-varying estimates of the coefficients over the period 1966:Q4 to 2017:Q4.<sup>10</sup> It is apparent that the weight given to lagged inflation, as measured by  $\beta_{1,t}$ , was low in the late 1960s and started to rise noticeably in the early 1970s. The first few estimates in the sample need to be interpreted with caution, as the forecast horizon in the GB/TB often did not cover four quarters. Initial conditions also matter, but it can be shown that the qualitative result of an increase in the importance of lagged inflation in the 1970s relative to the late 1960s is robust. This strand of the framework has regained importance recently, as there has been a noticeable decline in the weight on lagged inflation. As concerns the assessment of the short-run trade-off between inflation and unemployment,  $\beta_{2,t}$  in equation (1), the estimates are again noisy at the beginning of the sample, but views about the trade-off appear to have changed in the 1970s and 1980s. More recently, there has been a gradual but steady decline in the estimated impact of economic slack on inflation. The intercept term,  $\beta_{0,t}$ , also exhibits noticeable variation, and we will comment on these fluctuations shortly.

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<sup>10</sup> Given that the staff's forecasts are made public with a five-year lag, for our analysis of the period from 2013 to present we use the FOMC's economic projections. The Appendix provides details on how the SEP forecasts are used in the analysis.

In all, while admittedly simple, this exercise points to changes in the inflation model. Some of these changes have had a significant impact on the policy framework. By the end of the 1960s, the need to design monetary policy to account for the needs of fiscal policy and the executive branch—particularly given the increases in spending on the Vietnam War—had produced disappointing inflation outcomes.<sup>11</sup> The FOMC’s nervousness about the inflation situation at that time can be inferred from an increase in the mentions of inflation, shown in Figure 3.<sup>12</sup> Policy tightening in 1969 was seen as an opportunity to reduce inflation. Yet the realized decline was noticeably less than expected. Figure 4 shows that the persistent miss in the inflation forecast at the time cannot be attributed to a persistent downward bias in the unemployment rate forecast.<sup>13</sup>

The inflation under-prediction appears to have led to a reconsideration of the inflation model. The increase in the weight given to past inflation in (1) in the early 1970s signals a move towards an accelerationist view of inflation.<sup>14</sup> The estimates of  $\beta_{1,t}$  do not reach unity in (1) because with time-varying coefficients some of the persistence in the inflation process is shifted from lagged inflation to the time-varying intercept. But a fixed coefficients estimation of (1) over a period that spans the 1970s up to the early 2000s would yield a coefficient on lagged inflation very close to unity, consistent with the Friedman-Phelps natural rate framework. This change, coupled with a decline in the short-run trade-off between inflation and unemployment, entailed a significant increase in the

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<sup>11</sup> At the January 1969 FOMC meeting, Chairman Martin was noting that “*To Mr. Nixon he had expressed his view that inflation was the primary economic problem now facing the nation, and that the new Administration would have to deal with it effectively from the beginning if inflation were not to get out of control. He had done his best to emphasize the seriousness of the problem ...*” (Minutes, January 14, 1969).

<sup>12</sup> It is important to note that the terms used to discuss similar topics have changed throughout US monetary history. Here, the use of “inflationary psychology” was fairly common in the 1960s, but is less common today. More commonly-used terms involved inflation expectations and “anchoring” of expectations. For this reason, we must take care in interpreting the frequency of mentions of specific phrases.

<sup>13</sup> The horizontal axis in the charts denotes the quarter in which the Greenbook forecast was made. The forecast is given by the value of inflation or the unemployment rate expected to prevail on average three and four quarters into the forecast. We use the only the third quarter of the forecast whenever the fourth quarter is not available. The stop the exercise with the 1970:Q3 forecast because of the enactment of the Nixon wage and price controls in 1971:Q3.

<sup>14</sup> Sargent (2001) attributes the run-up in inflation in the late 1960s and 1970s to a slow learning about the true process for inflation.

perceived sacrifice ratio around the mid-1970s. Note that an increase in  $\beta_{1,t}$  from 0.2 to 0.8 and a decline in the absolute value of  $\beta_{2,t}$  from 0.4 to 0.25—which is roughly the magnitude of the movements that occurred from the late 1960s to the mid-1970s—imply that bringing inflation down from 5 to 4 percent over the course of eight quarters would require, other things equal, an unemployment rate gap of about 1 percent on average, up from 0.2 percent.

This pessimism about the cost/benefit tradeoff of using monetary policy to lower inflation has been documented before (see for example Romer and Romer, 2013). As a consequence, beginning in the early 1970s, price and wage controls were advocated as an alternative means for controlling inflation, and Figure 5 highlights how FOMC members were discussing such fiscal solutions to the inflation problem. The reluctance to engineer large employment losses as a way of reducing inflation had notable implications for another aspect of the framework, the inflation target. In the context of (1), it is possible to infer the FOMC operational inflation target from the time-varying intercept, which can be written as:

$$(2) \quad \beta_{0,t} = (1 - \beta_{1,t})\pi_t^* - \beta_{2,t}\bar{u}_t,$$

where  $\pi_t^*$  and  $\bar{u}_t$  are time-varying measures of longer-run inflation and the natural rate of unemployment, respectively. Together, (1) and (2) provide a representation of the Phillips curve, which is now often used to parsimoniously describe inflation. While this is a “modern” view of the inflation process, a looser interpretation in terms of a reduced form where inflation has a tendency to revert over the forecast horizon to the  $\pi_t^*$  objective—after controlling for an activity gap and supply shocks—is still valid and likely to have informed the Federal Reserve’s inflation forecast consistently over time.

Figure 6 depicts a derivation of  $\pi_t^*$  according to (2) given our estimated time-varying  $\beta$ 's under the assumption that the natural rate of unemployment  $\bar{u}_t$  evolves as in the most recent vintage of the CBO's estimate, over the period from 1969 to 2007. The current vintage of the CBO's natural rate of unemployment differs from real-time estimates, and such a difference will introduce biases in the estimate of  $\pi_t^*$ , a point which we return to shortly. Since the estimated time-varying parameters are noisy, the figure depicts the minimum and the median values of  $\pi_t^*$  over a centered moving window of nine quarters. We report the minimum value to provide a conservative assessment of the time variation in  $\pi_t^*$ .

The main takeaway from this exercise is that the attainable rate of inflation in the medium term was subject to profound reevaluations in the late 1960s and the 1970s. Furthermore, the tolerable level of inflation was also subject to reevaluations which continued until the late 1990s, when  $\pi_t^*$  finally settled around 2 percent. The figure depicts a steady increase in the implicit inflation goal over the course of the 1970s. Since the CBO's current view of the natural rate of unemployment in the 1970s is likely higher than most real-time assessments, our estimate of the rise in the inflation goal over this period is conservative.<sup>15</sup> It is possible that policy makers' long-run aspirations were always for low inflation, but in practice their perception of the attainable rate of inflation in the medium run was subject to frequent reevaluations in the face of adverse supply shocks.<sup>16</sup> Without a clear mandate, the costs of returning to a lower target were considered too high to be paid directly, a topic that will be further addressed when we discuss "opportunistic disinflation." Needless to say,

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<sup>15</sup> In deriving our estimate of the inflation goal from (2), we have purposely chosen the CBO estimate because it averages about 6.0 percent in the 1970s, with relatively little variation over the decade. This estimate is likely on the high side of the range of real-time estimates of the natural rate of unemployment, and will therefore make the reported  $\pi_t^*$  in the 1970s a conservative estimate.

<sup>16</sup> Ireland (2007) reaches similar conclusions about time variation in the inflation objective using a different approach based on estimating a small-scale DSGE model on actual data.



the lack of explicit targets was a significantly important missing piece to the monetary policy framework in the 1970s. But it is also important to note that the target was subject to, admittedly milder, revisions in the 1980s and most of the 1990s. By then the Federal Reserve had regained credibility in its stance towards inflation, but as we discuss later it was not yet transparent about its inflation goal.

From an inflation model perspective, the most recent period also stands out. The role for past inflation and economic slack in determining inflation has diminished, and more emphasis is placed on long-run inflation expectations. Figure 7 shows that discussions about “well-anchored expectations” increasingly appear in the transcripts starting in 2004. With a stable inflation goal at 2 percent, the focus was to maintain inflation near target rather than to achieve lower inflation. The notion here is that insofar as *long-run* inflation expectations are “well-anchored,” inflation will deviate only modestly from the inflation goal in proportion to the deviation of the unemployment rate from its equilibrium level. In this context, the role of the central bank is to ensure that long-run expectations are centered on the inflation goal, and to stabilize the economy at full employment, at which point inflation will equal its target.

As will be discussed later, the anchoring power of long-run expectations and the small effect of the unemployment rate gap on realized inflation have important repercussions for the monetary policy framework. The inflation costs of deviating from full employment are small in this setup. As a result, the costs/benefits analysis of probing for better labor market outcomes (in the form of a lower equilibrium unemployment rate) may be more favorable now. Issues surrounding the shape of the loss function are coming into better focus, too. With small inflation costs, what are the welfare costs of overshooting full employment? Are the losses symmetric to undershooting full employment, as the current statement on monetary policy strategy implies?

## *II.B. Changes in Policy Rules and Opportunistic Disinflation*

The target-less regime began to crumble by the end of the 1970s. The passage of the Humphrey-Hawkins Act of 1978 provided the Fed with a mandate to pursue targets, but not a roadmap as to how to get there. The act called for semi-annual reports to Congress and provided a mandate for the FOMC to “maintain long run growth of the monetary and credit aggregates commensurate with the economy’s long run potential to increase production so as to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates.” The 1979 monetary aggregates experiment could be looked at in the context of just such a roadmap, or rule. More generally, the topic of how a policy rule for the FOMC has evolved over time has been widely debated in the literature. To capture time variation in the policy rule, we consider the following reaction function:

$$(3) \quad \mathit{ff}_t = \gamma_{0,t} + \gamma_{\mathit{ff},t} \mathit{ff}_{t-1} + \gamma_{\pi,t} E_t \pi_{t+3} + \gamma_{u,t} E_t u_{t+3} + \nu_t ,$$

where  $\mathit{ff}$  is the federal funds rate and the other variables are defined as previously, with  $\nu$  denoting an error term.<sup>17</sup> The rule is forecast-based, with the forecasts being given again by the Board staff projections as published in the GB/TB. In addition to the forecasts of inflation and unemployment, the rule allows for interest rate smoothing. As before, the coefficients in the rule are time-varying, with their evolution assumed to follow a random-walk.

Equation (3) is estimated over the sample 1969:Q1 to 2008:Q4, and more details about the data and estimation are provided in the Appendix. Figure 8 reports the unsmoothed filtered estimates starting in 1973:Q4. We omit the earlier period because the estimates might be affected by the choice of initial conditions, for which we do not hold strong priors. The figure also reports the

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<sup>17</sup> The specification is similar to Boivin (2006). Our exercise, however, is conducted at a quarterly rather than at a Greenbook frequency. Another important difference is that we let the time-varying intercept capture not just potential changes in the equilibrium federal funds rate, but also changes in the policy makers’ assessment of the natural rate of unemployment.

long-run responses to inflation and unemployment, computed by dividing the contemporaneous responses by  $1 - \gamma_{ff,t}$ . In all, there has been some variation over time in the degree of interest rate smoothing and in how the FOMC has reacted to the inflation and unemployment rate forecasts.

It is interesting to note that the weight given to unemployment relative to inflation (in absolute terms) was, overall, at its largest in the 1970s, and then declined in the 1980s and the 1990s. The relative emphasis on unemployment deviations in the 1970s is consistent with the previous discussion about the FOMC being unwilling to generate large employment losses in order to reduce inflation. Such a focus on employment stabilization also raises the much-discussed issue of Fed independence. Still, it is the case that once taking into account changes in the operational inflation target (which in the context of the policy rule (3) are subsumed in  $\gamma_{0,t}$ ), the tenet that in the 1970s the FOMC was violating the “Taylor principle,” whereby the policy rates moves more than one-for-one with inflation, is far from settled.<sup>18</sup> In our exercise, the long-run response of the federal funds rate to the inflation projections is always estimated to be above unity.<sup>19</sup>

The estimated parameters in (3) signal a greater emphasis placed over the course of the 1980s and 1990s on deviations of inflation from target relative to deviations from full employment. After the sharp decline in inflation achieved by 1984, it is notable how the strategy over most of 1984-86 was one with a strong resemblance to a gradualist approach to driving inflation lower. During those years the unemployment rate was stable but at levels near 7 percent, above the natural rate. A variant of this strategy was later undertaken under Greenspan in the late 1980s and early 1990s, with the FOMC pursuing an “opportunistic disinflation” to reduce inflation below its average of 3.5-4.0 percent. The strategy accomplished a reduction in inflation by allowing some slack to remain in the

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<sup>18</sup> See, for example, Clarida, Galí, and Gertler (2000), and Orphanides (2003) for contrasting views about the FOMC rule’s consistency with the Taylor principle in the 1970s. Boivin (2006) reaches different conclusions from ours, likely as a result of the differences in specification that we have already discussed.

<sup>19</sup> In this regard, it is relevant to note that the effective federal funds rate increased substantially in 1973 before the oil price shock. And monetary policy had tightened already in 1978 and 1979 before Volcker became Chairman.

economy following the 1990-91 economic downturn, avoiding the arguably larger costs of initiating another recession. It is possible to motivate such a strategy by assuming an unconventional loss function in employment and inflation (see Orphanides and Wilcox 2002), a notion which hints at the times flexible interpretation of the loss function underlying the FOMC's policy framework.<sup>20</sup> The literature in the late 1980s and early 1990s was already examining the benefits of transparency. This is one instance where a regular conference on the framework during this period might have raised the issue of opportunism more clearly and fostered more discussion about transparency.

In the more recent period covered in the exercise, which spans the 2000s up to the onset of the Great Recession, the long-run response to unemployment has increased again in absolute value, with inflation and unemployment deviations carrying approximately the same weight in the reaction function. It is possible that the anchoring of inflation expectations and a “flat Phillips curve” have played a role in such a development. Here, we note that an optimal policy exercise with a credible inflation target would be consistent with a larger weight given to activity stabilization in a policy reaction function such as (3) when the slope of the Phillips curve becomes flatter (see, for example, Iakova 2007, and Erceg et al. 2018).

The time-varying nature of the reaction function (3) makes it complicated to talk about rules versus discretion, in that a changing unemployment response relative to inflation, or changes to the interest rate smoothing coefficient, could be interpreted as an exercise in discretion. Nevertheless, even with this flexible setup it is possible to identify other important changes to the conduct of policy. In particular, Figure 9 depicts the estimated error term  $\nu$  in the policy function. The dotted part of the line encompasses a period of high volatility in the early part of Volcker tenure associated

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<sup>20</sup> This reverse engineering exercise posited a loss function in the absolute value of unemployment and the squared deviation of inflation from a short-run inflation target. This loss function induces a region of inactivity for sufficiently small inflation deviations. In these circumstances, the central bank optimally waits for a shock that moves inflation toward the long-run goal, pocketing gains along the way without deliberately altering the output gap.

with the non-borrowed reserves operating procedure. Overall, it is apparent that the predictability of the rule has increased noticeably starting from the mid-1980s.

Another notable feature of the current policy environment is that changes in the policy rule are key to explaining the conduct of monetary policy after the liftoff from the zero-lower bound. Figure 10 plots the predicted federal funds rate using the coefficients in (3) as estimated in 2008:Q4, vis-à-vis the actual, from 2015:Q4 to present.<sup>21</sup> The simulation is static, in that it uses the actual lagged federal funds rate. Despite such a feature, it is apparent that the reaction function (3) with the 2008:Q4 estimated coefficients is a poor predictor of FOMC behavior in the most recent period. Modifying the intercept in (3) to account for changes in the assessment of the equilibrium value of the federal funds rate and the unemployment rate (as reported in the SEP projections over the simulation period) reduces but does not eliminate the difference. In other words, a decline in the estimate of the equilibrium federal funds rate has played an important role, but other factors have been at play also. These factors could be related to risk management considerations, and/or to shifts in the weights assigned in the rule to unemployment and inflation deviations. The potential for such shifts would point again to a flexible interpretation of the loss function underlying the FOMC's policy framework.

