The Challenges with Rules-Based Policy Implementation*

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Abstract

I discuss challenges in implementing a rule-based monetary policy (RBP) regime. Many of the arguments for and against RBP are similar to ones prominent 20 years ago in debates over inflation targeting. I draw a distinction, common in the literature on inflation targeting, between a strict and a flexible RBP regime, highlighting the trade-offs involved in moving towards a stricter regime. Under flexible regimes, deviations from the reference rule are allowed, and I derive the rule for deviating from the rule. Stochastic, transitory fluctuations in non-rulable variables, such as the long-run equilibrium real interest rate, are shown to increase the volatility of expected future inflation around target under a level rule, while permanent shifts threaten credibility as either policymakers must act consistent with the rule or with achieving the inflation target. The best simple rule depends on policymakers' preferences, which may make it difficult for a policy committee to agree if the central bank is charged with picking the rule. Turning to practical issues, I discuss how a desire to promote transparency and accountability can help one in choosing between alternative rules.

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1 Introduction

> It seems to me that a reaction function in which the real funds rate changes by roughly equal amounts in response to deviations of inflation from a target of 2 percent and to deviations of actual from potential output describes tolerably well what this Committee has done since 1986. This policy . . . is an example of the type of hybrid rule that would be preferable [to inflation targeting] in my view, if we wanted a rule. I think the Greenspan Fed has done very well following such a rule, and I think that is what sensible central banks do. Janet Yellen (Federal Reserve Board 1995, pp. 43–44).[1]

> "It would be a grave mistake for the Fed to commit to conduct monetary policy according to a mathematical rule." Janet Yellen, in testimony before the House Financial Services Committee (July 16, 2014).

Twenty-four years ago, John Taylor argued that "Policymakers, such as members of the FOMC, currently base their decisions on many factors: leading indicators, the shape of the yield curve, the forecast of the Fed staff models. There is no reason why a policy rule such as [the Taylor rule] could not be added to the list, at least on an experimental basis." (Taylor (1993), p. 208) Simple instrument rules have come a long ways in the years since Taylor made his modest suggestion. They are a regular input into policy decisions of the FOMC and at many other central banks. The debate has now evolved to the point where the U.S. Congress has considered legislation that would require the Federal Reserve to specify explicitly a rule that describes how it adjusts its policy instrument in response to economic conditions. The Financial Choice Act of 2017 (the CHOICE Act, H.R. 10), which was passed by the House of Representatives on June 8th of this year, also requires the GAO to certify the FOMC's rule "conforms" to the Taylor rule.

Instrument rules have proven their usefulness in practical policymaking. But recent legislative proposals seek to elevate rules to play a more central role in policy implementation. In this paper, I assess some of the challenges a central bank would face in implementing a rule-based policy (RBP) regime. What form should the rule take? How should its parameters be determined? Would deviations from the rule be allowed? Would

[1] Quoted in Svensson (2003), p. 428.

the rule be subject to change? I emphasize that considerations of preferences over short-run trade-offs, transparency, accountability, and verifiability affect the answers to each of these questions.

For the past 25 years, the blue-print for best-practices central banking has been to establish the primacy of price stability as the objective of monetary policy, and to grant the central bank wide independence to achieve this goal. This same 25 years have seen a large literature that discusses the costs and benefits of instrument rule-based monetary policy regimes. Modern work that focuses specifically on instruments rules begins with Taylor (1993) and includes McCallum (1993a), European Central Bank (2001), Svensson (2003), McCallum and Nelson (2005), Svensson (2005), Kohn (2012), Orphanides (2015), Orphanides (2017), Fischer (2017), and Federal Reserve Board of Governors (2017).[2] Benefits and costs depend, in part, on what the alternative policy regime is taken to be, and much of the literature on rules has contrasted RBP with discretionary policy.[3]

Attitudes towards discretion sharply divide advocates of RBP and its opponents. Proponents identify discretion with unsystematic, distortionary policy actions and are concerned with the consequences of unrestricted policy flexibility if objectives are potentially inconsistent, ill-defined, or unachievable. In arguing for instrument rules, Orphanides (2017) states that "The combination of meeting-by-meeting discretion and multiple conflicting goals makes the Fed vulnerable to all the pitfalls that monetary theory and history teach us are associated with the absence of systematic policy." (p. 1) Systematic policy is extremely important, not least because such policies, policies that can be characterized by rules, are the only policies we know how to analyze. This point was made convincingly almost 40 years ago by Lucas and Sargent (1978) who noted that "...[equilibrium methods] will focus attention on the need to think of policy as the choice of stable rules of the game, well understood by economic agents. Only in such a setting will economic theory help predict the actions agents will choose to take." If discretion is identified with policy that is not systematic, a commitment to a rule is a means of ensuring systematic policy.

Discretion, however, does not mean unsystematic, as was pointed out by McCallum (1993b) in his discussion of Taylor's 1993 paper. Discretionary policy in the normal

[2] I do not list here the extensive literature evaluating alternative rules in either calibrated or estimated macro models. These are discussed below.

[3] For example, Nikolsko-Rzhevskyy, Papell, and Prodan (2014) identify periods in which the funds rate deviated from the value implied by a Taylor rule as periods of discretionary policy.

sense in which the concept is used in the analysis of monetary policy is not arbitrary policy; it involves a systematic decision making process in which, at each policy meeting, the policy instrument is set to maximize the policymaker's objectives, taking as given current expectations and future policy. In the basic linear NK model with a quadratic loss function in inflation and the output gap, a discretionary policymaker ensures that a linear combination of inflation and the output gap is kept equal to zero. There is nothing unsystematic about such behavior, and it is the way discretion is modelled in most of the academic literature on inflation targeting.[4] Instrument rules and discretion both represent systematic policies. The question is, which leads to better macroeconomic outcomes?

Table 1 lists commonly cited benefits and costs of instrument rule-based policy regimes. The benefits are that rules limit discretion, help to frame policy debates, improve accountability as policy actions can be compared to the rules, and promote transparency. Some rules have been shown to be robust across a range of models, and they provide clear advice. Opponents list the costs as arising from the limits placed on discretion (flexibility), the dangers of framing debates around the rule rather than the goals of policy, and that fact that accountability and transparency are based on whether the central bank follows the rule rather than on achieving the ultimate goals of policy. By definition, simple rules ignore many factors that may be difficult to quantify, and, with many potential rules, conflicting advice may result.

Table 1: Benefits and costs of rule-based policies

Benefits	*Costs*
Limits discretion	Limits discretion
Frames decisions	Frames decisions
Promotes accountability	Promotes accountability (about the wrong thing)
Promotes transparency	Promotes transparency (about the wrong thing)
Robust	Ignores risk considerations
Provides clear advice	Provides conflicting advice

[4] Svensson (2005) provides a number of references, and Woodford (2012) discusses the practical use of forecast targeting policy based on first-order conditions consistent with optimal policy. There is also a hybrid approach in which an instrument rule is assumed to react directly to any violation of the first-order condition from the optimal policy problem, as in McCallum and Nelson (2005).

It is striking how similar this list, or at least its first four rows of Table 1, are to arguments made years ago during the debates over inflation targeting. Rudebusch and Walsh (1998) discussed the pros and cons of inflation targeting, citing four arguments against inflation targeting: it would reduce policy flexibility; it ignored the need to balance competing goals in an uncertain world; it would focus accountability on only one goal of policy; and it would promote transparency about one goal at the expense of transparency about other goals. Four arguments in favor were also discussed: it would anchor expected inflation; it would focus on an objective the Fed could achieve; it would institutionalize good monetary policy; and it would provide a means to monitor and hold the Fed accountable. These pros and cons parallel the arguments debated today in discussing rule-based policies, and these parallels should be kept in mind when evaluating the challenges of implementing a RBP regime. These challenges include many of those faced by inflation targeting regimes, but others are unique to a RBP regime. Critically, adopting a rule does not substitute for specifying policy goals such as the inflation target or deciding how short-run trade-offs among goals should be managed.