### *II.C. Fed's Transparency and Credibility*

The changes discussed so far to the policy framework in terms of the inflation goal and the systematic component of policy are also related to other elements of the framework, most notably transparency and the efficacy of Fed actions. In this regard, Gürkaynak, Sack, and Swanson (2005) find evidence of excess sensitivity of longer-dated forward rates to economic news, which they argue

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<sup>21</sup> Since the forecasts from the Board staff are not yet publicly available, we use instead the FOMC's Summary of Economic Projections.

is indicative of the public having to learn about the monetary authority’s inflation target.<sup>22</sup> More broadly, changing long-term inflation expectations could result from policy makers’ lack of transparency or lack of credibility. We revisit here the relationship between a short-run spot interest rate and forward rates in days when the CPI index or the PPI index were released, and compare this reaction with non-release dates:

$$(4) \quad \Delta i_t^{F,j} = \alpha_0 + \alpha_1 \Delta i_t \mathbf{d}_t(\text{release day} = 1) + \alpha_2 \Delta i_t (1 - \mathbf{d}_t(\text{release day} = 1)) + \varepsilon_t .$$

The dependent variable  $\Delta i_t^{F,j}$  is the daily change in the Treasury forward rate  $j$  years ahead, while the explanatory variable  $\Delta i_t$  is the daily change in the spot 3-month Treasury bill yield. The dummy variable  $\mathbf{d}_t$  takes the value of one in days when there was a CPI release or a PPI release, and a value of zero in the other days. The specification assumes that on release dates the change in the spot 3-month Treasury bill captures the “news” effect of the CPI or PPI release, and that the effect of the release on the forward rates can be assessed from its impact on the spot rate.<sup>23</sup> We consider instantaneous forward rates spanning the maturities from two to fifteen years ahead.<sup>24</sup> Near-term forward rates will be affected by cyclical variables, including expectations about monetary policy actions. Longer-term forward rates are determined by more persistent factors, including expectations about policy makers’ target for inflation.

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<sup>22</sup> Kozicki and Tinsley (2001), while not focusing specifically on economic news, also argue that movements in forward rates at the longer-end of the maturity spectrum have been related to shifts in market perceptions of the policy target for inflation.

<sup>23</sup> This assumption allows us to circumvent the issue of not being able to measure the “news” effect of the release using market survey data in the period before the 1990s. We focus on inflation release dates because these should capture potential shifts at the longer-end of the maturity spectrum that are motivated by shifts in perceptions about the long-run inflation objective.

<sup>24</sup> More detail about the data and estimation is provided in the Appendix.

Figure 11 reports estimation results for the coefficients  $\alpha_1$  and  $\alpha_2$  in equation (4) over two subsamples. The periods we consider are 1970 to 1996, and 1997 to 2007.<sup>25</sup> The sample split is informed by our previous inference on the FOMC's inflation objective. For the longer-dated forward rates, the reaction to inflation news is stronger than in non-release dates—that is, the black line is above the red line, or  $\alpha_1 > \alpha_2$ —in the 1970 to 1996 period. We take this finding as consistent with the view that since the 1970s and up until the late 1990s, financial markets had changing perceptions about the FOMC's inflation goal, with those perceptions being influenced by news about inflation. The exercise cannot assess whether the way the public was revising expectations about the FOMC's inflation objective was consistent with the FOMC's changing target  $\pi_t^*$  as depicted in Figure 6. Still, a lack of transparency about the inflation goal may have elicited movements at the longer-end of the curve which contributed to less effective monetary policy actions. The more recent period, with no significant response of longer-dated forward yields to changes in the short-term Treasury bill both on inflation release dates and on non-release dates, is consistent with the public perceiving the policy maker as having a credible and stable inflation target.

Needless to say, this exercise provides at best partial answers to the evolution of Fed transparency over time. And the findings over the 1970s and 1980s could have different interpretations. It is possible, for example, that the excessive reaction to inflation news at the longer end of the term structure was also a symptom of the Fed's lack of credibility in the 1970s. In the 1980s and early 1990s, the reasons for such a result could be different, and hinge not on the credibility of Fed in its stance about inflation, but on the FOMC's vagueness about its long-run inflation goal. Nevertheless, the results suggest that the steps taken to increase credibility and transparency over time took long to manifest themselves in the form of the long-end of the term

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<sup>25</sup> We use daily data from the 1970s to the end of 2007, and exclude the more recent period because of the complications associated with the conduct of monetary policy at the zero-lower-bound.

structure becoming unresponsive to short-run inflation news. One potential reason for this finding is that the move toward increased credibility and transparency was incremental.

It is possible to identify a number of steps in this incremental process. The Humphrey-Hawkins Act of 1978 certainly increased transparency and solidified the importance of the “dual mandate.” This act clarified the goals of monetary policy, increased accountability to Congress, and provided an opportunity for a more transparent discussion of monetary policy actions. And the detailed account in Goodfriend and King (2005) of the Volcker disinflation highlights Volcker’s understanding of the importance of credibility of monetary policy actions vis-à-vis financial markets, and in particular the role of credibility in informing markets’ expectations about inflation in the medium and longer run. Figure 12’s word count shows an increasing number of discussions at the FOMC table around credibility. Over time, this development led to important changes in the conduct of monetary policy. As already discussed, monetary policy actions became more predictable and more clearly anchored to dual mandate goals.

Through the 1990s several changes occurred concerning transparency of monetary policy. The first tentative step towards greater transparency occurred in 1994, when the Federal Reserve began to include the intended change in the federal funds target in its statement. While most financial market participants had been aware of the focus on the federal funds rate since 1987 or before, the Fed simply did not announce the new fed funds target prior to 1994. The adoption of a roughly 2 percent target was discussed and agreed upon internally by the FOMC in 1996. From a transparency standpoint, it is interesting that such a target was not initially made explicit to the public. It is possible that greater transparency was perceived as potentially carrying a credibility cost if that 2 percent target was subject to change at a future date. Another move toward greater transparency and predictability occurred during the slow recovery from the 2001 recession. By late summer 2003 the Fed had hit what it assumed was its effective lower bound. Given the low rate of inflation at the



time, the committee indulged in rudimentary “forward guidance” meant to provide the markets with the FOMC’s view of *future* policy actions.

Other important improvements to transparency have occurred during the most recent period which is not covered in our empirical exercise. Forward guidance became a crucial element in the conduct of monetary policy when the federal funds rate was at the effective zero-lower-bound. In addition, the Federal Reserve began to hold quarterly press conferences to explain to the public actions that were being taken, and recently it has been announced that those press conferences will be conducted after each meeting. Perhaps most important, starting in 2012 the FOMC provided a document explicitly outlining its monetary policy framework, including an explicit 2 percent inflation target. This framework document is explicitly voted on at the January meeting, and certainly provides an opportunity for changes in the monetary policy framework to be communicated at an annual frequency. To date, more extensive, comprehensive, and public discussions of the policy framework, such as conducted by the Bank of Canada, have not emerged through this process.

#### ***II.D. Other Strands of the Framework***

The empirical exercises so far have highlighted some, but not all, of the relevant changes to the monetary policy framework. One important element that has not been discussed so far is the role of financial stability in monetary policy. For an empirical examination of how financial stability has affected the conduct of monetary policy over time in the context of a reaction function similar to the one considered in (3), we refer the reader to Peek, Rosengren, and Tootell (2015). An enduring effect of the late-1990s “productivity revolution,” which was used as justification for the significant boom in equity prices relative to earnings, was an increase in the attention paid to asset prices and (more generally) financial stability in the policy discussion, as shown in Figure 13. This focus subsided somewhat after the 2001 recession, which was caused in part by a significant reduction in stock prices of internet-related stocks, but it was a precursor to the renewed focus on financial

stability issues following the 2008 financial crisis. It is reasonable to view increased attention to financial stability issues as a change in framework, tantamount in its extreme version to the adoption of a “ternary mandate.”

The other aspect of the evolution of the framework is more technical, and pertains to the instrument or set of instruments used for the conduct of monetary policy. A full discussion of these tools is beyond the scope of this analysis. Bernanke (2006) provides a historical perspective on the use of monetary aggregates as a guide for monetary policy, and their eventual demise in favor of the federal funds rate as the primary tool of monetary policy. Nevertheless, it is important to highlight the use of the balance sheet as a policy tool during the Great Recession and ensuing recovery, when the federal funds rate was at the effective zero-lower-bound. The way one judges the efficacy of those asset purchases has consequences on the urgency with which one perceives that the current framework necessitates changes.

### *II.E. Why Have a Formal Framework Review?*

Overall, it seems reasonably clear that the monetary policy framework has changed along several important dimensions since the late 1960s. Some changes occurred rapidly when necessitated by acute economic conditions, such as the Volcker disinflation. Other framework changes were considered and implemented gradually under relatively benign economic conditions as a response to long-standing problems with the framework, such as increases in transparency.

Concerning the merits of a formal framework review, several observations can be drawn from our historical assessment of framework changes. First, some of the past shortcomings in the conduct of monetary policy can be ascribed to missing elements of the framework that is laid out in section I. Lack of clarity on an inflation goal in the late 1960s and early 1970s contributed to a mix of fiscal and monetary policies in which output stabilization became the primary focus, and in which the responsibility of the central bank for price stability was more ambiguous. This subordination

may also have been a consequence of the lack of independence and credibility at the time in pursuing monetary policy actions to reduce inflation. These issues were later exacerbated by bad luck in the form of a number of adverse supply shocks, with the stabilization of inflation again taking the backseat, in part because the sacrifice ratio was perceived as being too high.

Other elements of the framework came into being in different ways. With the Humphrey-Hawkins Act, Congress specified the dual goals of monetary policy. But it was Chairman Volcker who ultimately reclaimed the role of monetary policy in controlling inflation. While we have shown that the implicit inflation target under Volcker was subject to change, the direction of the change was unmistakably towards lower inflation, even if the disinflation was a bit “opportunistic.” Another element of the framework that emerged under Volcker (after the non-borrowed reserves operating procedure) was greater predictability of Fed actions. These elements in the conduct of policy were largely cemented under Greenspan’s chairmanship. Others came into focus later, and had largely to do with a better appreciation of the role of expectations and the associated importance of transparency in communicating long-run goals and policy intentions. In sum, there has been an evolutionary aspect to many of the key elements of the framework that have been put in place. The evolution of economic thinking and the lessons gleaned from historical experience have been instrumental in providing a better understanding of the ways to improve central bank design (see Blinder 1998, and Reis 2013). This evolution of our understanding of monetary policy provides one way in which regular conferences might be helpful.

Second, it is interesting to note that the significant change in approach to policy taken under Volcker occurred with an essentially unchanged committee. Thus this episode provides a stark example of the crucial role of the FOMC chair in policymaking. It is notable that accounts of the history of U.S. monetary policy often identify regimes or frameworks with the FOMC chair at the time (for example Romer and Romer 2013). While our account of relevant framework changes

suggests that such a view can be an over-simplification, it is only recently under Chairman Bernanke that the FOMC has taken steps to codify the policy framework and make it less chair-dependent. The 2012 introduction of the “Statement on Longer-Run Goals and Monetary Policy Strategy” is the clearest example, but there are many others. The increased transparency and accountability with the publication of the FOMC projections forces a more focused discussion of the policy issues at stake at FOMC meetings. And the regular assessments of the risks to financial stability are a step towards better incorporating financial developments into the policy decision process. A key goal of a regular framework review of the type outlined in this paper is to continue the progression towards a more stable framework.

Third, the large and diverse composition of the FOMC should in principle provide for a better representation of different viewpoints and a more continuous “stress testing” of the framework in place. While there is truth to that notion, the previous observation about the importance of the chair in the decision-making process also makes it clear that “the FOMC is not a simple democracy, but a consensus-driven organization with the agenda set by the chair” (Bernanke 2016). This approach to decision making has benefits, but might well be improved by putting in place processes that ensure that the status quo is regularly challenged and necessary changes are adopted in a timely fashion. Again, a regular conference would help serve this function.

In sum, we view a formal framework review as a natural step following those already undertaken to strengthen the Federal Reserve as an institution. While good policy will always benefit from a good chair, it will also benefit from a resilient framework. Having a regular assessment of the framework that solicits input from different sources increases accountability and transparency, and helps to ensure that the framework in place is followed if it remains appropriate, and changed if economic circumstance or understanding make that appropriate. In so doing, a regular assessment

also improves the Fed's accountability, as it forces policy makers to better articulate to markets and the public at large the rationale for their actions in the context of the framework.

### **III. How Should the Federal Reserve Regularly Evaluate the Framework: A Suggested Approach**

Currently the Fed reviews the framework document once a year. At issue is the depth at which it re-assesses the document, the openness of the process, and the inputs from which it draws in reviewing. Instituting a less frequent and more thorough process for evaluating the Fed's monetary policy framework, such as with the Bank of Canada, sounds straightforward. But in practice, such a process would require decisions on a number of key features of the review. We briefly outline here the trade-offs involved with each of the key features, and recommend one approach to the review process that we believe nicely balances the trade-offs.

#### ***III.A When to Conduct a Review?***

A key margin for this dimension is whether the timing of the review should be regular or state-dependent. Ideally, a central bank should be able to make effective changes to its operating framework whenever the need arises. The history in section II suggests that the state of the economy has not always provided sufficient inducement to trigger a framework change. Section II implicitly provides some possible guidelines for conditions that could prompt a state-dependent re-evaluation:

- i. A significant deterioration in economic performance that is not readily linked to non-monetary policy factors, perhaps along the lines of the loss function estimates (squared deviations of inflation from target and unemployment from the estimate of the natural rate) presented in Figure 1;

- ii. A significant change in the behavior of long-run inflation expectations, and other financial market signals that could imply a loss of efficacy and credibility, for example along the lines of the results presented in Figure 11;
- iii. Or, on a brighter note, compelling evidence provided by new research in the field that a superior framework exists.

In practice, such indicators and others are routinely examined by the Federal Reserve System's staff. The circumstantial evidence over the Federal Reserve's 105-year history, a portion of which has been examined in the previous section, suggests that changes to the framework have often occurred too slowly at key junctures, most notably during the Great Depression when the persistent adherence to the Gold Standard critically constrained the Fed's ability to respond to the crisis. Another widely-studied example is the 1970s, when it took more than a decade to successfully address the significant rise in inflation. Given the non-systematic way in which framework changes have occurred historically, and the mixed history on the timeliness and effectiveness of such changes, we would suggest that the FOMC regularly reassess key elements of its framework at a fixed interval, perhaps more formally than the current annual sign off of the "Statement on Longer-Run Goals and Monetary Policy Strategy."

A choice to employ a fixed frequency should not, however, be overly rigid. It would be foolish to assume that policy makers can anticipate all of the circumstances that might require a change in the monetary policy framework. Thus even within a regular frequency review, it might be wise to allow for an "escape clause" that makes it possible to reassess off regular schedule.

### *III.B Who Sets the Agenda, and Who Provides Input for the Review?*

If a formal review process is undertaken, there are several options for how to structure such a review, most notably who sets the agenda and who participates in the review discussion. These decisions can be more important than it might seem. On the one hand, outside political influence in

setting the review's agenda could be viewed as eroding the Fed's independence. On the other hand, including outside voices in the review discussion (and making the discussion public) could go a long way towards building public accountability for the Fed's framework decisions.

Because the goal is to use the review as an input into an FOMC decision about its framework, we argue that agenda-setting should be done primarily by the FOMC. Committee members would be required to vote on changes, so there should be Committee support for any changes that are considered.<sup>26</sup> Moreover, the FOMC members should know about the key issues they have been grappling with better than anyone else. The Federal Reserve staff is constantly reassessing the framework, and as a result over the course of time there should be a fairly large inventory of topics from which the FOMC can choose.

While we suggest that the FOMC and Federal Reserve staff should have primary responsibility for setting the review agenda, one cannot rule out that consensus-building pressures at the FOMC might overlook dissenting views. To ensure that dissenting views are presented, it may be helpful in addition to have non-Fed economists and academics suggest possible topics for discussion at the review. Of course, ultimately the Committee would decide which topics will be considered.

While we would argue that the Committee hold primary responsibility for setting the agenda, it seems important for the review itself to include participants from many viewpoints, both internal and external. The details of how to include diverse viewpoints could vary. At one end of the spectrum, the review process could only be internal. In this case, the process could still draw on expertise from outside, perhaps by surveying relevant research, but possibly also by soliciting external analyses. The FOMC would choose how much and when to disclose the outcome of the meeting. At the other end of the spectrum, the analysis supporting the framework review could come solely from external contributors. Such a process might be akin to the processes at some

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<sup>26</sup> Any changes to the existing framework would likely be voted on at the following January organizational meeting when the current framework is approved and other organizational changes for the FOMC occur.

central banks that have engaged an expert panel to provide an independent review of their monetary policy performance in recent years.<sup>27</sup> A key drawback of this option is that external reviewers might be unaware of all the internal work done by staff at the Federal Reserve evaluating the framework. And one could argue that external evaluations already take place to some extent, as reflected in the volume of academic research and conferences devoted to this topic. Thus on balance, we would argue for a synthesis of these two approaches, incorporating both internal and external inputs into the review.