Legislation like the CHOICE Act contains two rules: a Reference Policy Rule (the Taylor rule) and a Directive Policy Rule. The latter describes the actual setting of the policy instrument as a quantitative function of Intermediate Policy Inputs. In addition to providing the Directive Policy Rule, section 2C(c)(6) would required the FOMC to provide "a statement as to whether the Directive Policy Rule substantially conforms to the Reference Policy Rule and, if applicable—(A) an explanation of the extent to which it departs from the Reference Policy Rule; (B) a detailed justification for that departure; and (C) a description of the circumstances under which the Directive Policy Rule may be amended in the future;....". Under such legislation, the Reference Policy Rule (RPR) would play a critical role in framing policy debates and in establishing a benchmark for assessing the FOMC's actions.

Critics of RBP often characterize such regimes as mechanical, though the CHOICE Act clearly anticipates that departures from the RPR may occur. Early critics of inflation targeting also focused on strict inflation targeting (an "inflation nutter"). In section 2, I argue that, in the same way actual inflation targeting regimes are flexible targeting regimes, one should focus on flexible rule-based regimes. The degree of flexibility involves a trade-off between reducing distortions arising under discretion and allowing for the flexibility needed to respond to new information. The degree of flexibility also characterizes how tightly the central bank is held accountable for following the rule. The problems that would arise if the RPR contains forecasts or unobservables are also considered

Section 3 asks whether a commitment to a rule can be credible. Shifts in a non-rulable variable can increase the expected future volatility of inflation around target or even force the central bank to chose between committing to the rule and committing to its inflation goal. Or the rule could be changed. The role of escape clauses and the need to have a mechanism for changing the rule, issues that touch on what it means to commit to a rule, are also subjects of section 3.

Establishing a RPR through legislation restricts a central bank's independence, marking a significant shift from reforms beginning with the Reserve Bank of New Zealand Act of 1989 that increased central bank instrument independence by establishing clear policy goals and limiting the ability of elected politicians to influence policy decisions. While inflation targets may be set by the government, often they are set directly by the central bank, as the FOMC did in 2012 in its Statement on Longer-Run Goals and Monetary Policy Strategy, which set an inflation goal of 2%. Similarly, a central bank itself might adopt a RBP regime, using a publicly announced, simple rule as a means of communicating and explaining its policy actions. In this case, Svensson (2003) has listed three steps to implementing a rule-based regime: pick the rule, pick the parameters, and commit to the rule. The challenges faced in taking the first of these steps are discussed in sections 4, which emphasizes the key role of policy objectives in any debate over which rule to adopt. Then, in section 5, the focus shifts to some practical issues such as which variables should appear in the rule, and how parameters should be chosen. Conclusions and directions for future research are the subject of section 6.

2 Strict or flexible RBP?

Early opponents of inflation targeting (IT) often attacked a strict interpretation of IT, and critics of rules such as Svensson (2003), Kohn (2012), Fischer (2017), and Yellen (2017) have also characterize rule-based policy as a mechanical regime in which policy implementation would simply involve pugging numbers into the rule; no discretion would be allowed.[5] Advocates of rule-based regimes, however, seem to image a more flexible

[5]Discussions of rule-based policies also bear parallels to debates in the 1970s and early 1980s over monetary targeting. For example, Tobin (1998) characterizes the era of monetary targeting as one of "mechanical monetarism" (p. 2). In addition to instrument rules and targeting rules, an older literature focused on rules that involved intermediate target variables, that is, variables that were neither direct instruments of monetary policy or among the ultimate goals of policy. Monetary aggregate targeting is a

regime. John Taylor has stated that "Just because a monetary policy rule can be written down as a mechanical-looking mathematical equation does not imply central banks should follow them mechanically."[6] Other proponents of rules also seem to have a flexible regime in mind; for example, Orphanides (2017), p. 3, describes a simple rule for the Fed as one that "should guide its *systematic* monetary policy." (emphasis added).

Under a flexible RBP regime, deviations from the rule would be allowed. But then, just as with inflation targeting, how flexible should the regime be if the objective is to make monetary policy more predictable and systematic while limiting the discretion of the central bank? Thus, a first challenge in implementing a rule-based policy is to understand the trade-offs posed by allowing deviations from the rule.

The question of policy flexibility in the context of inflation targeting was investigated by Rogoff (1985). He considered whether society would be better of in a regime of strict inflation targeting or whether the policymaker should be allowed flexibility to deviate from the target. While such flexibility allowed for better stabilization policies, it also led to higher average inflation. Rogoff showed that the greater the volatility of shocks, the more flexible the targeting regime should be. This same trade-off between lower average inflation and improved stabilization was revisited by Kocherlakota (2016). In his model, discretion can produce an excessive average inflation rate but allows policymakers to respond to information that cannot be captured in the rule. Strict adherence to the rule eliminates the inflation bias but prevents the policymaker from responding to non-rulable information. Kocherlakota argues that, at least for the U.S., any average inflation bias under discretion is small and that, therefore, society is worse off if the policymaker is constrained to follow a rule.

The issue of how much flexibility (discretion) a policymaker should have in a RBP regime was explored in Walsh (2015), where the rule defined a measure for assessing the central bank's performance.[7] If performance is evaluated strictly on adherence to the rule, the policymaker has no flexibility to incorporate information not captured by the rule, nor can the policymaker pursue objectives not perfectly aligned with the rule. Under a flexible regime, deviations from the rule are allowed.

The key issues can be illustrated using the model employed in Walsh (2015). Let π^T be the socially optimal steady-state inflation rate, and define $\hat{\pi}_t \equiv \pi_t - \pi^T$ as actual

classic example of a policy regime involving an intermediate target. See Friedman (1990).

[6] Taylor (2000), p. 443; also quoted in Svensson (2003), p. 445.

[7] See also Walsh (2016).

inflation relative to the target rate. Social loss is taken to be

$$L_t^s = \frac{1}{2}\mathrm{E}_t \sum \beta^i \left(\hat{\pi}_{t+i}^2 + \lambda x_{t+i}^2\right), \tag{1}$$

where $x_t \equiv x_t - x^*$ is the (log) gap between output and the socially efficient output level. Policy is delegated to a central bank with instrument independence but subject to pressures that result in the central bank minimizing

$$L_t^{cb} = \frac{1}{2}\mathrm{E}_t \sum \beta^i \left[\left(\hat{\pi}_{t+i} - \varphi_{t+i}\right)^2 + \lambda \left(x_{t+i} - u_{t+i}\right)^2\right], \tag{2}$$

where φ and u are mean zero, distortionary stochastic shocks that generate wedges between the central bank's objectives and society's. This formulation contrasts with the common approach in the literature on central bank independence. There, the distortions were seen as arising from political pressures on the central bank which could be alleviated through greater central bank independence.

The economy is represented by a new Keynesian Phillips curve given by

$$\hat{\pi}_t = \beta \mathrm{E}_t \hat{\pi}_{t+1} + \kappa x_t + e_t, \tag{3}$$

and an expectational Euler equation given by

$$x_t = \mathrm{E}_t x_{t+1} - \left(\frac{1}{\sigma}\right)\left(i_t - \mathrm{E}_t \pi_{t+1} - r_t^*\right), \tag{4}$$

where $r_t^* = r^* + \mu_t$, and μ_t and e_t are taken to be mean zero exogenous stochastic processes.

The targeting rule characterizing optimal discretionary policy takes the form

$$\kappa \hat{\pi}_t + \lambda x_t = v_t, \tag{5}$$

where $v_t \equiv \kappa \varphi_t + \lambda u_t$. The central bank responds to the distortionary shock v_t, and this is costly in terms of welfare. Consequently, the unconditional expected social loss under optimal discretion is increasing in the variance of v_t.[8] The first-order condition for

[8] See Walsh (2015) for details.

optimal commitment (from a timeless perspective) is

$$\kappa\pi_t + \lambda(x_t - x_{t-1}) = v'_t,$$

where $v'_t \equiv \kappa\varphi_t + \lambda(u_t - u_{t-1})$. So it is not simply the inability to commit that causes policy to be distorted by the distortionary shocks φ and u.

Because it is the policymaker's objectives that are distorted, it can be appropriate to limit the central bank's independence. Taylor (2013) and Orphanides (2017) are explicit in viewing rule-based policy regimes as the means by which this could be done. This is in contrast to the earlier literature which saw political pressures on central banks as the source of poor policy (i.e., the source of v_t); central bank independence was viewed as a means of limiting government influence over monetary policy and therefore ensuring the central bank's objectives aligned with society's, not as a means of limiting the central bank.