### *III.C What Should Be the Content of a Review?*

One feature that should be common to all reviews is an evaluation of the current framework along some agreed-upon criteria—estimates of economic loss in recent years from a variety of loss functions, deviations from estimated policy rules, comparisons to optimal policy exercises, deviations between SEP and market expectations (adjusted for other substantive and methodological differences), for example. These elements of the review should provide a starting point for a discussion about potential changes to the framework. Much of this assessment could be compiled by the staff, but it might be augmented by conference participants' independent performance assessments. Candidates for altering the framework would then be considered, drawing on analyses from both staff and external participants.

Issues related to the elements of the framework outlined in section I are all potential candidates for a review, although as suggested above, we would likely shy away from issues that require alterations to the Federal Reserve Act. In the next section we describe two challenges facing the

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<sup>27</sup> Most often, these external reviews focus on monetary policy performance broadly defined, rather than on more specific aspects of the policy framework. Examples include the Norges Bank's "Norges Bank Watch," an annual report written by an independent committee of economists to evaluate the Bank's monetary policy performance; Ingimundur Fridriksson's 2010 report on the Norges Bank's monetary policy process; the 2000 "Independent Review of the Operation of Monetary Policy" for the Reserve Bank of New Zealand (RBNZ); and a 2010 review of the Reserve Bank of Zimbabwe's monetary policy.



current monetary policy framework that could be the subjects of a review. Needless to say, there are other issues worth considering. The historical review of framework changes in the previous section highlighted shifts in the conduct of monetary policy that were arguably related in part to changing views about the appropriate loss function to minimize. In current circumstances, a discussion about the symmetry of losses related to unemployment—apart from inflationary consequences, does low unemployment imply losses as large as high unemployment?—could be an ideal focus for a framework review. Changes in economic structure and their influence on the conduct of monetary policy would also be candidates for discussion.

#### ***III.D Who Decides if the Framework Needs to Change?***

This element of the review process should be less controversial. The recommendations that result from the review will depend on who sets the agenda for the review and how such a review is structured. Whether the review is internal, external, or a hybrid of the two will affect who provides the recommendation about potential framework changes. But in the final analysis only the FOMC has the responsibility for making a decision about the framework, since the FOMC is the one body that is accountable to Congress and the public for monetary policy performance.

#### ***III.E A Proposal for a Framework Review***

A framework review could comprise a number of possible combinations along the dimensions we have just described. One candidate would be a purely internal review, an augmentation of the internal processes already in place. As suggested above, Federal Reserve staff and FOMC members already devote considerable effort to evaluating the policy framework. But in our view, the internal processes suffer from some shortcomings: The time allotted for discussion of the review of the annual framework document has been modest; the scope of questions discussed is normally relatively narrow; and it has not to date been the case that an alternative framework has been

discussed in depth, including a motion with an up or down vote on moving in a new direction. Given the historical record, it can be argued that changes in framework, when these have occurred, have not always been timely, and have often been heavily dependent on the leadership of the chair. Thus if one were to choose an internal process, it would be valuable to set aside significant time for the Committee to discuss recent performance, to identify shortcomings either in the framework or in its implementation, and to consider changes to the framework that might address any shortcomings identified.

While the point of a framework review is indeed to augment the internal decision-making process of the FOMC, it is not clear that keeping the process entirely internal would achieve the desired results. After all, the FOMC has had the option to use its internal processes to alter its framework since its inception. But the historical record outlined in section II suggests that delays and/or ineffective changes to the monetary policy framework were in part due to issues with the FOMC's internal decision-making processes. The literature on monetary policy decision-making by committee is growing, but still small.<sup>28</sup> And the extent to which the vast literature on group behavior from social psychology can be readily applied to a committee such as the FOMC is not clear. Nevertheless, one cannot rule out that a committee such as the FOMC may at times be subject to some of the same issues in terms of performance, coordination, and polarization highlighted in the social psychology literature. Broadly speaking, this literature notes that accountability, transparency, and outside examination of the group decision-making process are potential ways of mitigating pitfalls associated with group behavior (see Sibert 2006).

For these reasons, our preferred approach to a framework review is one that provides a role for the FOMC, the Federal Reserve staff, and outside specialists. An open FOMC-designed evaluation with internal and external input would increase transparency and accountability, and would broaden

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<sup>28</sup> Blinder and Morgan (2005), Gerlach-Kristen (2004), Riboni and Ruge-Murcia (2010), and Sibert (2006) are notable contributions.

perspectives without ignoring the work done internally in the System. There are issues to opening up the review process, most notably the risk of politicizing the framework review. But such concerns may be mitigated by a review that employs evidence-based argumentation, an important tool to falsify claims driven by political motives only. And it is important to note that there are political risks to an opaque, internal process as well. Making important changes in the monetary policy framework without clearly explaining the process and rationale to the public risks political backlash.

Specifically, we envision a review that occurs mostly at regular frequency. The Bank of Canada's five-year horizon seems a reasonable starting point. A potential option is to adapt that timing to take account of the term of the Federal Reserve chair: allowing for one framework reevaluation for each Fed chair's four-year term. As noted earlier, we favor the inclusion of an "escape clause" that makes possible a reassessment off-schedule when necessary.

The FOMC should take the lead in the setting of the agenda, although external input could also be taken into consideration. At the very least, the review should include supporting work by staff explaining the issues and why these were selected. Once the agenda is set, a call for papers on the selected topics would allow interested researchers from academia, other central banks, think tanks, and the private sector to submit their ideas for consideration. Again the FOMC would take primary responsibility for selecting contributions from among those submitted, perhaps in consultation with external experts. As discussed earlier, the review should include an evaluation of the current framework, which could include both staff-generated and external evaluations of monetary policy performance. The results of the work presented at the conference could be summarized by staff, detailing the findings and what they may imply for framework changes. With the results of this public conference, as well as additional internal work, the FOMC would be well positioned to take formal action on changes they judge to be appropriate.

### ***III.F Potential Costs of a Regular Review***

While we believe our recommendation could modestly improve the Federal Reserve's performance over time, it is wise to consider potential costs in undertaking such a review. In particular, the Fed should consider the effect such a process might have on expectations and credibility. Just the existence of such a process might imply to markets that (say) the inflation goal was somewhat more subject to change than it is at present, which might in turn increase the uncertainty around long-run expectations of inflation. The consideration of a specific change in the lead-up to a formal evaluation, if it became public, could similarly increase uncertainty about the Fed's actions in coming years. Suppose, for example, that it became known that, as noted earlier for the Bank of Canada, the FOMC was considering the merits of price-level targeting. Knowledge of this fact should shift some probability weight towards its adoption, and could imply a different trajectory for the funds rate and for inflation over the medium horizon.

It is not obvious how to mitigate such effects, apart from clear communication about the scope of the review and a gradual build-up of experience with routine framework evaluations. But it is important to recognize that such effects may be at play, and to work to minimize their impact on economic outcomes. It is also important to note that framework changes may be perceived as improvements, and thus help reduce any economic stress; just as the cost of unemployment fluctuations around the natural rate declined when inflation expectations became well-anchored.

### ***III.G How a Formal Review Differs from the Current Process***

As already noted, staff around the Federal Reserve System are continuously evaluating some elements of the framework. How would the proposed review differ from the ongoing process? There are a number of dimensions in which this framework evaluation would deviate from the ongoing internal process:

- i. From the Committee’s perspective, the current annual process is more concerned with minor changes than major evolutions. This process would require a more significant amount of FOMC time to focus on the performance of the current and prospective framework.
- ii. The current process does not typically include a performance evaluation of the current framework, in particular:
  - a. Is the current framework showing signs of stress, or is it expected to in the near future?
  - b. Has the Committee deviated significantly from framework, and if so for what reason?
  - c. Has the Committee deviated significantly from our “normal” (i.e. estimated policy rule) behavior, and if so for what reason?
  - d. Have economic losses been larger than usual in recent history? Are some of these losses attributable to monetary policy?

The evaluation would entertain much more input from outsiders. It may not be that outsiders possess unique knowledge about how to improve the framework, but they would bring somewhat different perspectives, and they could reduce any tendency for institutional inertia or group-think.

#### **IV. Is Now a Time When We Should Be Rethinking the Monetary Policy Framework?**

Could the current framework be improved? For example, is it at risk of failure when the next downturn occurs? Is there a recognition among current FOMC members that a change should be considered now, perhaps consistent with other times when regimes changed? The past ten years have been marked by a record-sized recession and financial crisis, the use of alternative tools to reduce the effects of the disruption, and a disappointingly long recovery back to full employment, despite the efforts undertaken during and in the aftermath of the crises. It would be difficult to say that economic performance during the recovery—specifically, the rate at which we re-attained full employment—was completely satisfactory. Hence the monetary policy framework is far from

perfected; for a variety of reasons, more needs to be done. Despite the very significant changes over the past decade, the changes to date in its framework document, as detailed earlier, have been relatively minor. This may be one reason for having a more regularized schedule to discuss framework changes.

It is relevant to note that the two largest episodes of sub-par economic performance in *modern* Fed history have been the Great Inflation of the 1970s and the Great Recession and recovery that began at the end of 2007. In both of these cases, it is arguable that one key failing has been that the Fed did not adequately address an emerging problem— whether or how to offset the rising inflation and inflation expectations in the first case, and how to overcome the lack of potent tools to offset recession in a low-inflation, low-real rate environment in the second case.

In an important sense, these observations provide the strongest motivation for our recommendation for a regular review of the performance of the monetary policy framework. The economic environment is constantly changing, in the examples above, whether the economy is subjected to large supply shocks or the real rate falls significantly. The framework must be flexible enough to adapt not only quickly but effectively. The hope is that a regular review would ensure that the Fed would be ready to make the correct adjustments as soon as possible when they are required.

We will consider two high-level challenges currently facing the Fed’s monetary policy framework, both of which might be viewed as requiring a change in framework: The potentially increased likelihood of protracted periods at the effective lower bound on interest rates; and the limited ability to stabilize the economy, including a chronic pattern of significantly overshooting full employment—a risk to which nonzero probability attaches in this cycle.

#### ***IV.A The Effective Lower Bound on Interest Rates***

We have been in a low-inflation regime for the better part of two decades. More recently, we appear to be in a low-real-interest-rate regime. Those two observations imply that equilibrium

nominal interest rates will, for some time, be quite low by historical standards.<sup>29</sup> That in turn implies that the amount of policy “buffer” for conventional short-term interest rate policy—the amount by which the central bank can lower its policy rate in response to an economic downturn—will likely be limited for some period of time. Thus one motivation for considering alternative policy frameworks might be a desire to find a framework that would provide the central bank with a larger policy buffer.

During the Great Recession, we also learned about the efficacy of some key alternative monetary policy instruments. Most notably, the Fed’s forays into quantitative easing (QE) and forward guidance provided an opportunity for researchers to estimate the effects of such policies on longer-term interest rates, on other asset prices, on inflation expectations, and on real economic outcomes (see for example Christensen and Rudebusch 2012; Gagnon, Raskin, Remache, and Sack 2011; D’Amico and King 2013; Hamilton and Wu 2012; Swanson 2017). Those findings bear on the confidence with which the Fed might use such tools in the future, which should in turn influence its comfort with a reduced policy buffer for its conventional instrument. If one accepts the median estimates of QE and forward guidance efficacy, and if one takes into account the difficulty experienced in returning the economy to full employment and target inflation following the Great Recession, one cannot assume that the current framework for monetary policy will necessarily provide enough potency to satisfactorily offset a modest to large-sized economic downturn, even combining the effects of conventional and unconventional policies. Thus the prospect of a continued low-inflation, low-real rate environment might well prompt consideration of monetary policy framework alternatives.

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<sup>29</sup> Kiley and Roberts (2017) assess the probability of becoming stuck at the effective lower bound from the perspective of two large econometric models.

#### *IV.B Stabilizing the Economy is Easier in Theory than in Practice*

When thinking about alternative policy frameworks in the form, for example, of adopting a price-level target, it is important to consider the record of monetary policy at stabilizing the economy. The first panel of Figure 14 shows the 12-month change in the unemployment rate, with recession shading, from 1949 to the present. The recurrent feature here is that whenever the unemployment rate increases by more than one-half of 1 percentage point, the economy always falls into a recession. The second panel in the figure displays the unemployment rate gap over the same period. Whether using latest-vintage estimates of the natural rate (the red line) or real-time estimates (the green line), the figure shows a pronounced tendency for the unemployment rate to dip significantly and persistently *below* these estimates of the natural rate at the end of expansions. In every case, this overshooting is followed by a recession. The depth of the overshoot varies, and the magnitude of the ensuing recession varies, but the pattern is nearly perfect for post-war U.S. economic history.

This limited ability to stabilize the economy could be due to events that are beyond the control of monetary policy. In some circumstances, the central bank intentionally caused a recession, most notably in the case of the Volcker disinflation. It is relevant to note that for the three most recent downturns, staff forecasts as reported in the Greenbook/Tealbook (GB/TB) featured only a mild increase in the unemployment rate, to a level roughly consistent with the real-time estimate of the natural rate of unemployment. In other words, the recurrent pattern was one where the tightening of monetary policy was expected to slow the economy down gently from above-capacity to full employment. Ex-post, one might judge that monetary policy contributed to the unexpected recession, but this is not what the Federal Reserve Board staff was envisioning ex-ante. The limited ability to predict a recession is well known, and not just a feature of Federal Reserve forecasts. Here, we want to highlight that once the unemployment rate starts to rise by a relatively modest amount,



dynamics take hold that tend to push the economy into a recession in ways that standard linear models do not adequately capture.

There could be many reasons for the tendency of the economy to “overshoot” full employment (or correspondingly to undershoot the natural rate of unemployment). The Fed (and other forecasters) could be surprised by the vigor of private growth late in the expansion, or by a late-recovery fiscal expansion (as occurred in the late 1960s during the ramp-up of the Vietnam War). Still, one never sees an “undershoot,” by this definition—a landing “above the runway,” in which unemployment plateaus above the estimated natural rate before slipping into recession. The pattern is consistent enough that it should prompt thought about the role of monetary policy in this recurrent pattern.

The next charts provide some evidence on the Fed’s forecast errors, to see if they might help explain the tendency for the economy to systematically overshoot full employment. Figure 15 examines the GB/TB forecast errors for real GDP growth and unemployment at the four-quarter horizon.<sup>30</sup> The periods chosen are the forecast dates leading up to the time that the unemployment gap (as displayed above) changes sign from positive to negative. Because the data for the GB/TB are collected beginning in 1965, the first such episode that we can examine is late 1971. After that, there are four other episodes—1978, 1987, 1997, and 2005, as well as a potentially late-breaking episode right now, with the quarterly average unemployment rate at 3.9 percent for 2018:Q2, and the CBO’s latest estimate of the natural rate at 4.6 percent. Thus, unemployment has been below the current natural rate estimate since March of 2017, or about 17 months—not a very long time by historical standards.

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<sup>30</sup> Errors are computed using real-time actual data from the Philadelphia Fed’s database, using the vintage of data eight quarters after the forecast was made. Data for longer-horizon forecasts are not as reliably available for the GB/TB dataset, although the pattern for the available six- and eight-quarter-ahead unemployment forecasts is quite similar.

The top panel of the figure shows that around the time that the unemployment rate begins to undershoot the natural rate (and correspondingly employment overshoots full employment), the GB/TB systematically over-predicts the unemployment rate four quarters ahead (errors are defined as actual minus forecast, so negative numbers indicate an over-prediction). The same is true for eight-quarter forecasts, not shown.<sup>31</sup> As indicated in the bottom panel, at the same time, the GB/TB forecasts tend to systematically under-predict real GDP four quarters hence—consistent with the kind of Okun’s Law relationship that appears to be embedded in the GB/TB forecast process.

Overall, forecast errors around peaks and troughs could be just a reflection of the fact that the economy is hard to forecast, especially at turning points.<sup>32</sup> But it is also possible that these systematic errors and patterns at key junctures of the business cycle are indicative of more fundamental challenges that make it difficult to fine-tune the economy. Importantly for this paper, this inherent difficulty could be relevant when evaluating possible changes to the framework, such as price-level targeting. In such a regime the need can arise to keep interest rates low for quite some time to offset the effects of the recession on the price-level gap, and subsequently to restrain the economy for some time, engineering a growth recession that brings inflation back down to target and employment back to full-employment. The empirical record of policy makers’ ability to engineer a growth recession that nicely lands the economy at full employment without morphing into a full-blown recession is not comforting. Similarly, a soft landing from an overheated economy—whether unexpected or not—to full employment has been a recurrent feature of past forecasts, but not of actual outcomes.

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<sup>31</sup> Unfortunately, there are far fewer eight-quarter-ahead than four-quarter-ahead forecasts recorded in the GB/TB historical dataset.

<sup>32</sup> Recall that an optimal forecast will generally be less variable than the series being forecasted.

#### *IV.C What Are the Alternatives?*

If this is indeed an appropriate time to be considering the effectiveness of our current framework, what are the alternative approaches we should be considering? Key alternatives should probably include:

- a. Inflation targeting with a different (higher) target rate;
- b. Adopting an inflation target range, rather than a point target. The target range could vary with significant (perceived) and persistent changes in the equilibrium real rate of interest, à la Rosengren (2018);
- c. Price level targeting, including:
  - Conventional price-level targeting, and
  - Opportunistic or asymmetric price-level targeting (in the wake of a large recession), i.e. making up for price-level misses on one side of the notional price path, when the policy rate hits the effective lower bound;<sup>33</sup>
- d. Nominal GDP targeting, i.e. a fixed combination of price-level and real GDP-gap targeting;<sup>34</sup>
- e. What should the loss function look like? Is the workhorse function the right one?

Other authors have reviewed the merits of these alternative frameworks, some in more detail than others. Blanchard, Dell’Ariccia, and Mauro (2010), Coibion, Gorodnichenko, and Wieland (2012), Ball (2014), Krugman (2014), Williams (2016) and Summers (2016) have discussed the potential benefits (and costs) of raising the inflation goal to 3 or 4 percent. Dorich et al. (for Canada, 2018) and Kiley and Roberts (for the United States, 2017) provide estimates of the potential gains to a higher inflation goal. These authors find that in some circumstances, raising the inflation goal can provide substantial gains to macroeconomic stabilization.

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<sup>33</sup> See Bernanke (2017).

<sup>34</sup> Nominal GDP targeting may be seen as a special case of a dual mandate policy that pursues price-level and output gap targeting, as it imposes weights of one on these two components of the GDP gap.

The second option is discussed in a speech by Rosengren (2018), and is motivated by the observation that current estimates of equilibrium real short rates are quite low, implying (with a 2 percent inflation goal) a low equilibrium federal funds rate. Thus the rationale is the same as for most of the authors cited above. To date, no one has provided a numerical estimate of the benefits of an inflation goal that moves up and down with estimates of the equilibrium real rate.

The literatures on price-level targeting and nominal GDP targeting are voluminous. Svensson (1999) and Coibion, Gorodnichenko, and Wieland (2012) discuss aspects of price-level targeting. Nominal GDP targeting, which implicitly imposes fixed weights of unity on both the real GDP gap and the price-level gap, has the advantage of ignoring the split between real and nominal activity, and thus in a sense automatically adjusts the policy rate when productivity growth (or other determinants of potential GDP growth) slows or speeds up. Hall and Mankiw (1994), Cecchetti (1996), and Woodford (2012) discuss the relative merits of nominal GDP targeting.

While it is beyond the scope of this paper, in order to intelligently consider any of the above alternatives, we need to consider how we should evaluate the performance of historical and prospective monetary policy frameworks. Relatedly, the Fed (and any evaluation partners) would need to agree on how to assess the counterfactual of whether and/or how much an alternative framework might improve on the current one.

#### *IV.D Limits to the Alternative Monetary Policy Strategies*

Most of the solutions mentioned above involve either temporary or permanent increases in the inflation goal. However, one must be realistic about how much comfort one should take in a (say) 1 percentage point indefinite increase in the inflation goal, or a 2 percentage point temporary increase in the goal. Starting from a steady-state with a commensurately higher nominal interest rate would afford more latitude to lower interest rates, and would no doubt decrease the severity of a recession. But one must be realistic about the amount of relief such a framework would offer. Some of the

studies cited above provide evidence bearing on the benefits of additional policy “cushion,” defined in this sense (Kiley and Roberts 2017, Dorich et al. 2018). But to simplify, using estimates from FRB/US, vector autoregressions, and the Federal Reserve Bank of Boston’s econometric models, every additional 1 percentage point of a federal funds rate decrease would yield about 1 percentage point more of real output, and one-half of a percentage point lower unemployment rate. Thus a regime with a 4 percent inflation goal would offset roughly an additional 1 percentage point of unemployment than would a 2 percent inflation regime. While helpful, one should not expect such a framework to provide a complete solution to the monetary policy constraints faced during the Great Recession, for example.<sup>35</sup>

In addition, the apparently shallow slope of the Phillips curve makes the implementation of these policies more complicated. First, moving the economy to a significantly higher inflation rate today would entail a rather protracted period of sub-natural rate unemployment. Second and related, on an ongoing basis, recessions that lowered inflation would similarly require protracted periods of low interest rates that, working through the Phillips curve, would move inflation back up to target. These periods of “low for long” would become a regular feature of macroeconomic policy under all of these policies, which likely entails some risk of inducing either financial or macroeconomic instability.

The implication of these observations is that we should probably not rely on monetary policy alone, even with the best-designed framework, to take sole responsibility for economic stabilization. There are practical limits to the amount of stimulus that monetary policy could provide in the face of significant economic downturns. That observation implies that one should also consider whether

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<sup>35</sup> The same logic applies to the use of balance sheet policies (“QE” or “LSAP” in Fed parlance) to stimulate the economy. The effects of these policies on interest rates to date have been of the same order of magnitude, and thus cannot be expected to offer more stimulus than policies that increase the amount by which short rates can be reduced.

there is an important role for fiscal policy in managing short-run fluctuations. That is of course a topic for another paper.

## V. Conclusions

We review some facts about monetary policy frameworks. First, they have changed quite a bit over time, with a frequency that is measured in years, but not decades. Second, they have changed for a variety of reasons. In some cases, such as the change in the Fed chair in 1979, it was clear that economic performance had deteriorated, and a change was required.<sup>36</sup> In others, the economics profession's understanding of monetary policy frameworks had evolved, and the Fed (often gradually) adapted to that change, as was the case with the adoption of an explicit numerical inflation objective. In still others, key aspects of economic structure necessitated a change in framework, as in the failure of monetary aggregates to provide reliable indications of nominal GDP growth or inflation. Third, it seems best to characterize *most* changes in framework as evolutions, rather than overnight revolutions. Recognition of framework deficiencies, recognition of key changes in economic structure, improvements in the profession's understanding of monetary economics—all of these take time, and adoption normally lags recognition. Fourth, the distinction between a change in framework and a discretionary departure from a perfectly sound framework is subtle, but perhaps important. It matters because in some episodes, it may not have been the monetary policy framework, but the lack of adherence to that framework that caused problems, and necessitated a change in monetary policy implementation. Whether that change constituted the adoption of a new framework, or better adherence to an old framework, remains an open question.

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<sup>36</sup> One can of course debate whether the 1979 changes constitute a change in framework, or the correction of a misperception regarding the inflation/unemployment trade-off, or a recognition that discretionary deviations from the extant framework had been detrimental, and required a forceful return to the same framework. For the purposes of this essay, we will take this to be a change in monetary policy framework.

Given this characterization of monetary policy frameworks, we believe the process that ensures adherence to a framework as well as the process for making needed changes to the framework can be improved. In particular, it is important that the Fed should consider a regular assessment of its monetary policy framework at a fixed interval and that this assessment provide a transparent evaluation of the current framework and how that framework could be improved or possibly changed. We hope that such a review process—in part, with the aid of outside contributors—would help the Fed to more consistently adhere to its framework when it can continue to work well, and also to make timely changes when it has not. While changes have regularly been made to the framework, an improved process would institutionalize the process of change, making the Fed less reliant on extraordinary leadership. As a transparent process, it would also help to hold the Fed accountable for adhering to the framework it announces, and to provide public and transparent justifications for changes to its framework. One can overstate the likely impact of such a process, but our judgment is that, over the long span of time, it could well help to improve the economic outcomes delivered by the U.S. central bank.

## References

- Ball, Laurence M. 2014. “The Case for a Long-Run Inflation Target of Four Percent.” International Monetary Fund Working Paper 14–92. Washington, DC: International Monetary Fund. <https://www.imf.org/external/pubs/ft/wp/2014/wp1492.pdf>.
- Bank of Canada. 2016. “Renewal of the Inflation-Control Target, Background Information.” October, Bank of Canada, [https://www.bankofcanada.ca/wpcontent/uploads/2016/10/background\\_nov11.pdf](https://www.bankofcanada.ca/wpcontent/uploads/2016/10/background_nov11.pdf).
- Bernanke, Ben S. 2006. “Monetary Aggregates and Monetary Policy at the Federal Reserve: A Historical Perspective.” Remarks at the Fourth ECB Central Banking Conference, Frankfurt, Germany, on November 10, 2006.
- Bernanke, Ben S. 2016. “Federal Reserve Economic Projections: What Are they Good For?” November 28, 2016. <https://www.brookings.edu/blog/ben-bernanke/2016/11/28/federal-reserve-economic-projections/>.
- Bernanke, Ben S. 2017. “Monetary Policy in a New Era.” Paper prepared for a conference titled “Rethinking Macroeconomic Policy,” held at the Peterson Institute, Washington, DC, on October 12–13.
- Binder, Sarah, and Mark Spindel. 2016. “Independence and Accountability: Congress and the Fed in a Polarized Era.” Washington, DC: Center for Effective Public Management, Brookings Institution. <https://www.brookings.edu/wp-content/uploads/2016/07/Monetary-politics.pdf>.
- Blanchard, Olivier J., Giovanni Dell’Ariccia, and Paolo Mauro. 2010. “Rethinking Macroeconomic Policy.” *Journal of Money, Credit and Banking* 42 (Supplement 1, September): 199–215.
- Blinder, Alan S. 1998. *Central Banking in Theory and Practice*. Cambridge, MA: MIT Press.
- Blinder, Alan S. and John Morgan. 2005. “Are Two Heads Better than One? Monetary Policy by Committee.” *Journal of Money, Credit and Banking* 37(5): 789–811.
- Boivin, Jean. 2006. “Has U.S. Monetary Policy Changed? Evidence from Drifting Coefficients and Real-Time Data.” *Journal of Money, Credit and Banking* 38(5): 1149–1174.
- Cecchetti, Stephen G. 1996. “Inflation Indicators and Inflation Policy.” In *NBER Macroeconomics Annual 1995*, Volume 10, edited by Ben S. Bernanke and Julio J. Rotemberg, 189–236. Cambridge, MA: MIT Press.
- Christensen, Jens H., and Glenn D. Rudebusch. 2012. “The Response of Interest Rates to US and UK Quantitative Easing.” *The Economic Journal* 122(564): F385–F414.
- Clarida, Richard, Jordi Galí, and Mark Gertler. 2000. “Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory.” *Quarterly Journal of Economics* 115(1): 147–180.



Coibion, Olivier, Yuriy Gorodnichenko, and Johannes Wieland. 2012. “The Optimal Inflation Rate in New Keynesian Models: Should Central Banks Raise Their Inflation Targets in Light of the Zero Lower Bound?” *Review of Economic Studies* 79 (4): 1371–1406.

Conti-Brown, Peter. 2016. *The Power and Independence of the Federal Reserve*. Princeton, NJ: Princeton University Press.

D’Amico, Stefania, and Thomas B. King. 2013. “Flow and Stock Effects of Large-Scale Treasury Purchases: Evidence on the Importance of Local Supply.” *Journal of Financial Economics* 108(2): 424–448.

Dorich, José, Nicholas Labelle St-Pierre, Vadym Lepetyuk, and Rhys R. Mendes. 2018. “Could a Higher Inflation Target Enhance Macroeconomic Stability?” BIS Working Papers 720. Basel: Bank of International Settlements. <https://www.bis.org/publ/work720.pdf>.

Erceg, Christopher, James Hebden, Michael Kiley, David López-Salido, and Robert Tetlow. 2018. “Some Implications of Uncertainty and Misperception for Monetary Policy.” Finance and Economics Discussion Series 2018-059. Washington, DC: Board of Governors of the Federal Reserve System.

Gagnon, Joseph, Raskin, Matthew, Remache, Julie, and Brian Sack. 2011. “The Financial Market Effects of the Federal Reserve’s Large-Scale Asset Purchases.” *International Journal of Central Banking* 7(1): 3–43.

Gerlach-Kristen, Petra. 2004. “Is the MPC’s Voting Record Informative about Future UK Monetary Policy?” *Scandinavian Journal of Economics* 106(2): 299–313.

Goodfriend, Marvin, and Robert G. King. 2005. “The Incredible Volcker Disinflation.” *Journal of Monetary Economics* 52(5): 981–1015.

Greenspan, Alan. 2004. “Risk and Uncertainty in Monetary Policy.” Remarks at the Meetings of the American Economic Association, San Diego, California January 3, 2004. <https://www.federalreserve.gov/boarddocs/speeches/2004/20040103/default.htm>.

Greenspan, Alan. 2005. “Reflections on Central Banking.” Remarks at a symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming, August 26, 2005. <https://www.federalreserve.gov/boarddocs/speeches/2005/20050826/default.htm>.

Gürkaynak, Refet S., Brian Sack, and Eric Swanson. 2005. “The Sensitivity of Long-Term Interest Rates to Economic News: Evidence and Implications for Macroeconomic Models.” *American Economic Review* 95(1): 425–436.

Gürkaynak, Refet S., Brian Sack, and Jonathan H. Wright. 2007. “The U.S. Treasury yield curve: 1961 to the Present.” *Journal of Monetary Economics* 54(8): 2291–2304.

Hall, Robert E., and N. Gregory Mankiw. 1994. “Nominal Income Targeting.” In *Monetary Policy*, edited by N. Gregory Mankiw, 71–94. Chicago: University of Chicago Press.

Hamilton, James D., and Jing Cynthia Wu. 2012. “The Effectiveness of Alternative Monetary Policy Tools in a Zero Lower Bound Environment.” *Journal of Money, Credit and Banking* 44(Supplement 1, February): 3–46.

Iakova, Dora M. 2007. “Flattening of the Phillips Curve: Implications for Monetary Policy,” International Monetary Fund Working Paper 07-76. Washington, DC: International Monetary Fund. <https://www.imf.org/en/Publications/WP/Issues/2016/12/31/Flattening-of-the-Phillips-Curve-Implications-for-Monetary-Policy-20530>.

Ireland, Peter N. 2007. “Changes in the Federal Reserve's Inflation Target: Causes and Consequences.” *Journal of Money, Credit and Banking* 39(8): 1851–1882.

Kiley, Michael T., and John M. Roberts. 2017. “Monetary Policy in a Low Interest Rate World.” *Brookings Papers on Economic Activity* (Spring): 317–372.

King, Robert G., Yang K. Lu, and Ernesto S. Pastén. 2008. “Managing Expectations.” *Journal of Money, Credit and Banking* 40(8): 1625-1666.

Kozicki, Sharon, and Peter A. Tinsley. 2001. “Shifting Endpoints in the Term Structure of Interest Rates.” *Journal of Monetary Economics* 47(3): 613–652.

Krugman, Paul. 2014. “Inflation Targets Reconsidered.” Working paper prepared for the European Central Bank Forum on Central Banking, held at Sintra, Portugal, on May 26. <https://online.ercep.com/media/attachments/inflation-targets-reconsidered-en-70089.pdf>.

Meltzer, Allan H. 2002. *A History of the Federal Reserve*. Volume 1: 1913–1951. Chicago: University of Chicago Press.

Meltzer, Allan H. 2010. *A History of the Federal Reserve*. Volume 2, Book 1: 1951–1969. Chicago: University of Chicago Press.

Meltzer, Allan H. 2014. *A History of the Federal Reserve*. Volume 2, Book 2: 1970–1986. Chicago: University of Chicago Press.

Murray, John David. 2018. “Why the Bank of Canada Sticks with 2 percent Inflation Target.” In *Rethinking the Fed's 2 percent Inflation Target*, June 7. Washington, DC: Hutchins Center on Fiscal & Monetary Policy, Brookings Institution. [https://www.brookings.edu/wp-content/uploads/2018/06/ES\\_20180607\\_Hutchins-FedInflationTarget.pdf](https://www.brookings.edu/wp-content/uploads/2018/06/ES_20180607_Hutchins-FedInflationTarget.pdf).