The type of discretionary distortion modeled here via the preference shock v_t is not the only distortion under discretion. In the presence of forward-looking expectations, the optimal commitment policy introduces inertia that discretion does not. A rule that includes lagged variables may, by also introducing inertia, improve over discretion even in the absence of v_t. Also, as shown by Clarida, Galí, Gertler, Clarida, Gertler, and Gertler (1999), a non-inertial rule can improve over discretion if the cost shock e_t is serially correlated. I focus here on distorted preferences, in part, because the rule in the CHOICE Act is non-inertial and because advocates of rules stress the need to limit discretion rather than that discretion is not sufficiently inertial.

A rule-based regime assess the central bank's performance on a comparison of the policy instrument and the value implied by a simple instrument rule. I assume the central bank continues to have preferences over actual outcomes given by (2) but is now also concerned with minimizing deviations of outcomes from its assigned performance measure. Thus, under an RBP regime, the central bank sets policy under discretion to minimize

$$L_t^{cb} = \frac{1}{2}\mathrm{E}_t^{cb}\sum \beta^i \left[\left(\hat{\pi}_{t+i} - \varphi_{t+i}\right)^2 + \lambda\left(x_{t+i} - u_{t+i}\right)^2 + \delta\left(i_{t+i} - i^r_{t+i}\right)^2\right], \tag{6}$$

where δ is the weight placed on minimizing deviations of the policy rate from i^r_t, the rate implied by the reference rule. The question for central bank design is whether a rule-based system with $\delta > 0$ can, in an environment of discretionary decision making, improve welfare. In other words, would the government choose a non-zero value of δ if it wished to minimize (1)?

To keep the analysis as simple as possible, assume that the reference rule is defined by[9]

$$i_t^r = r^* + \pi^T + \psi_\pi \hat{\pi}_t. \tag{7}$$

The first order conditions for the central bank's problem imply

$$\kappa\hat{\pi}_t + \lambda x_t = v_t + a\delta\left(i_t - i_t^r\right), \tag{8}$$

where $a \equiv \sigma + \kappa\psi_\pi$. (8) shows how basing accountability on the rule distorts policy relative to pure discretion (see 5).

From (3), (4), and (7), (8) can be written as

$$\kappa\hat{\pi}_t + \lambda x_t = v_t + \frac{a\delta}{\kappa}\left(\kappa r_t^* + \sigma e_t - a\hat{\pi}_t\right). \tag{9}$$

A positive realization of v_t would, under discretion, induce a distortionary policy expansion. As inflation rises, $a\hat{\pi}_t$ on the right side of (9) increases, acting to offset partially the distorting effect of v_t. Thus, the rule-based regime limits the impact of v_t shocks. But stabilization policy in the face of an inflation shock e_t is distorted, and demand shocks, represented by r_t^*, now affect the behavior of inflation and the output gap.[10] These new distortions are the costs of offsetting v_t.

[9] In Walsh (2015) this reference rule was taken to be the Taylor Rule, as in the CHOICE Act. For evidence that the Fed has implicitly placed some weight on the Taylor rule, see Kahn (2012) and Ilbas, Roisland, and Sveen (2013). Ilbas, Roisland, and Sveen (2012) consider adding a term such as $(i_t - i_t^r)^2$ to the policymaker's loss function as a means of increasing the robustness of optimal policy. They analyze alternative defintions of i_t^r and find the the Taylor rule performs well as a reference rule.

[10] Suppose the reference policy rule had a time-varying intercept and was given by

$$i_t^r = r_t^* + \pi^T + \psi_\pi \hat{\pi}_t.$$

Then (9) would become

$$\kappa\hat{\pi}_t + \lambda x_t = v_t + \frac{a\delta}{\kappa}\left[\sigma e_t - \left(\sigma + \kappa\psi_\pi\right)\hat{\pi}_t\right]$$

and demand shocks would not affect inflation or the output gap, just as under pure discretion. The presence of e_t on the right side indicates that the rule would still distort responses to inflation shocks.

The effects of the rule-base regime can also be illustrated by rewriting (8) as

$$i_t = i_t^r + \frac{1}{a\delta}\left(\kappa\hat{\pi}_t + \lambda x_t - v_t\right). \tag{10}$$

In the absent of the rule-based performance measure, the central bank would set the term in parentheses equal to zero. The greater the value of δ – that is, the more costly it becomes for the central bank to deviate from the reference policy rule – the smaller the role this unconstrained optimality condition plays in the setting of i_t, and the closer i_t comes to the value given by the reference rule. And in particular, the smaller is the effect of the distortionary shock v_t on inflation and the output gap.[11]

Svensson (2003) criticized RBP regimes for lacking a rule for deviating from the rule. However, the rule for deviations is provided by (10), just as (5) provides the rule for deviating from the target in a flexible inflation targeting regime. Allowing deviations from the rule under a flexible regime does not mean the reference rule is irrelevant, just as the inflation target is not irrelevant under flexible inflation targeting. Assuming the central bank is systematically pursuing its objectives, deviations are governed by a form of targeting rule (equation 10) just as deviations of inflation from target are governed by (5).

The impact δ has on the economy's response to shocks can be illustrated using the simple NK model given by (3)and (4), with policy objectives given by (6). The reference rule is taken to be the basic Taylor rule as in the CHOICE Act. Figure 1 shows the impulse response to a serially correlated v_t shock for $\delta = 0$, 0.5, and 1.5.[12] The black line with circles ($\delta = 0.0$) shows the responses of inflation, the output gap, the nominal interest rate, and deviations from the reference rule (7) under pure discretion.[13] This distortionary shock leads to an rise in inflation and the output gap. Positive values of δ succeed in significantly dampening the impact of this distortionary shock. Discretion is limited, and both inflation and the output gap remain close to zero. The effect of the shock is not completely eliminated, as the realization of v_t causes a small deviation of the nominal rate from the rule (shown in the lower right panel), and this deviation is smaller

[11] The instrument rule (10) takes the form analyzed by McCallum and Nelson (2005) and criticized by Svensson (2005).

[12] Other parameter are set to values typical in the literature: $\beta = 0.99$, $\sigma = 1$, the Calvo fraction of price adjusting firms is 1/3, and a Fisch labor supply elasticity of 1. These values imply $\kappa = 0.34$ with a linear production technology. The AR(1) parameter for each shock is set to 0.5.

[13] The target inflation rate is set to zero.

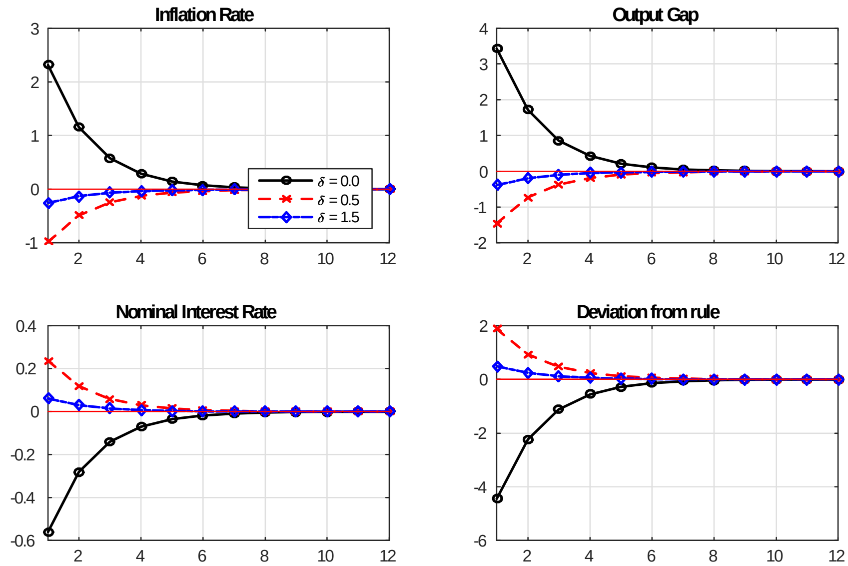

Figure 1: Response to a one unit distortionary policy preference shock v_t in a simple NK model.

when δ is increased.

Figure 2 illustrates the effects of a positive shock to r_t^*. Discretion ($\delta = 0$) completely stabilizes inflation and the output gap, while the shock causes a rise in both inflation and the output gap when $\delta > 0$. While figure 1 showed the benefit of a rule-based system in reducing the effects of distortionary preference shocks, figure 2 reveals the cost of setting $\delta > 0$. The constraint imposed by holding the policymaker accountable for following the reference rule, even when deviations are allowed, dampens the reaction of policy to r_t^*. Policy ends up deviating little from the reference rule for the values of δ shown, and, as a consequence, inflation and the output gap both rise inefficiently.