Orphanides, Athanasios, and David W. Wilcox. 2002. “The Opportunistic Approach to Disinflation.” *International Finance* 5: 47–71.

Orphanides, Athanasios. 2003. “Historical Monetary Policy Analysis and the Taylor Rule.” *Journal of Monetary Economics* 50(5): 983–1022.

Peek, Joe, Eric S. Rosengren, and Geoffrey M.B. Tootell. 2015. “Should U.S. Monetary Policy Have a Ternary Mandate?” Paper prepared for the Federal Reserve Bank of Boston’s Annual Economic

Conference, October 2015. <https://www.bostonfed.org/macprudential2015/papers/Rosengren-Peek-Tootell.pdf>.

Reis, Ricardo. 2013. "Central Bank Design." *Journal of Economic Perspectives* 27(4): 17–44.

Riboni, Alessandro, and Francisco J. Ruge-Murcia. 2010. "Monetary Policy by Committee: Consensus, Chairman Dominance, or Simple Majority?" *Quarterly Journal of Economics* 125 (1): 363–416.

Romer, Christina D., and David H. Romer. 2002. "The Evolution of Economic Understanding and Postwar Stabilization Policy." Proceedings of the Economic Policy Symposium at Jackson Hole, Federal Reserve Bank of Kansas City: 11–78.

Romer, Christina D., and David H. Romer. 2013. "The Most Dangerous Idea in Federal Reserve History: Monetary Policy Doesn't Matter." *American Economic Review* 103(3): 55–60.

Rosengren, Eric S. 2018. "Considering Alternative Monetary Policy Frameworks: an Inflation Range With an Adjustable Inflation Target." Speech given at the "Money, Models, & Digital Innovation Conference," sponsored by the Global Interdependence Center, San Diego, California, on January 12.

Rotemberg, Julio J., and Michael Woodford. 1997. "An Optimization-Based Econometric Framework for the Evaluation of Monetary Policy." In *NBER Macroeconomic Annual 1997*, Volume 12, edited by Ben S. Bernanke and Julio J. Rotemberg, 297–361. Cambridge, MA: MIT Press.

Sargent, Thomas J. 2001. *The Conquest of American Inflation*. Princeton, NJ: Princeton University Press.

Sibert, Anne. 2006. "Central Banking by Committee." *International Finance* 9(2): 145–168.

Staiger, Douglas, James H. Stock, and Mark W. Watson, 1997. "How Precise are Estimates of the Natural Rate of Unemployment?" In *Reducing Inflation: Motivation and Strategy*, edited by Christina D. Romer and David H. Romer, 195–246. Chicago: University of Chicago Press.

Stock James H., and Mark W. Watson, 1998. "Median Unbiased Estimation of Coefficient Variance in a Time Varying Parameter Model." *Journal of the American Statistical Association* 93(441): 349–358.

Summers, Lawrence H. 2016. "A Thought Provoking Essay from Fed President Williams." <http://larrysummers.com/2016/08/18/6937>.

Svensson, Lars E.O. 1999. "Price-Level Targeting versus Inflation Targeting: A Free Lunch?" *Journal of Money, Credit and Banking* 31(3, Part 1): 277–295.

Swanson, Eric T. 2017. "Measuring the Effects of Federal Reserve Forward Guidance and Asset Purchases." Working Paper No. 23311. Cambridge, MA: National Bureau of Economic Research.

Williams, John C. 2016. "Monetary Policy in a Low R-star World," FRBSF Economic Letter 2016–23, August 15. <https://www.frbsf.org/economic-research/files/el2016-23.pdf>.

Woodford, Michael. 2002. "Inflation Stabilization and Welfare." *Contributions to Macroeconomics* 2(1): Article 1.

Woodford, Michael. 2012. "Methods of Policy Accommodation at the Interest-Rate Lower Bound." Proceedings of the Economic Policy Symposium at Jackson Hole, Federal Reserve Bank of Kansas City: 185–288.

## Appendix

In this appendix we provide information about data and estimation methods for equations (1), (3), and (4) reported in the text. We start with the inflation forecast equations, which we rewrite here for ease of exposition:

$$(1) \quad E_t \pi_{t+i} = \beta_{0,t} + \beta_{1,t} E_t \pi_{t+i-1}^4 + \beta_{2,t} E_t u_{t+i-1} + v_{i,t}, \quad i = 1, 2, 3.$$

In this system of equations,  $\pi_{t+i}$  denotes the annualized rate of inflation in quarter  $t+i$ ,  $\pi_{t+i-1}^4$  is the average of inflation prevailing over the four quarters from  $t+i-1$  to  $t+i-4$ , and  $u_{t+i-1}$  is the level of the unemployment rate at  $t+i-1$ . The operator  $E_t$  denotes a forecast made in quarter  $t$ . We consider forecasts of inflation one, two and three quarters out, as indexed by  $i$ . We exclude the “nowcast”  $E_t \pi_t$ , because such a forecast is likely to be influenced by short-term factors that would not be adequately captured by (1). At each of the three forecast horizons, the relationship is augmented by an error term  $v_{i,t}$ . These errors are assumed to be persistent. In particular, we posit that  $v_{1,t}$  evolves as an *MA(4)* process. In each quarter  $t$ , we then have that  $v_{2,t} = E_t v_{1,t} + \varepsilon_{2,t}$ , and  $v_{3,t} = E_t v_{1,t} + \varepsilon_{3,t}$ , where the innovations  $\varepsilon_{2,t}$  and  $\varepsilon_{3,t}$  are such that  $Cov(\varepsilon_{2,t}, \varepsilon_{2,t-j}) = Cov(\varepsilon_{3,t}, \varepsilon_{3,t-j}) = 0$  for any  $j \geq 1$ , but we allow  $Cov(\varepsilon_{2,t}, \varepsilon_{3,t})$  to be different from zero.

The  $\beta$  coefficients in (1) are assumed to evolve as random walks, with uncorrelated innovations across coefficients. The coefficients remain the same at the three forecast horizons the relationship (1) is estimated over, as only the timing of the variables is changing in accordance with  $i$ . This multiple-horizon aspect of the forecasts is especially useful for our purposes in that, under the plausible assumption that the same model is being used to forecast inflation at different horizons, it increases the degrees of freedom at the estimation stage, possibly allowing for a better identification of the coefficients of interest. The specification we use to model the inflation forecasts is admittedly simple, but it captures a fraction of the variation in the inflation forecasts which, absent time

variation in the estimated  $\beta$  coefficients, is already above 90 percent. The behavior of the inflation forecasts in (1) at the three different horizons is estimated jointly via maximum likelihood using the Kalman filter, over the period 1966:Q4 to 2017:Q4.

The Federal Reserve Board staff forecasts reported in the Greenbook/Tealbook (GB/TB) are produced at every scheduled FOMC meeting, and the meetings have occurred at varying frequency but always more than once per quarter. To avoid estimation issues associated with uneven frequencies, we only consider one GB/TB per quarter, usually the one that coincides with the quarter's middle month. When this is not possible, we consider the last GB/TB forecast made in any given quarter. Given that the staff's forecasts are made public with a five-year lag, for the period from 2013 to present we use for our analysis the FOMC's economic projections. Specifically, for each SEP forecast that we consider, we take the middle point of the published "central tendency" range. Unlike the staff's forecasts, where the outlook is described at a quarterly frequency, the FOMC forecasts are less granular and follow a yearly frequency. We therefore interpolate those yearly forecasts to convert them to quarterly frequency. Such a procedure obviously injects additional noise into the exercise, but our findings are not affected qualitatively by the use of the publicly available FOMC projections for the most recent period. The inflation forecast is for the GDP deflator until 1985:Q4, for core CPI from 1986:Q1 to 2005:Q4, and for the core PCE deflator from 2006:Q1 to 2017:Q4. Given the forecasts horizons that we consider, the variable  $E_t \pi_{t+i-1}^4$  will include a mix of forecast and realized inflation. Whenever actual inflation is involved, we consider real-time realizations.

As concerns the estimated policy rule, which takes the form:

$$(3) \quad \mathit{ff}_t = \gamma_{0,t} + \gamma_{\mathit{ff},t} \mathit{ff}_{t-1} + \gamma_{\pi,t} E_t \pi_{t+3} + \gamma_{u,t} E_t u_{t+3} + v_t ,$$

the only variable we have not defined already is the federal funds rate,  $\mathit{ff}$ , which is given by the average value prevailing in the week after the FOMC meeting. The frequency is quarterly, with the

same GB/TB selection criterion for the forecast variables  $E_t \pi_{t+4}$  and  $E_t u_{t+4}$  described earlier in the context of the inflation equation (1). The error term  $v_t$  is assumed to follow an  $MA(1)$  process. We allow for the variance in the error to exhibit breaks in 1979:Q4, 1986:Q1, and 1997:Q1. Accounting for the possible presence of heteroscedasticity in  $v_t$  is potentially important in order to correctly apportion time-variation to the estimated coefficients. We posit that the  $\gamma$  coefficients evolve as random walks, with uncorrelated innovations across coefficients. The policy rule is estimated via maximum likelihood using the Kalman filter, over the period 1966:Q4 to 2017:Q4. We do not consider the post-2008 period because of the binding floor on the federal funds rate, while the starting date is dictated by the availability of the GB/TB forecast at the chosen horizon. For the exercise reported in Figure 10, which uses forecasts of inflation and the unemployment rate from 2015:Q4 to present, we consider the SEP projections as described earlier. In the context of the univariate equation (3), maximum-likelihood estimates via the Kalman filter of the variance of the innovations in the random-walk processes underlying the time-varying coefficients  $\gamma$  will be biased towards zero. We use the median unbiased estimation procedure in Stock and Watson (1998) to first estimate the variance in these innovations. Given such estimates, we then apply the Kalman filter to estimate the remaining parameters in (3).

Finally, in the daily-frequency regression

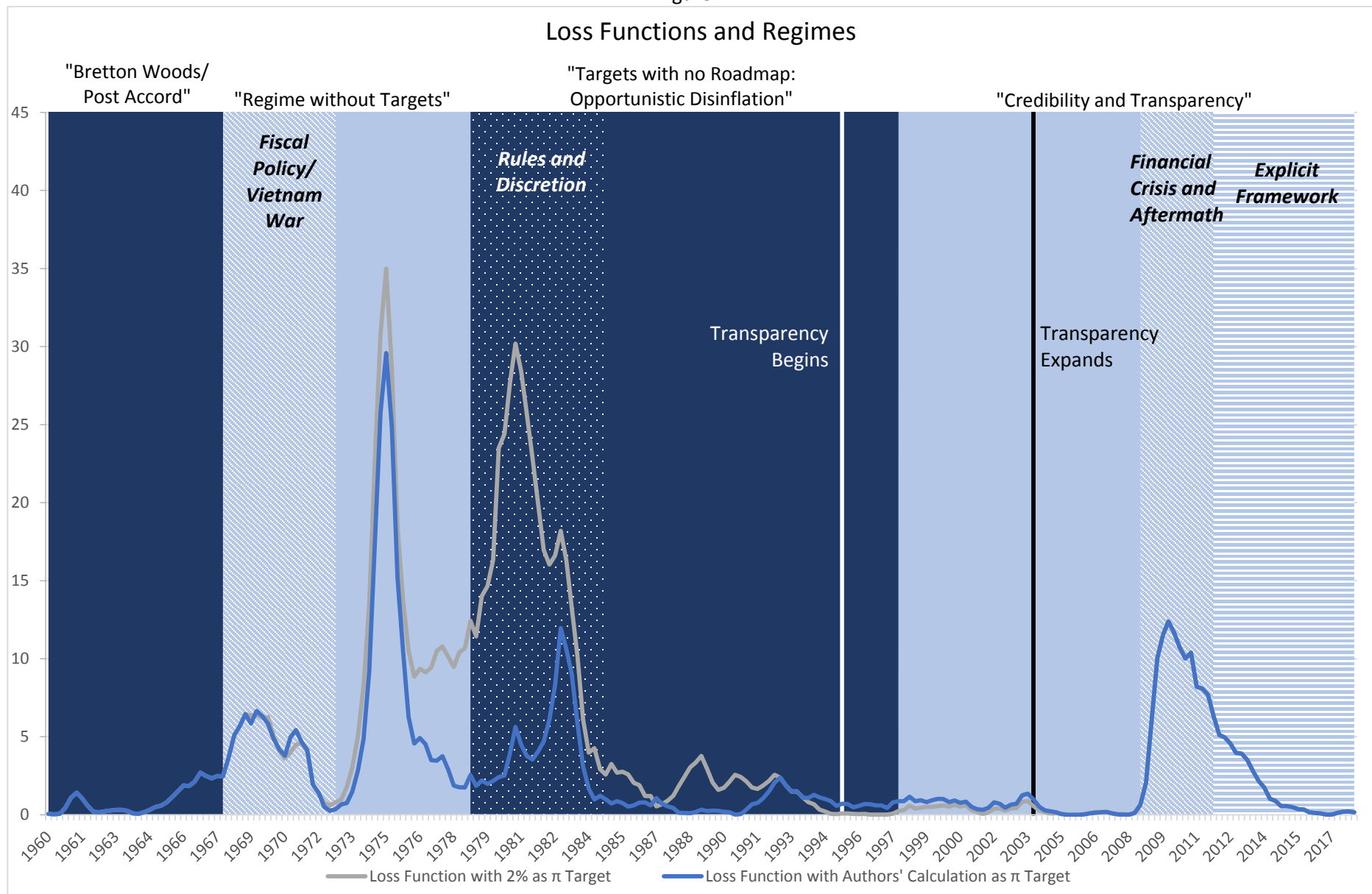
$$(4) \quad \Delta i_t^{F,j} = \alpha_0 + \alpha_1 \Delta i_t d_t(\text{release day} = 1) + \alpha_2 \Delta i_t (1 - d_t(\text{release day} = 1)) + \varepsilon_t,$$

we use data on U.S. Treasury forward rates  $i_t^{F,j}$  maintained by the Federal Reserve Board. These data are computed from U.S. Treasury yields, and the details of the computations can be found in Gürkaynak, Sack and Wright (2007). The dummy variable  $d_t$  takes the value of one in days when there was a CPI release or a PPI release, and a value of zero in the other days. The equation is estimated via OLS for each of the forward rates with maturity  $j$  going from 2 to 15 years. The

estimates reported in Figure 11 over the two subsamples that we consider, 1970 to 1996, and 1997 to 2007, feature heteroscedasticity-consistent confidence bands. Estimation results in the earlier sample are sensitive to outliers, and for this reason we have excluded from the estimation observations featuring a daily change in the 3-month Treasury Bill rate  $\Delta i_t$  in excess of 50 basis points in absolute terms. Once excluding outliers, it is of interest to note that considering separately the 1970s, 1980s, and early 1990s produces estimates that are qualitatively similar to the ones reported for the entire 1970 to 1996 period.



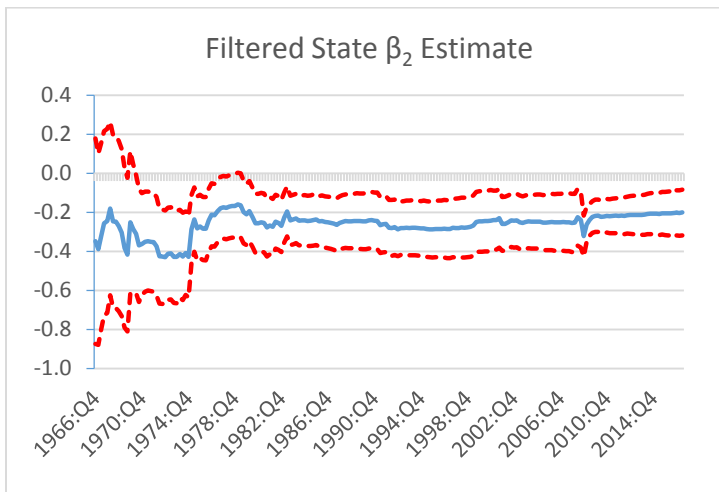
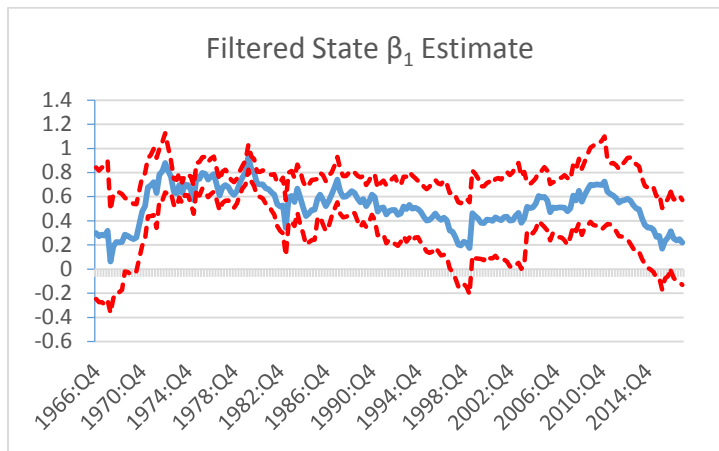
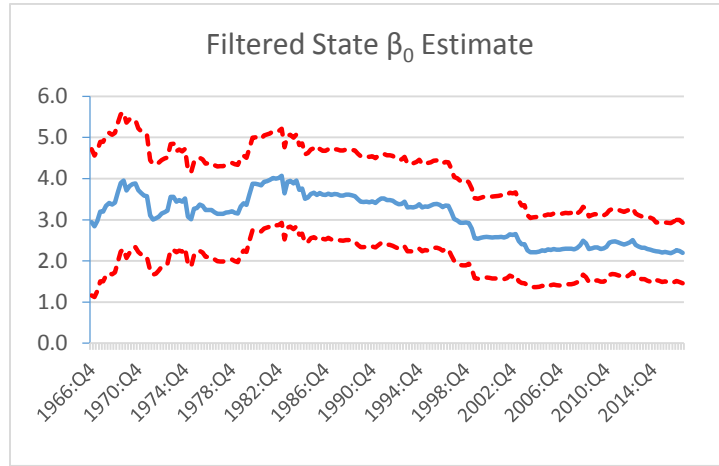
Figure 1



Sources: Authors' Calculations, Bureau of Economic Analysis, Bureau of Labor Statistics, Congressional Budget Office, and Federal Reserve Board.

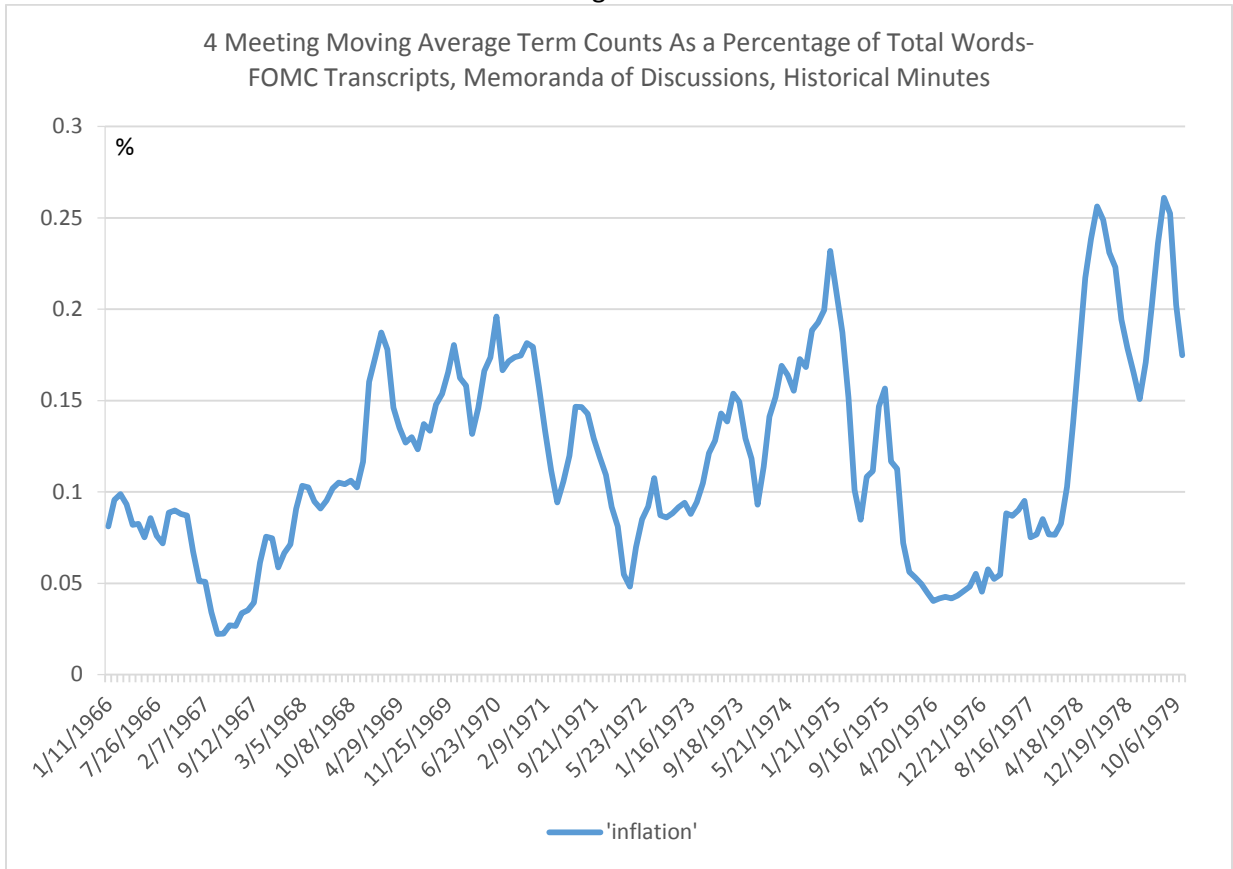
Figure 2

Estimated Coefficients for  $E_t \pi_{t+i} = \beta_{0,t} + \beta_{1,t} E_t \pi_{t+i-1} + \beta_{2,t} E_t u_{t+i-1} + v_{i,t}$



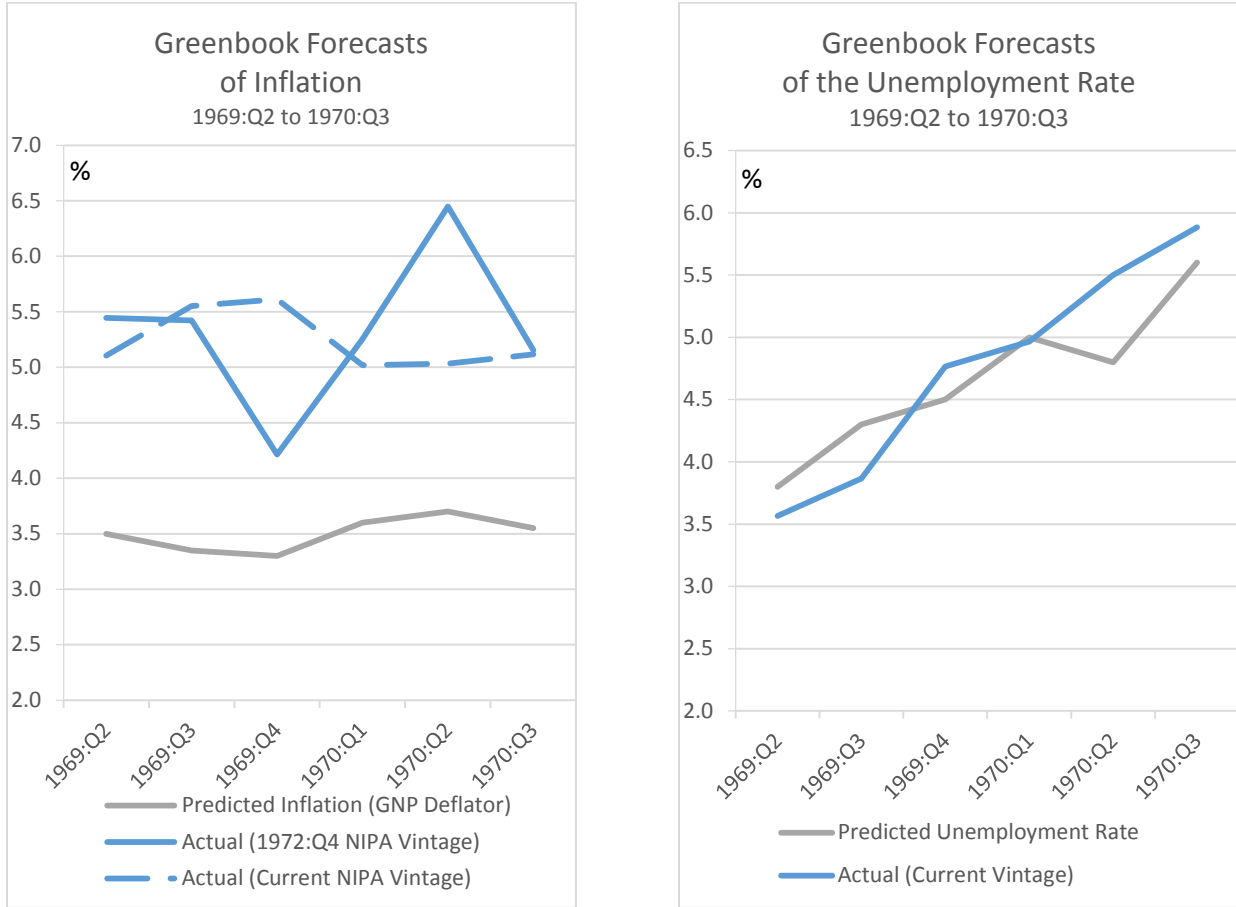
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Figure 3



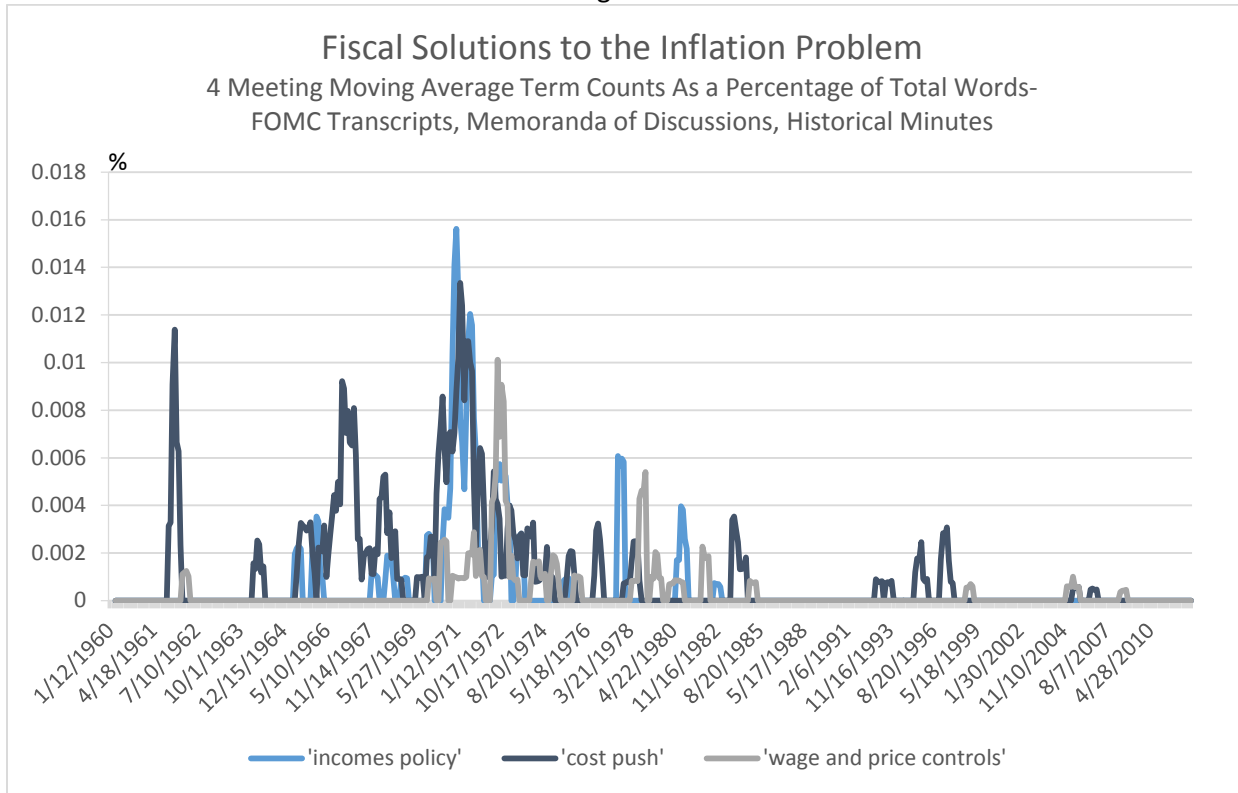
Source: Federal Reserve Board.

Figure 4



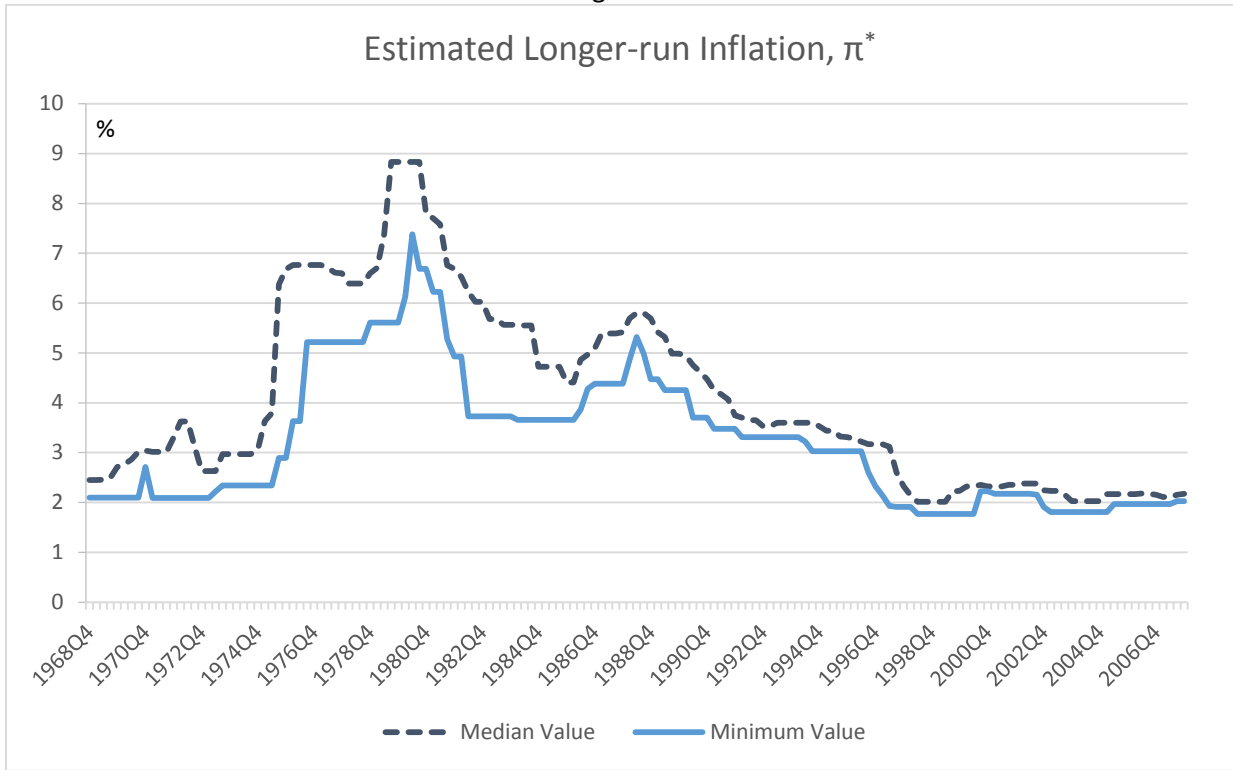
Sources: Bureau of Economic Analysis, Bureau of Labor Statistics, Federal Reserve Board, and Haver Analytics.