Finally, figure 3 illustrates the response to a cost shock. By dampening the policy response, the policy with $\delta > 0$ succeeds in stabilizing the output gap more, leading to more inflation volatility relative to pure discretion.

The parameter δ captures the degree of flexibility under a RBP, but it is also captures aspects of central bank independence, is a measure of accountability, and governs the role of the rule in framing policy debates. When the reference rule is chosen by the

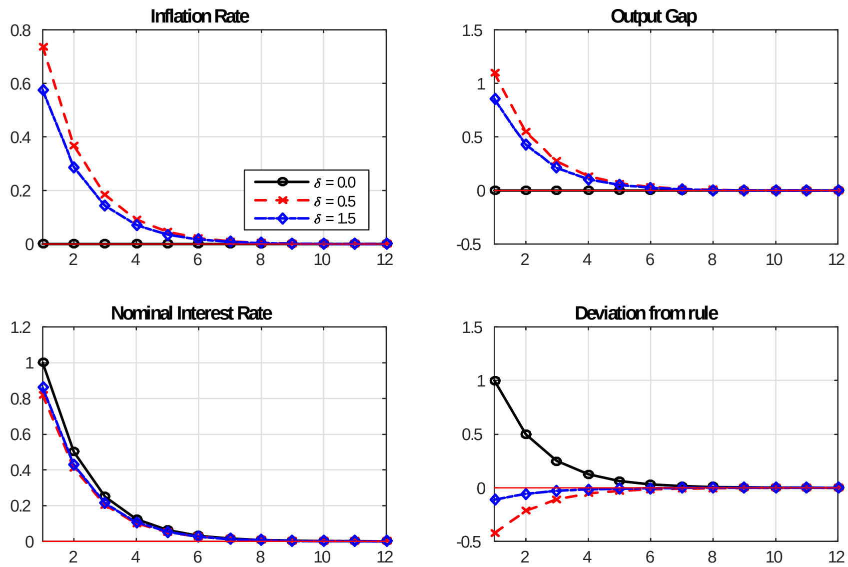

Figure 2: Response to a one unit shock to r_t^* in a simple NK model.

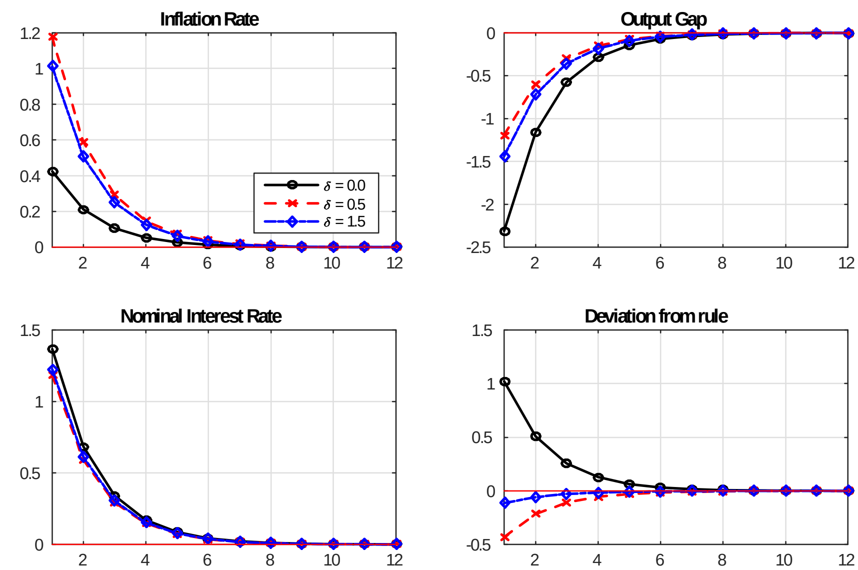

Figure 3: Response to a one unit shock cost shock in a simple NK model.

government, δ also measures the degree to which the central bank's independence is limited. Such a limit is appropriate when the objectives pursued by the central bank deviate from those of society (i.e., $\sigma_v^2 \neq 0$). The benefit of this loss of independence is the welfare gain as short-run shifts in the bank's objectives have a smaller effect on inflation and output gap volatility. The cost is the welfare loss due to reduced policy flexibility in conducting stabilization policies.

Accountability is strengthened as δ increases, because the performance of the policymakers can be assessed by comparing actual policy actions to those called for under the rule. However, policy performance is measured by adherence to the rule and not by achieving the ultimate goals of monetary policy – price stability or a low and stable rate of inflation, for example. Accountability is based on the wrong thing; this was also one of the arguments made against inflation targeting, as discussed by Rudebusch and Walsh (1998). Yet inflation is arguable the primary goal of monetary policy. The level of nominal interest rates does not hold the same position as an ultimate goal of policy. And a poorly designed performance measure distorts policy choices; this distortion might easily dominate the original policy distortions the RBP regime was designed to address.

The distinction between strict and flexible RBPs is also useful for considering the role a rule plays in framing policy debates. The policy action suggested by the rule becomes the focal point for discussions; it anchors the debate on a particular action. To argue for doing something else requires making a compelling case for deviating from the rule. This can serve a useful purpose in ensuring that the arguments for deviating are carefully articulated and supported by strong evidence. However, if the rule plays a major role in assessing the central bank's policy actions (i.e., if δ is large), it will similarly be prominent in framing and potentially distorting discussions over policy actions. Kocherlakota (2016) argued that during 2009-2010, the FOMC was not sufficiently aggressive in pursuing expansionary policies despite the fact that the policies adopted implied a very slow recovery of unemployment and a persistent undershooting of the committee's inflation target. He attributes "this lack of aggressiveness to the FOMC's unwillingness to deviate greatly from the recommendations of the Taylor Rule, because it provided a good approximation to the Committee's pre-2007 policy reaction function."

2.1 Optimal flexibility

The power of the RBP regime, measured by δ, is a measure of the flexibility of the system. Just as strict inflation targeting would put no weight on stabilizing real economic activity ($\lambda = 0$), a strict rule-based policy is obtained when $\delta \to \infty$ (the case of a "rule nutter"). However, just as Rogoff showed an inflation nutter is not generally optimal, some flexibility in the rule-based regime is also desirable.

For the case of *iid* shocks, one can solve analytically for the value of δ that minimizes the unconditional social loss. It is given by

$$\delta^* = \frac{\left(\lambda + \kappa^2\right)\sigma_v^2}{\left(\lambda + \kappa^2\right)^2 \sigma_{r^*}^2 + \Lambda \sigma_e^2}, \tag{11}$$

where

$$\Lambda \equiv \sigma\kappa\left(\sigma\kappa - \psi_\pi \lambda\right). \tag{12}$$

In the absence of the distortionary shock v_t, $\delta^* = 0$; the reference rule should not be used to constrain discretionary policy for the simple reason that (in this example), there is no problem that needs to be solved by imposing a rule. δ^* is decreasing in the volatility of inflation (cost) and demand shocks; as the scope for welfare-improving stabilization policy increases, the cost of distorting the central bank's objectives either by requiring it to place more weight on inflation variability or on matching the benchmark instrument rule rises.

The expression for δ^* given in (11) was derived for an arbitrary policy response coefficient ψ_π. Suppose instead this is optimally chosen. The optimal response to inflation under pure discretion with *iid* shocks is equal to $\psi_\pi^* = \sigma\kappa/\lambda$. In this case, $\Lambda = 0$ and δ^* is proportional to $\sigma_v^2/\sigma_{r^*}^2$; greater volatility of the distortionary shock v_t calls for a greater focus on following the rule, while greater volatility in aggregate demand disturbances represented by r_t^* call for less focus on the rule to allow greater policy flexibility to respond to such shocks. If the reference rule is the optimal non-inertial rule (i.e., $i_t^r = r_t^* + \pi^T + \psi_\pi^* \hat{\pi}_t$), the denominator in (11) goes to zero and $\delta^* \to \infty$; a strict RBP regime would be optimal. Designing an optimal policy regime based on rules, requires knowledge of the model, the model's parameters and the nature of the stochastic shocks, as well as society's preferences for trade-offs among the ultimate goals of policy. But ψ_π^* is model specific and r_t^* is an unobservable and therefore, as discussed next, unlikely to be a candidate for inclusion in a reference rule designed to support transparency and public accountability of the central bank. Thus, even in a simple model such as the one used here, it is unrealistic to treat the optimal reference rule as achievable. And therefore a RBP regime must be a flexible regime.