Figure 5



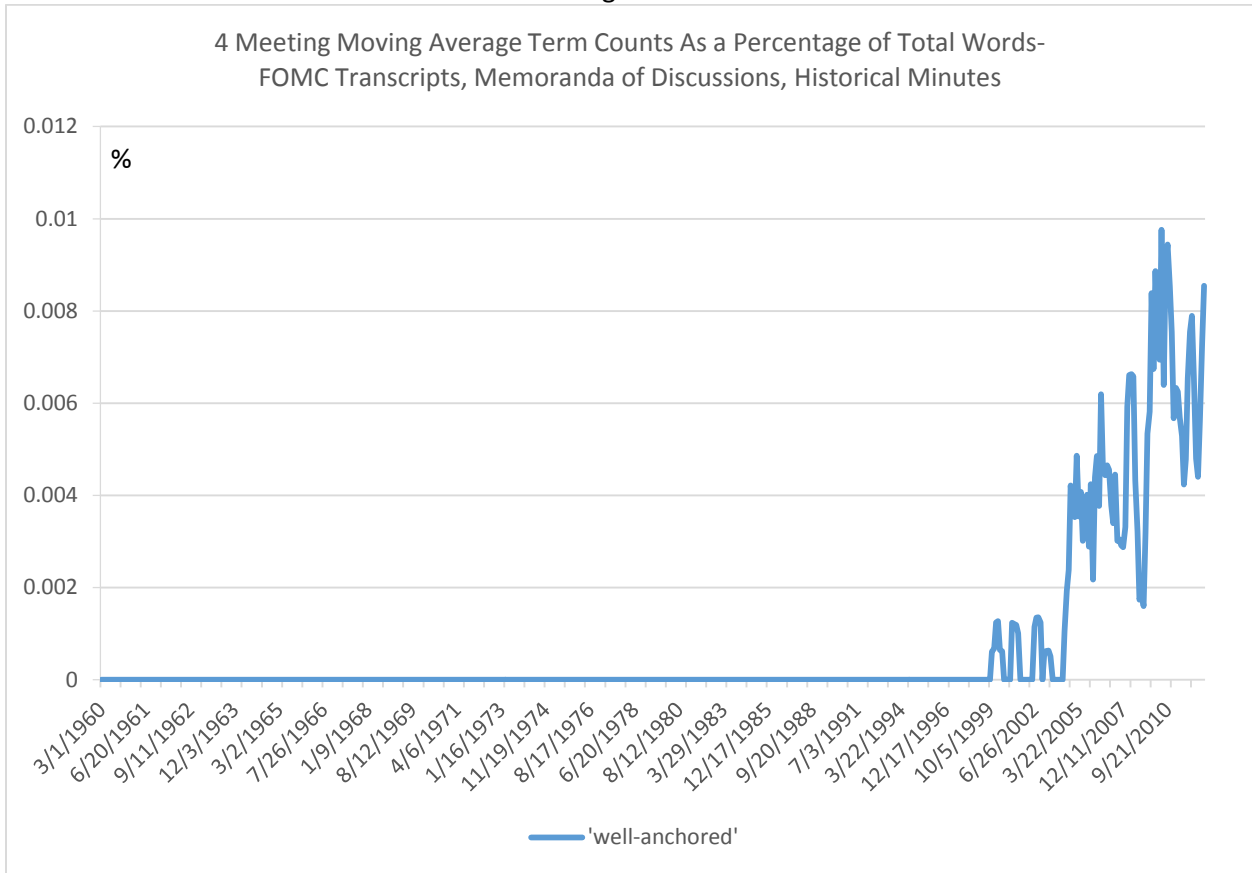
Source: Federal Reserve Board.

Figure 6



Sources: Authors' Calculations, Congressional Budget Office, and Federal Reserve Board.

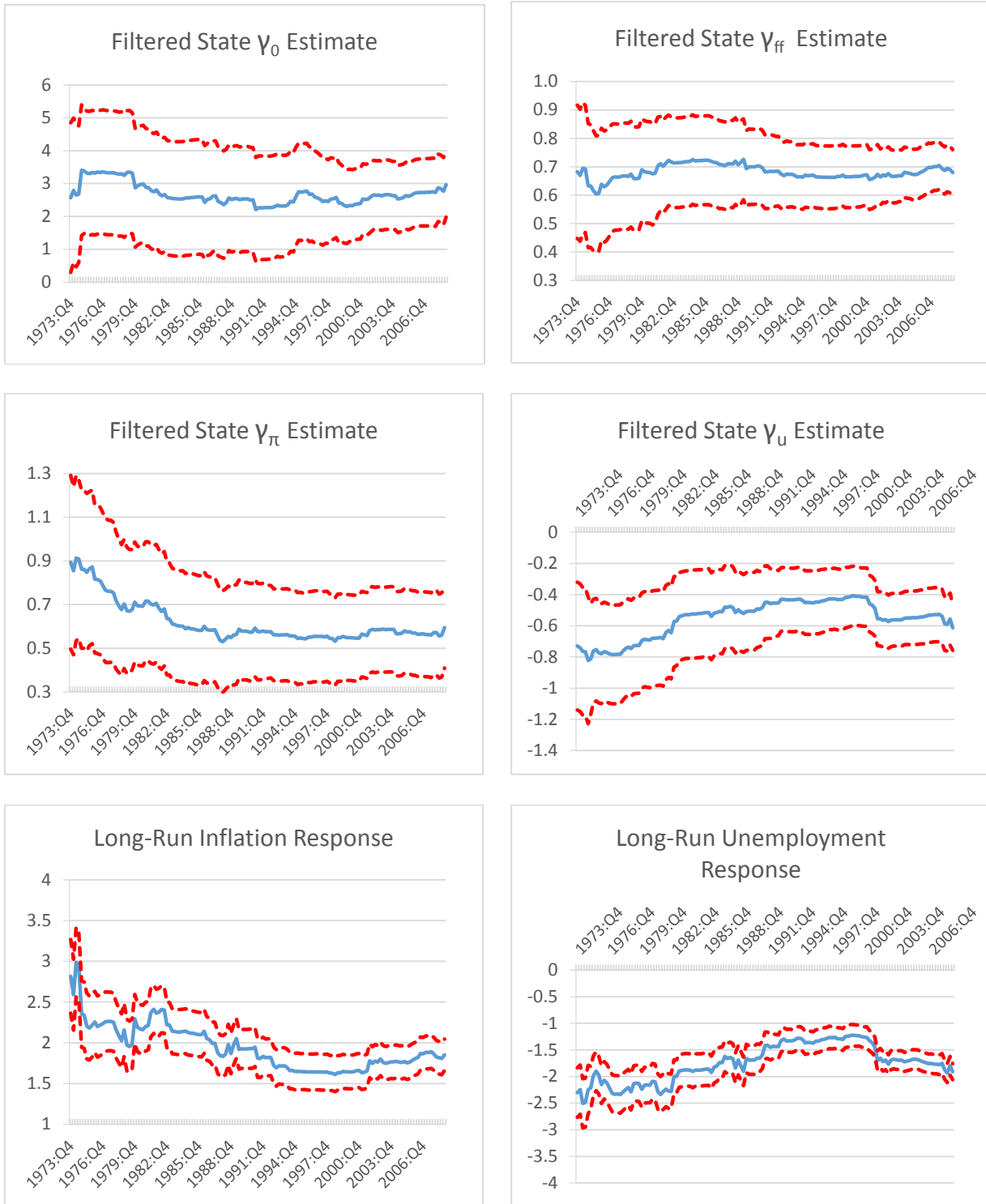
Figure 7



Source: Federal Reserve Board.

Figure 8

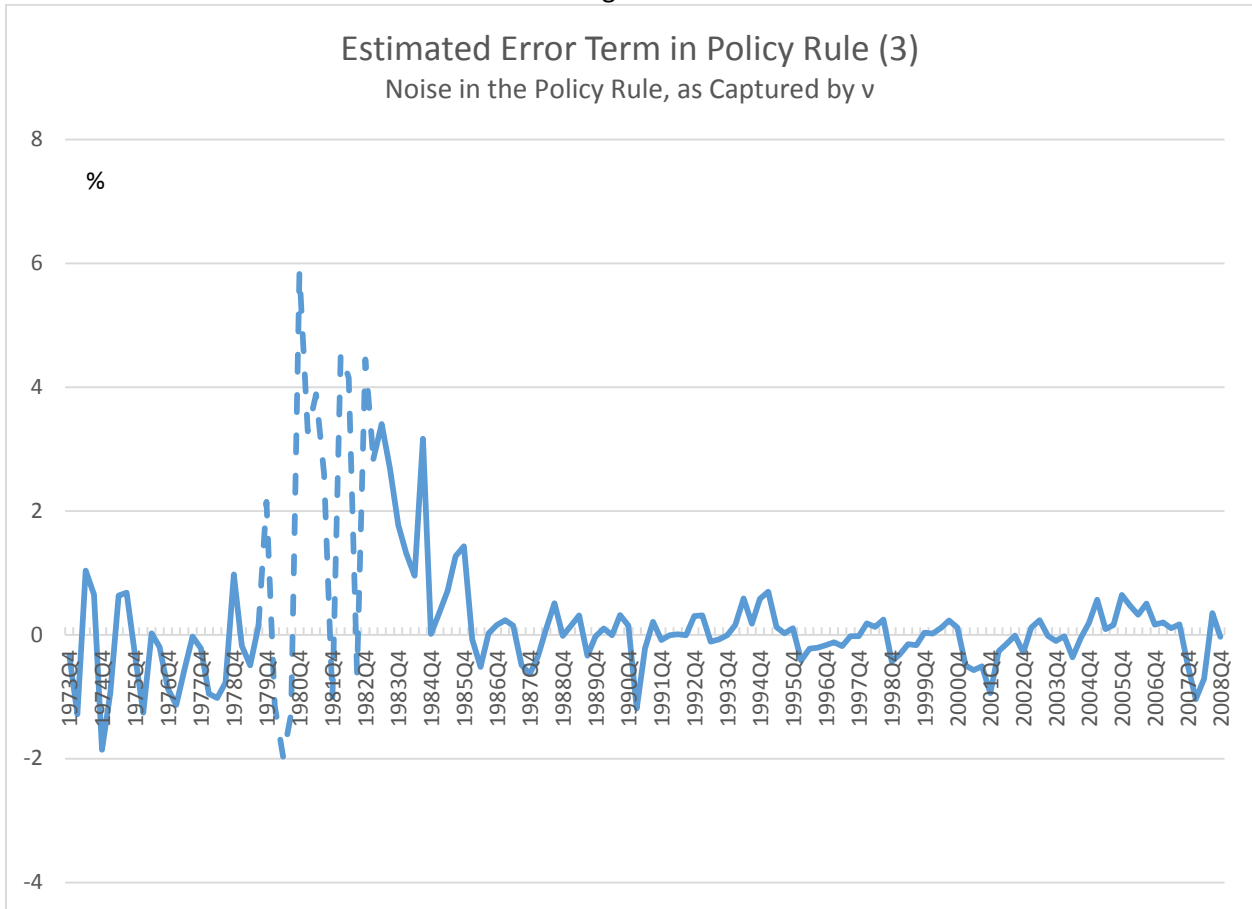
Estimated Coefficients for  $ff_t = \gamma_{0,t} + \gamma_{ff,t}ff_{t-1} + \gamma_{\pi,t}E_t\pi_{t+3} + \gamma_{u,t}E_tu_{t+3} + v_t$  (3)



Sources: Authors' Calculations and Federal Reserve Board.

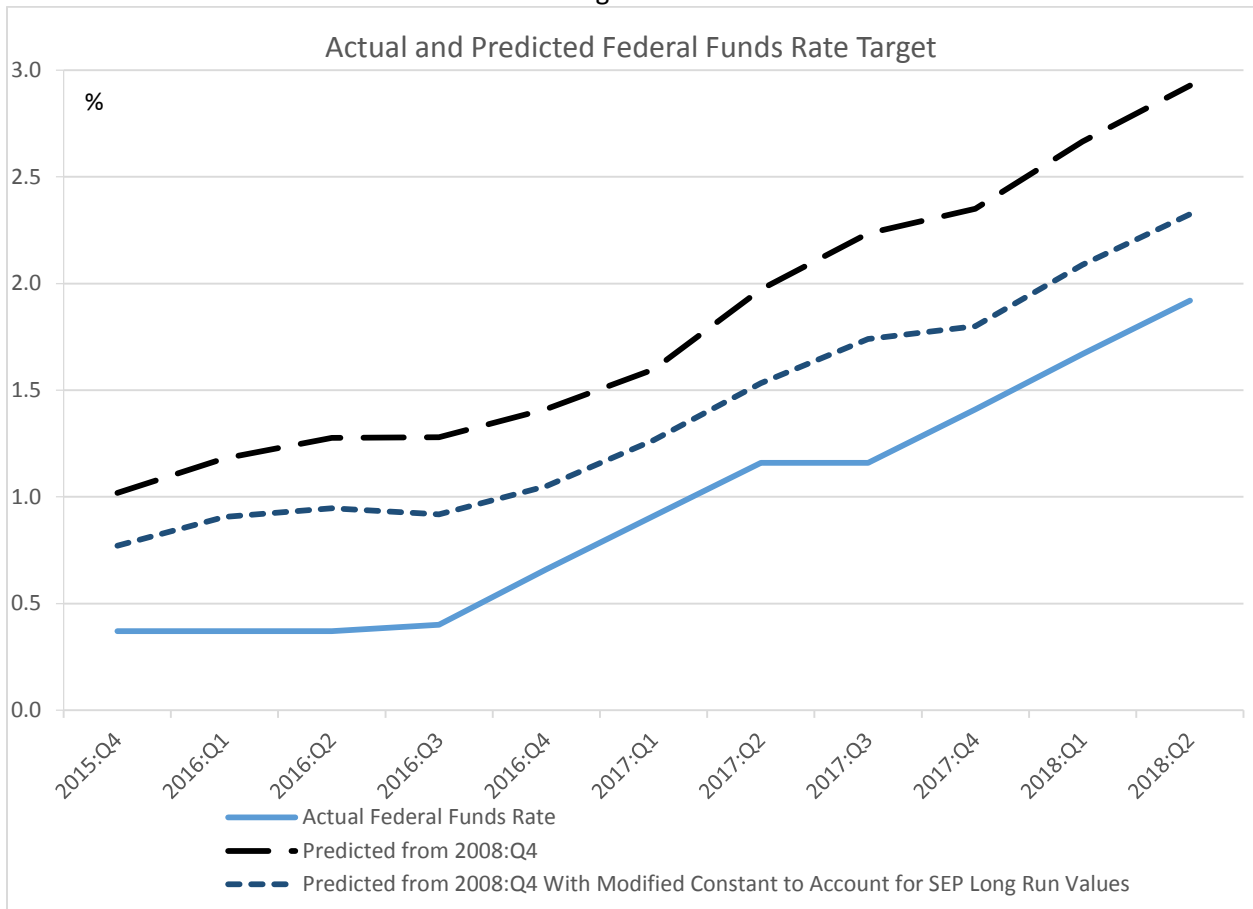


Figure 9



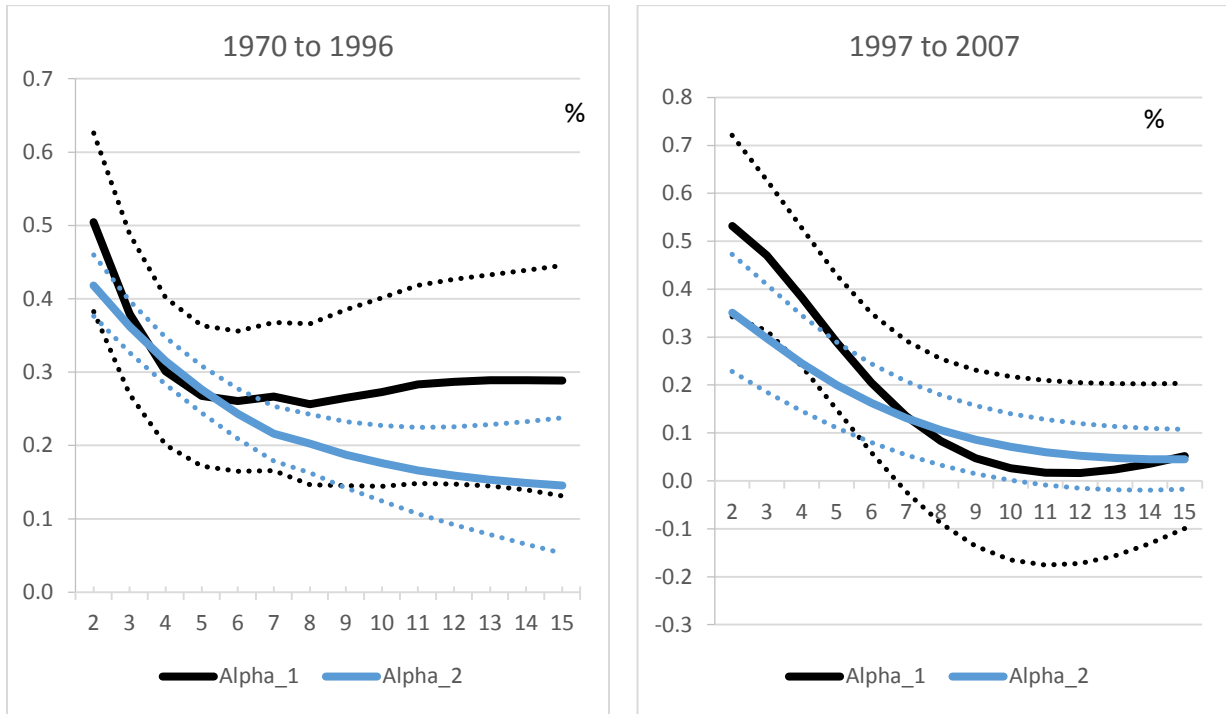
Sources: Authors' Calculations and Federal Reserve Board.