If the optimal degree of flexibility is too model specific to provide much practical guidance, a challenge in implementing a RBP would be to determine the appropriate degree of flexibility. With IT, the central bank can assess the output consequences of returning inflation back to target after a deviation as a means of deciding on the best degree of flexibility. A similar approach can be taken for a RBP by, for example, assessing impulse responses such as those shown in figures 1 - 3 for the simple NK model. However, doing so requires (i) a model or set of models and (ii) a means of evaluating the implied outcomes. In figure 3, for example, a Rogoff conservative policymaker would prefer larger δ as it produces smaller inflation deviations, while a policymaker more focused on the costs of negative output gaps would prefer a smaller δ. Preferences over objectives matter.

2.2 Forecasts and unobservables

When monetary policy affects inflation and the real economy with lags, optimal policy rules will depend on forecasts, and so a rule meant to provide policy guidance would include forecasts. There are, however, three problems with a rule involving forecasts: (1) The use of forecasts (or unobservables) weakens the value of the rule in supporting accountability; (2) The rule becomes an implicit rule rather than an explicit instrument rule in the terminology of Svensson (2003); (3) The forecasts of inflation and economic activity may not be consistent with the rule.

Many central banks do provide forecasts of future inflation and measures of economic activity. But unless these forecasts are based on a single and publicly available model, they potentially can be distorted by the central bank to ensure the recommendation from the rule will accord with the policymaker's decision. This weakens the role of the rule in ensuring accountability. To illustrate this point, consider the setting of the policy rate under the rule-based regime of section 2. Equation (8) was

$$i_t = i_t^r + \frac{1}{a\delta}\left(\kappa\hat{\pi}_t + \lambda x_t - v_t\right).$$

Suppose the reference rule is

$$i_t^r = r_t^a + \psi_\pi \hat{\pi}_t,$$

where r_t^a is the central bank's announced forecast of r_t^*. The optimal strategy for the central bank is to announce a value of r_t^a such that $i_t = i_t^r$. In this case, one is back to the discretionary and distorted outcome in which

$$\kappa\hat{\pi}_t + \lambda x_t = v_t.$$

It is true that the central bank can, through its announcement of r_t^a, ensure that stochastic fluctuations in the equilibrium real interest rate do not affect inflation or the output gap. But now the rule-based policy fails to mitigate any of the distortionary shock v_t, regardless of the power of the performance measure given by δ. In the special case in which $\psi_\pi = \psi_\pi^* = \sigma\kappa/\lambda$, the value of the equilibrium real interest rate the central bank will find it optimal to announce is

$$r_t^a = r_t^* - \left(\frac{\sigma}{\lambda}\right) v_t.$$

The announcement is skewed away from the true r_t^* by the preference distortion the rule-based regime is meant to alleviate. When the ex-post realization is not verifiable, as is the case with an unobservable such as r_t^*, the public cannot determine whether a negative deviation of the nominal rate from the rule reflects simply a forecast error or a distortionary shock to objectives that is concealed through a biased announcement.[14]

When the rule contains forecasts of endogenous variables, it becomes an implicit rule rather than an explicit rule. Svensson (2003) defines an implicit instrument rule (or reaction function) as "a function relationship between the instrument and another endogenous non-predetermined variable." As such, forecasts cannot be substituted into the relationship to obtain the setting for the policy instrument. Instead, the instrument setting and the forecast are jointly determined. But determining both then depends on the use of a specific model. Such a rule makes it more difficult for the public to verify policymakers are actually using the rule.

Finally, the forecasts may be inconsistent with the rule. This problem with instrument rules that contains forecasts is highlighted by feeding in forecasts to a rule such as (15) to project a forecast for the policy rate. One can conduct such an exercise on the Cleveland Fed's web site. While serving a useful role in highlighting potentially different implications of alternative rules, such an exercise is based on an internal contradiction. It invites one

[14] Canzoneri (1985) analyzed the problems that arise under discretion when the central bank has private information.

to conduct experiments that involve substituting alternative forecasts into the rule and then concluding that the interest rate will be higher or lower than the level based on the Fed's forecasts. But these forecasts may be inconsistent with any model in which policy was actually set based on (15).[15] This means the rule may actually contribute to public confusion rather than clarifying policy decisions.

Interestingly, Orphanides and Wieland (2013) consider robust simple rules for eleven euro area models. Using a model averaging approach, the optimal rule does not involve any future dated variables; only the lagged policy rate, current inflation, the current output gap, and the four quarter change in the output gap appear.[16] Their findings, at least for the euro area, suggest restricting rules to contemporaneous or lagged variables may not lead to a worsening of policy outcomes.[17]

Optimal policies depend on forecasts, but they also depend on variables that not directly measured such as r_t^* or output gap measures. These must be estimated in ways that are statistically sophisticated and/or model dependent, making them poor inputs into a rule that is meant to promote transparency and accountability. Rules often attempt to avoid or lessen this problem by, for example, replacing the theoretically appropriate output gap with output relative to potential, essentially a detrended measure of output. This too is poorly measured, not clearly defined (which methods is appropriate for removing the trend?) and does not correspond to any welfare-based concept. As the earlier example suggested, policymakers may have an incentive to distort estimates of unobservables to pursue their own objectives. Hence, if a purpose of rules is to promote accountability and transparency, the appearance of such variables in the rule is problematic and likely to render the rule ill suited for achieving either purpose.

3 Credibility, changing the rule, and escape clauses

Can a commitment to a rule be credible? The evidence from inflation targeting is that central banks are able to commit to an inflation target even if policy actions are taken

[15] Woodford (2012) discussions forecasts issues with targeting rules.

[16] This result continues to be true when they average over only the NK DSGE models among their 11 models. They do find a role for forecasts when averaging over the other models which generally give more importance to lags. When they introduce output gap measurement error in the NK-DSGE models, they do find the optimal rule includes 2-quarter ahead forecasts.

[17] That rules shoud be based on information known at the time policy is set was emphasized by McCallum (1988).

in a discretionary manner and short-run deviation from the inflation target are allowed. The credibility of the central bank's commitment to its inflation target, however, can be evaluated by comparing medium-term inflation expectations to the target inflation rate. Let $z_{t/t+h}$ denote the time t forecast of z at t+h. In the model of section 2 and assuming $x_{t/t+h} = 0$ for h sufficiently large, (5) implies $\hat{\pi}_{t/t+h} = 0$, or $\pi_{t/t+h} = \pi^T$.[18]

Any RBP regime that does not simply require a mechanical implementation of the rule would also allow deviations from the rule. These deviations would satisfy (10), but if deviations can always be justified by special, short-run circumstances, to what extent does a flexible RBP system ensure the central bank is committed to the rule? Does a flexible RBP regime have a natural measure of credibility, like $\pi_{t/t+h} - \pi^T$, that is also consistent with policy objectives?

Using the reference rule and the Fisher equation that led to (13), expectations of future inflation must satisfy

$$\hat{\pi}_{t/t+h+1} = r^* - r^*_{t/t+h} + \phi\hat{\pi}_{t/t+h},$$

where $\phi \equiv \psi_\pi + \kappa/a\delta$. If $r^*_{t/t+h} = r^*$, the locally unique, stationary rational expectations equilibrium is $\hat{\pi}_{t/t+h} = 0$, or $\pi_{t/t+h} = \pi^T$ (recall that ψ_π, and therefore ϕ exceed 1). So expectations of future inflation should equal the target rate, and $i_{t/t+h} = i^r_{t/t+h} = r^* + \pi^T$; expected future nominal rates should align with the reference rule. Thus, $i_{t/t+h} - i^r_{t/t+h}$ provides a measure of the credibility of the RBP regime. Suppose the central bank makes public its forecasts for the path of inflation, the unemployment rate gap (or its preferred measure of economic activity) and the policy rate. If $\pi_{t/t+h} = \pi^T$, $x_{t/t+h} = 0$ and $i_{t/t+h} = i^r_{t/t+h}$ for all $h > h^*$ for some positive h^*, then one would conclude the projections are internally consistent with the rule and that the regime is credible.