Figure 10



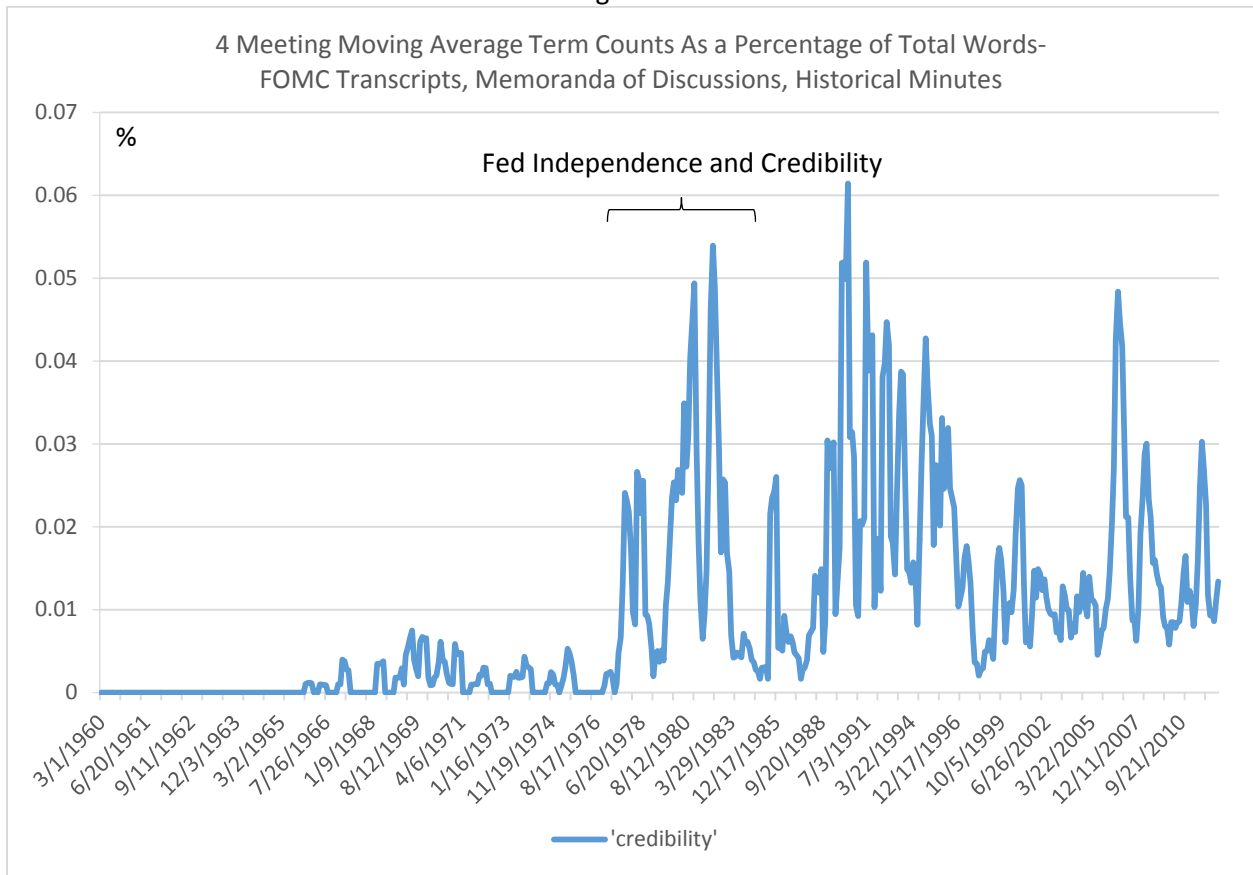
Source: Authors' Calculations and Federal Reserve Board.

Figure 11  
 Estimated Coefficients for  $\Delta i_t^{F,j} = \alpha_0 + \alpha_1 \Delta i_t d_t + \alpha_2 \Delta i_t (1-d_t) + \varepsilon_t$  (4)



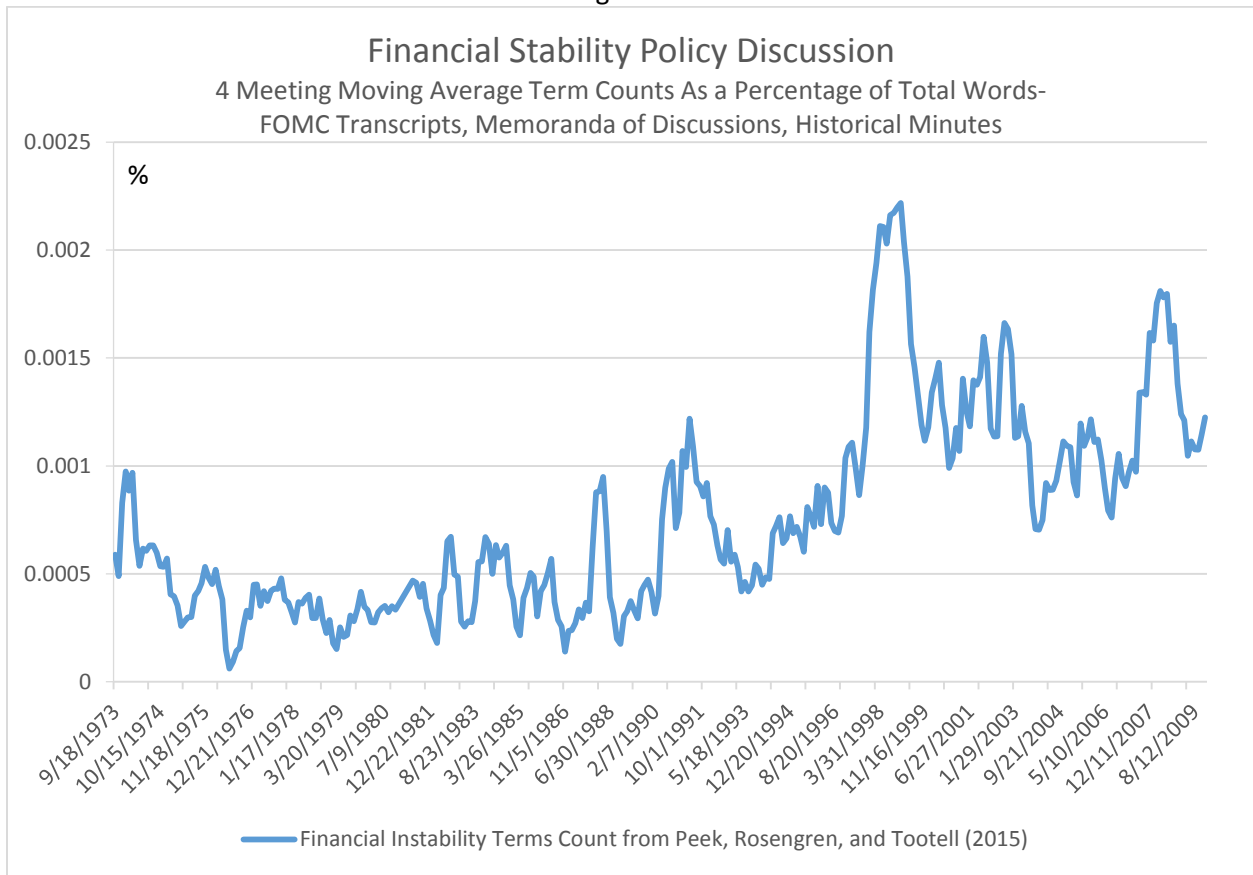
Sources: Authors' Calculations and Federal Reserve Board.

Figure 12



Source: Federal Reserve Board.

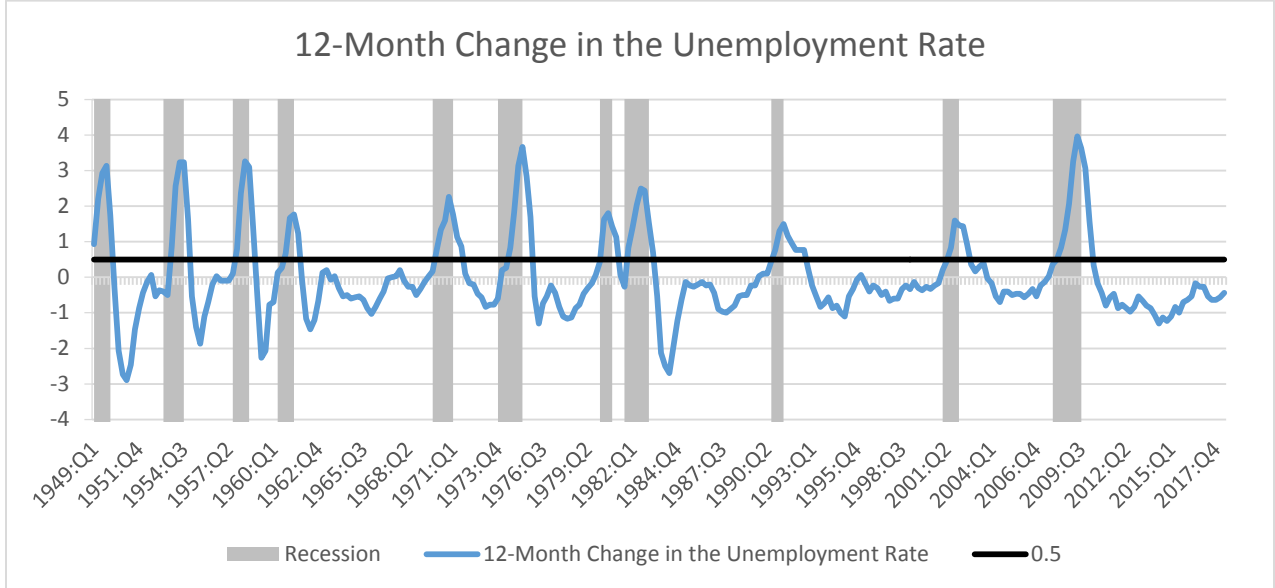
Figure 13



Source: Federal Reserve Board, Peek, Rosengren, and Tootell (2015).

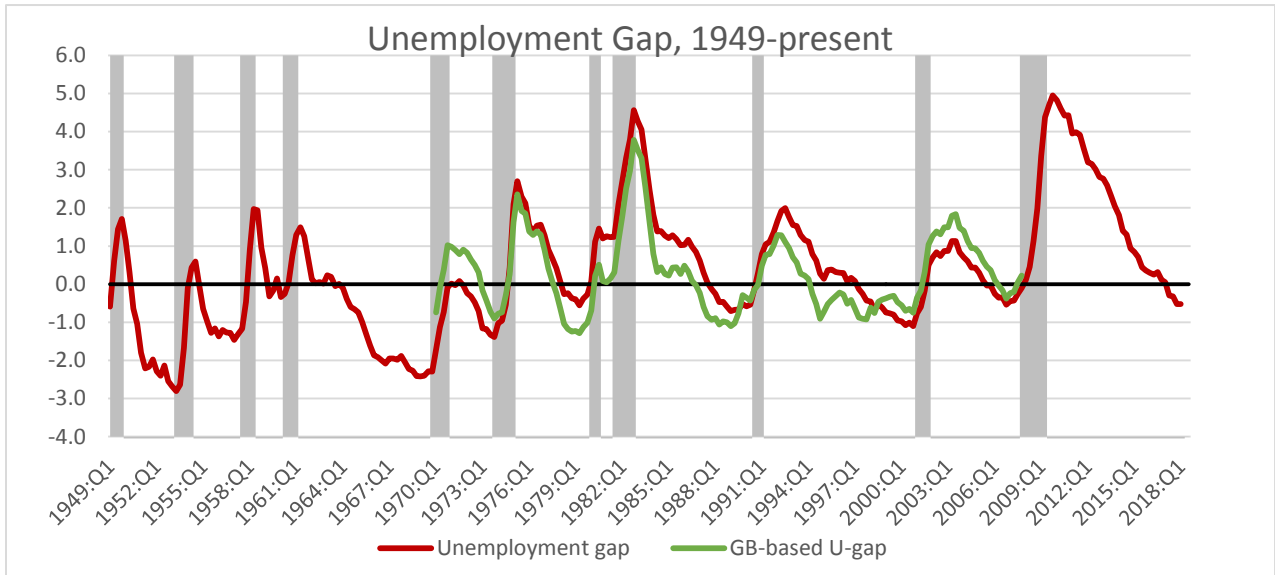
Figure 14

Panel 1:



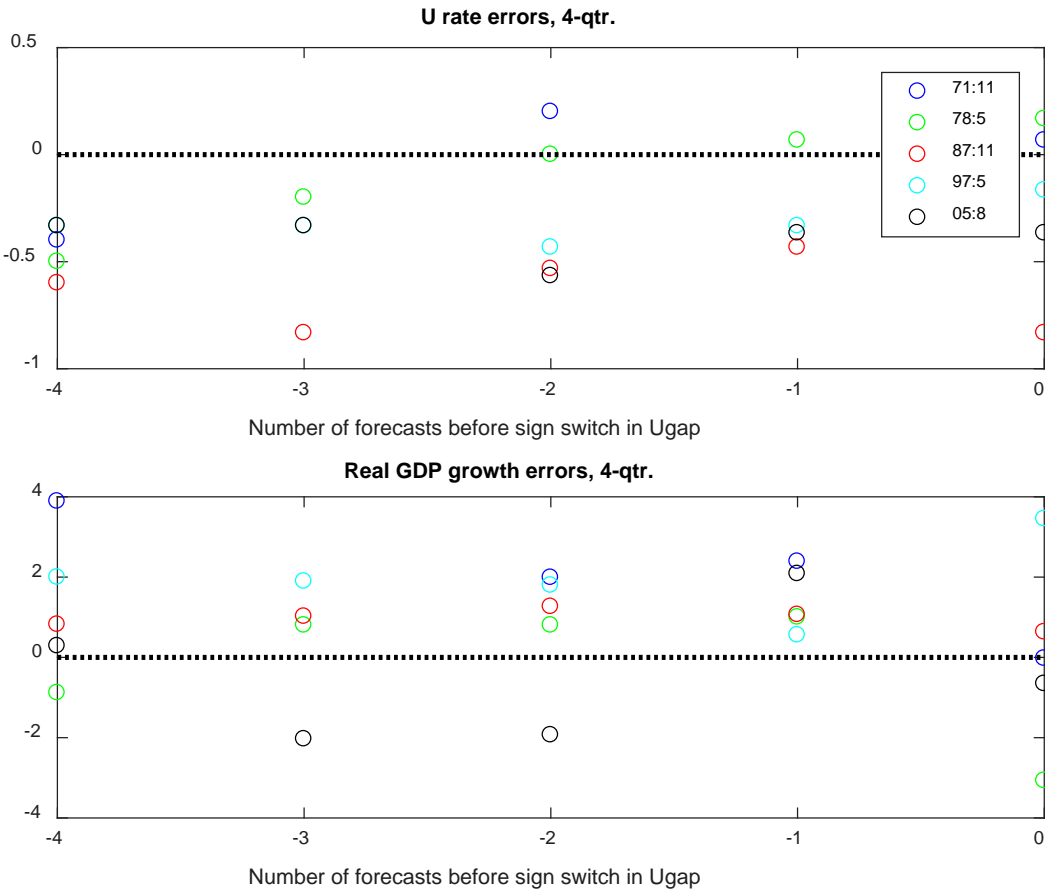
Sources: Bureau of Labor Statistics, Haver Analytics, and National Bureau of Economic Research

Panel 2:



Sources: Bureau of Labor Statistics, Congressional Budget Office, Federal Reserve Board, Haver Analytics, and National Bureau of Economic Research.

Figure 15  
 Greenbook/Tealbook forecast errors around unemployment gap turning points



Sources: Bureau of Economic Analysis, Bureau of Labor Statistics, and Federal Reserve Board.