However, the ability of the public to assess the credibility of a RBP regime is more challenging than it is for inflation targeting, as it relies not on a commitment to achieve a goal, but it also depends on the belief that the rule is correct. Suppose r^*, the constant in the reference rule, does not coincide with $r^*_{t/t+h}$, e.g. $r^*_{t/t+h} \to \bar{r}^* \neq r^*$. Then either $i_{t/t+h} \neq r^* + \pi^T$ or $\pi_{t/t+h} \neq \pi^T$. More specifically, if the steady-state real rate is $\bar{r}^*$ and the constant in the policy rule assumes a real rate of $r^* \neq \bar{r}^*$, then the credibility of the

[18] The preference shock was assumed to be white noise, so $v_{t/t+h} = 0$.

rule implies steady-state inflation will equal

$$\pi = \pi^T + \left(\frac{\bar{r}^* - r^*}{\phi - 1}\right) \neq \pi^T.$$

With $\phi > 1$, a fall in $\bar{r}^*$ relative to $\bar{r}$ implies inflation will fall short of the target value. For example, if the RPR is $i_t^r = 4 + 1.5\hat{\pi}_t$ (i.e., as with a Taylor rule with $r^* = \pi^T = 2\%$ and a strict RBP) and r^* has fallen to 1%, the credibility of the rule means steady-state inflation will equal zero, not 2%, while the credibility of the inflation target would imply $i_{t/t+h} = \bar{r}^* + \pi^T = 3\% < 4\%$.

If expectations of future inflation remain anchored at 2%, then expectations of the future nominal rate cannot be anchored at the level implied by the rule. That is, if the public believes the inflation target, they must believe that the reference rule will have to change if the natural real rate is subject to permanent shifts. If they believe the reference rule, they must believe inflation will differ from target. The reference rule and inflation target are consistent in the medium term only if the real interest rate is constant or subject to only short-lived transitory fluctuations.[19] Sustaining credibility is therefore likely to be a challenge in a RBP regimes.[20]

Uncertainty about r_t^*, and concerns that it has declined have played a prominent role in recent policy discussions. Work by Laubach and Williams (2003), recently undated to incorporate international factors by Holston, Laubach, and Williams (2016), suggest a significant fall in r_t^* over the past 30 years. Figure 2 of Nechio and Rudebusch (2016) shows the largest source of funds rate changes implied by their policy rule is the result of revisions in r_t^*, while Hamilton, Harris, and West (2015) find that uncertainty about r_t^* is considerable.

Declining estimates of r_t^* are reflected in FOMC member projections of the long-term real rate, which can be inferred from their longer-run assessment of the level of the federal funds rate and the Fed's 2% inflation target. The mean longer-run projection of the real rate has falling steadily from 2.11% in 2012 to 0.92% in the July 2017 Monetary Policy Report.[21] This corresponds to a lowering over the past 5 years of the mean, longer-run projected level of the funds rate from 4.11% to 2.92%. Any rule expressed in terms of the

[19] This assumes r_t^* is not a rulable variable and so is not in the RPR.

[20] Svensson (2015) investigates discrepencies between market expectations of the future path of the policy rate and the central bank's announced path. As he notes, these discrepencies can shed light on the credibility of the central bank's policy rate projections.

[21] And to 0.78 according to the dot plot released after the September 20th FOMC meeting.

level of the funds rate would need to be adjusted for this decline. Yet these projections are essentially unverifiable, implying the longer-run real rate is not rulable.

If r_t^* is not rulable, persistent shifts in its value, even if ultimately transitory, can cause significant volatility in expected future inflation. For example, suppose shifts in the natural real rate ultimately die out, but do so at a very slow rate so that one can model r_t^* as

$$r_t^* = \rho r_{t-1}^* + (1-\rho) r^* + \eta_t,$$

where η_t is white noise and ρ is very close to one. If the medium-term is represented by a flexible-price equilibrium as in a standard NK model, inflation and the nominal interest rate must satisfy the Fisher equation and the policy rule (10) with $x_{t/t+h} = 0$:

$$i_{t/t+h} = r_{t/t+h}^* + \pi_{t/t+h+1}$$

$$i_{t/t+h} = i_{t/t+h}^r + \left(\frac{1}{a\delta}\right)\left(\kappa\hat{\pi}_{t/t+h} - v_{t/t+h}\right),$$

and

$$i_{t/t+h}^r = r^* + \pi^T + \psi_\pi \hat{\pi}_{t/t+h},$$

where $\psi_\pi > 1$. If v_t is white noise, as was assumed in section 2, $v_{t/t+h} = 0$. If $r_{t-1}^* = r^*$, the solution for this system implies

$$\pi_{t/t+h} - \pi^T = \left[\frac{a\delta\rho^h}{a\delta(\psi_\pi - \rho) + \kappa}\right]\eta_t = B\eta_t. \tag{13}$$

The variance of inflation around target is $B^2\sigma_\eta^2$, and B is increasing in δ; a stricter RBP regime increases the volatility of expected future inflation around its target. Let $\rho = 0.99$, $\sigma = 1$, $\lambda = 1$, $\kappa = 0.34$ (as in Boehm and House (2014)), and $a = \sigma + \kappa\psi_\pi$, with $\psi_\pi = 1.5$. Figure 4 plots B^2 as a function of δ for different values of λ for a 4 year horizon ($h = 48$). As the δ increases and the RBP regime becomes stricter, the volatility of future inflation around target increases significantly.[22] As $\delta \to \infty$ and the regime becomes a strict RBP regime, the variance of inflation around target converges to $\left[\rho^h/(\psi_\pi - \rho)\right]\sigma_\eta^2 = 1.3\sigma_\eta^2$ for this calibration.

[22] If the distortionary shock v_t is also AR(1), then a stricter RBP regime reduces future inflation volatility due to $v_{t/t+h}$. A stricter inflation targeting regime also reduces the effects of $v_{t/t+h}$ while eliminating the effects of the real interest rate shock, resulting in the variance of future inflation around the target going to zero.

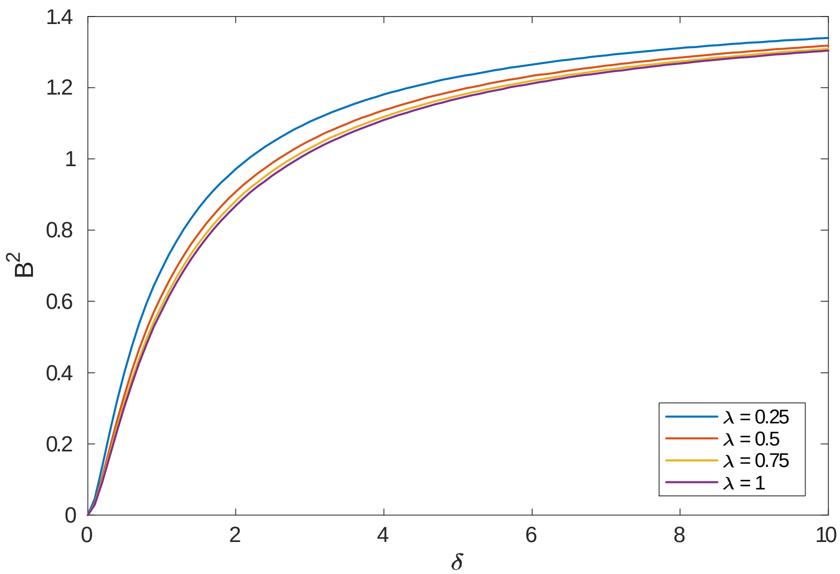

Figure 4: The volatility of inflation deviations from target 48 quarters in the future in response to a persistent shock to the natural real rate of interest as a function of δ when $r_t^* = \rho r_{t-1}^* + (1-\rho)r^* + \eta_t$ with $\rho = 0.99$.

Thus, permanent shifts in a non-rulable variables such as r_t^* imply the reference rule and the inflation target are inconsistent. And even transitory shocks to r_t^* will increase the volatility of expected future inflation around target if the targeting regime is relatively strict. The solution to this problem is to allow for a time-varying intercept in a levels rule. In the case of this example, a fall in r_t^* would call for reducing the level of the policy rate, that is, it would require changing the rule. If one accepts the evidence in, for example Holston, Laubach, and Williams (2016), that the real rate has fallen, then a RBP needs a process through a reference rule can be changed over time.

The need to change the rule as the structure of the economy or our understanding of it evolves is likely to be a more serious problem for rules expressed in level form. This is one reason imbedding a particular value of the natural real rate into legislation, as is done in the CHOICE Act, is not a good idea. If the reference rule is instead established by the FOMC, then its adoption could also be accompanied by a review process as suggested by Levin (2014) and Orphanides (2017). However, the Fed's best current estimate of r_t^*, based as it would be on internal models and analysis, would be unverifiable. And if there is a process of reviewing and potentially adjusting parameters of the rule, even if the form of the rule were unchanged, then the predictability of policy that is sought in a RBP regime would be lost. If the policy rule can be changed, how does that contribute to making policy more systematic?

Changes in r_t^* would also affect first-difference rules, that is, rules of the form

$$i_t^r = i_{t-1} + \phi\hat{\pi}_t$$

that are discussed in section 4. The evidence of a declining r_t^* would call for introducing a negative drift term in the reference rule. While the meeting-to-meeting decline might be small, the communications problems might be large if, over a sequence of meetings, the FOMC consistently lowered the policy rate more than called for on the basis of inflation developments, or developments in any measure of real activity contained in the rule. Or the FOMC could persist in following the rule, delaying the downward adjustment until it was time for a regular review of the rule. Such a strategy would seem inconsistent with any notion of forward-looking decision making and risks postponing adjustments too long. However, a first-difference rule is at least consistent with $\pi = \pi^T$ in a stationary equilibrium, as a constant nominal rate would imply that $\hat{\pi} = \pi - \pi^T = 0$.

3.1 Escape clauses

Escape clauses describe situations in which the normal rules are suspended. In the context of a RBP regime, they make the most sense under a strict or mechanical interpretation of the regime. In an early analysis of escape clauses, Flood and Isard (1989) considered a discretionary environment subject to infrequent and imperfectly known shocks. In the absence of such shocks, a rule-based regime eliminates the distortions arising from discretion, but such a regime performs poorly when a shock does occur. They considered escape clauses that allowed for deviations from the rule when a shock occurs.[23] Lohmann (1992) showed that an escape clause can improve over Rogoff's conservative central banker solution to an inflation bias arising under discretion. In the Rogoff analysis, the conservative central bank is allowed complete instrument independence, and, as a consequence, distorts stabilization policy away from the socially preferred trade off. Lohmann shows that outcomes are improved if the central bank losses its independence whenever shocks are too big. This threat causes the policymaker to respond more aggressively to larger

[23] See the correction to their analysis by Lohmann (1990) and the authors' reply in Flood and Isard (1990).

shocks, thereby extending the range of shocks over which independence is preserved.

Lohmann-type escape clauses were a feature of New Zealand's original inflation targeting regime. For example, the first Policy Target Agreement (PTA) in 1990 allowed the target inflation rate to be renegotiated in the face of changes in the goods and services tax, major changes in the terms of trade, natural disasters, or "a major disease-induced fall in livestock numbers." Each of the items mentioned represents a supply-side disturbance which, under flexible inflation targeting, would call for inflation to deviate from its target. The most recent PTA, signed this year, lists "exceptional movements in the prices of commodities..., changes in indirect taxes, ... or a natural disaster" as examples of developments that would justify short-run deviations of inflation around its medium-term target.

New issues arise under instrument rule-based regimes, however, in the presence of an effective lower bound on the nominal policy rate. In the face of large shocks, the reference rule might call for a policy rate setting that is negative, as the Taylor Rule did during the Great Recession. In the case of a regime such as inflation targeting, the goals of policy are unaffected; if a primary instrument is no longer available, the central bank must develop new instruments as it strives to achieve its goals. This is exactly what the Federal Reserve and other major central banks did during the financial crisis and Great Recession. Balance sheet policies substituted for further cuts in the nominal policy rate.

Four options present themselves. The first would require the Fed to develop an implicit measure of the effective policy instrument that incorporates the impact of balance sheet and credit policies at the ELB. The Wu-Xia shadow rate might serve this purpose, for example. This option has the disadvantage that it would rely on an unobserved indicator of policy that is model dependent and so weakens the transparency and accountability roles of the rule. The second option would require that the constraints of an effective lower bound be eliminated by allowing for negative nominal rates. Goodfriend (2000), Goodfriend (2016), and Rogoff (2017) discuss reforms that would remove the current asymmetry at zero that exists in the present monetary system. This option would increase greatly the applicability of a RBP, eliminating the need for special escape classes or theory-based measures of policy stance at the ELB. However, the literature on rules in linear models assumes increasing the policy rate from 2% to 3% would have the same impact, except for the sign, as a cut from −2% to −3%. Absent historical experience, one would want to be caution about committing to a rule that is symmetric around zero.

The third option would be to raise the inflation target. This proposal, first raised by

Blanchard, Dell'Ariccia, and Mauro (2010), would, like the previous option, expand the range of applicability of an instrument rule, but it is a strategy that calls for altering policy goals to make an instrument rule work better, rather than simply rethinking the rule to achieve existing goals.

The fourth option is to incorporate factors into the rule that would mimic the behavior of optimal commitment policies if the ELB constraint binds. The idea would be to construct a rule that would maintain the policy rate at zero (or its effective lower bound) for a period after the point at which the basic reference rule would imply rates should be increased. For example, Reifschneider and Williams (2000) proposed a method of augmenting the Taylor rule to deal with the zero lower bound.[24] The idea is to mimic an optimal commitment policy by generating expectations that the policy rate will be kept at zero after the point at which the basic Taylor rule would call for the rate to be increased. The fact that Reifschneider and Williams proposed a rule to deal with ELB situations long before such an episode was wide believed to be relevant in the U.S. is a testament to their insight, but it was not until the Great Recession and experience at the ELB that the need for such a modified rule became apparent. Unfortunately, the CHOICE Act lacks any explicit mechanism for dealing with the ELB. This is surprising, given that during seven of the last ten years the federal funds rate target was fixed at 25 basis points. Technically, the FOMC could have explained to the GAO that the balance sheet policies effectively substituted for lowering the funds rate (perhaps pointing to the Wu-Xia shadow rate in support). The GAO could then certify that these actions conformed to the Taylor rule and therefore to the requirements of the CHOICE Act.

If legislation written in 2017 lacks clarity as to how it would be applied at the ELB, it is clear that any RBP adopted prior to the Great Recession would also have failed to address the ELB and therefore failed as a guide for policy during the financial crises and Great Recession.[25] And it seems unlikely a rule adopted in 2017 would successfully incorporate factors in it that would anticipate the situation faced in the next unforeseen crisis.

[24] In Federal Reserve Board of Governors (2017), this is the rule described as the adjusted Taylor rule.

[25] Advocates of rules might argue that had the Fed been following the Taylor rule during 2003-2006 the global financial crisis and Great Recession would not have occurred.

4 Whose rule? The role of preferences

The CHOICE Act specifies that the reference rule should be the Taylor rule, but this rule is one of many possible rules. For example, 5 different instrument rules are discussed in Federal Reserve Board of Governors (2017). The Federal Reserve Bank of Cleveland has a web site that allows one to calculate the funds rate implied by 7 difference instrument rules,[26] while the Atlanta Fed has a site that allows one to calculate the recommendation of an inertia Taylor rule.[27] Taylor and Williams (2011) consider 5 rules in 9 different models. The Monetary Models Database project allows one to choose from 9 different rules as well as specifying one's own rule.[28] Tetlow (2015) analyzes 8 rules. Many others have been evaluated in the literature. In addition, estimated DSGE models include a variety of different rules meant to capture empirically the behavior of policy for specific countries and sample periods.

There exists a large literature evaluating rules, seeking robustness across models. I want to emphasize a different challenge in choosing a rule – the role of preferences.

In section 2, the reference rule was chosen by the government. An alternative approach, one more consistent with the discussion of monetary policy strategies by Levin (2014) and Orphanides (2017), would have the central bank pick the reference rule. While it is useful to speak of "the FOMC," the FOMC is a committee, and a RBP regime would require the FOMC to agree on a single reference rule.[29] Reaching a committee consensus on a rule would be much more difficult that agreeing on an inflation target. In many policy models, for example, the real side is independent of average inflation, making the choice of a target inflation rate orthogonal both to real economic issues and to short-run trade-offs among policy goals.[30] In contrast, the choice of a rule is a choice about short-run trade-offs among competing goals. This may make it more difficult to reach agreement and would risk shifting debate away from achieving the medium-term inflation

[26] https://www.clevelandfed.org/our-research/indicators-and-data/simple-monetary-policy-rules.aspx

[27] https://www.frbatlanta.org/cqer/research/taylor-rule.aspx?panel=1

[28] See Wieland, Cwik, Müller, Schmidt, and Wolters (2012). The latest version of this database is MMB 2.2.

[29] Fischer (2017) provides a recent discussion of the advantages of policy by committee. These advantages come, in part, from the ability of a committee to aggregate information efficiently. However, a rule acts to limit the efficient use of information.

[30] Many modern DSGE models, for example, impose forms of indexation to ensure short-run dynamics and the steady-state are independent of average inflation. However, this seperation is not consistent with standard monetary theory. For a survey of the real effects of trend inflation under Calvo pricing, see Ascari and Sbordone (2014).

objective.

To illustrate how preference disagreement affects the ranking of alternative candidate reference rules, I employ the Smets and Wouters (2007) model of the U.S. economy. This is a well-known medium-scale DSGE model that provides a useful laboratory for conducting some simple comparisons of alternative rules. The model is solved for 9 difference policy rules. One rule is the estimated policy rule from Smets and Wouter's paper. Table A, p. 37 of Federal Reserve Board of Governors (2017) presents 5 alternative rules. These include the Taylor rule from 1993, a "balanced approach rule" that puts more weight on the measure of economic activity, a "change rule" that relates the policy rate change to the level of inflation and the real activity measure, and a "first-different rule" that gives the rate change as a function of the level of inflation and the change in the activity measure.[31] All the rules in Federal Reserve Board of Governors (2017) use the unemployment rate gap as the measure of real economic activity. The advantages of using this measure are discussed below, but Smets and Wouter's model does not include unemployment, so using an Okun's Law coefficient of 2, I replace the unemployment rate gap with either the model-consistent output gap or output relative to trend. This yields 8 alternative rules, summarized in Table 2. All variables are expressed at annual rates, and π_t and $\pi_{4,t}$ denote the one-quarter and four-quarter inflation rates. Parameter values are set to the posterior mean of the estimated coefficients.[32] The rule denoted TRy is the reference rule in the CHOICE Act.

[31] I drop the adjusted Taylor rule, as it is modified to account for the zero lower bound on the nominal in rate and so is not relevant over the sample period employed by Smets and Wouter.

[32] The Taylor Rule and Balanced Approach rules in Federal Reserve Board of Governors (2017) included time-varying constants equal to an estimate of the long-run real interest rate plus the 2% inflation target. In the Smets-Wouter model, the long-run real interest rate is a constant, and the model is expressed in terms of deviations around trend-growth adjusted steady state. Thus, constants drop out.

Table 2: Alternative policy rules

SW	$i_t = 0.82 i_{t-1} + (1 - 0.82)(2.04\pi_t + 0.09 x_t) + 0.23 (x_t - x_{t-1})$
TRx	$i_t = 1.5\pi_{4,t} + 0.5 x_t$
TRy	$i_t = 1.5\pi_{4,t} + 0.5 y_t$
BAx	$i_t = 1.5\pi_{4,t} + x_t$
BAy	$i_t = 1.5\pi_{4,t} + y_t$
CRx	$i_t = i_{t-1} + 1.2\pi_{4,t} + x_t$
CRy	$i_t = i_{t-1} + 1.2\pi_{4,t} + y_t$
FDx	$i_t = i_{t-1} + 0.5\pi_{4,t} + 0.5 (x_t - x_{t-4})$
FDy	$i_t = i_{t-1} + 0.5\pi_{4,t} + 0.5 (y_t - y_{t-4})$

Table 3 reports the standard deviations of the policy rate, inflation, the output gap and output under the alternative rules using the historical shocks implied by the original SW model. That is, these standard deviations are obtained from a counterfactual experiment in which the shocks the Smet-Wouter model estimates as having generated the historical data over their sample (1966:1 - 2004:4) are fed back into the model with the estimated policy rule replaced by the alternatives in Table 2. Values are expressed relative to the standard deviations observed in the data. Thus, values less than 1 in the table indicate a variable is less volatility under a particular rule than it was historically. The rows labeled No MP Shock reports results when the monetary policy shock in the estimated model is set to zero. With the estimated SW policy rule, this experiment shows the effects of removing the *unsystematic* component of monetary policy. Note that this reduces the standard deviation of inflation by 4.7% and of output by 7.6%. However, the volatility of the output gap increases by 2.3%. Using a standard loss function in the volatility of inflation and the output gap to rank outcomes, whether one concludes that unsystematic policy is welfare reducing or enhancing depends on the relative weight placed on the inflation and output gap objectives. If a large relative weight is placed on reducing output gap volatility, the Smets-Wouter monetary policy shock – that is, unsystematic policy – is welfare improving.

Table 3: Standard deviations*: Counterfactuals

		$std(r_t)$	$std(\pi_t)$	$std(x_t)$	$std(y_t)$
Alternative rules		1.000	1.000	1.000	1.000
SW	No MP shock	0.863	0.953	1.023	0.924
TRy	No MP shock	1.446	1.641	1.117	0.830
	MP shock of SW	1.524	1.639	1.113	0.828
TRx	No MP shock	1.652	2.099	1.004	0.854
	MP shock of SW	1.702	2.099	0.999	0.854
BAy	No MP shock	2.002	2.430	1.080	0.722
	MP shock of SW	2.063	2.429	1.076	0.720
BAx	No MP shock	2.37	3.292	0.859	0.713
	MP shock of SW	2.467	3.293	0.855	0.714
CRy	No MP shock	1.376	1.210	1.219	0.985
	MP shock of SW	1.571	1.203	1.220	1.018
CRx	No MP shock	1.496	1.708	1.081	0.948
	MP shock of SW	1.631	1.710	1.084	0.986
FDy	No MP shock	0.626	0.528	1.148	0.877
	MP shock of SW	0.859	0.674	1.135	0.985
FDx	No MP shock	0.538	0.526	1.072	0.863
	MP shock of SW	0.776	0.691	1.074	0.982

*STDs relative to historical STDs

Turning to the alternative rules – and eliminating the monetary policy shock – the Taylor rule, whether based on the model-consistent output gap (TRx) or on output (TRy) as in the CHOICE Act, increases the standard deviation of inflation significantly. TRy leads to a 12% increase in the volatility of the output gap relative to the historical experience, though output volatility declines by 17%. If based on the output gap, the Taylor rule more than doubles the volatility of inflation relative to historical experience, while leaving output gap volatility unaffected and reducing output volatility by 15%. The balanced approach rules (BAx and BAy) generate large increases in inflation volatility while reducing output volatility. The change rules lead to worse outcomes for inflation and the output gap while reducing output volatility. The final two rules, FDy and FDx, are first different rules that include the 4-quarter change in economic activity. Both these rules lead to a large decline in the standard deviation of inflation at the cost of a rise in output gap volatility. However both rules lead to a fall in the volatility of output itself.

This exercise illustrates that even in the absence of model uncertainty, the preferred rule will depend on how policymakers evaluate the trade-off between volatility in inflation and volatility in real activity (and whether policymakers care about output or output gap volatility). For example, assume a standard quadratic loss function given by

$$L^{cb} = (1 - \alpha_z)\,\sigma_\pi^2 + \alpha_z \sigma_z^2, \tag{14}$$

where z is either output (y) or the output gap (x), with $\alpha_z \in [0\ 1]$. Consider first the case in which $z = y$ so that policymakers care about stabilizing fluctuations in output.[33] For each rule in Table 3, (14) can be evaluated as α_z varies from 0 to 1. If $z = y$, the shaded (yellow) region in figure 5 shows the loss defined by the rules in Table 2 as a function of α_y. The lower boundary of the shaded set defines the lowest loss available as α_z varies. For $\alpha_y < 0.4118$, FDx is the efficient rule; it is BAy for $0.4118 \leq \alpha_y \leq 0.9199$ and BAx for $\alpha_y > 0.9199$. Thus, policymakers who place a relatively large weight on stabilizing output would prefer the BAy or BAx rules; those placing less weight on output stability would favor FDx. None of the other rules are efficient. No rule dominates for all α_y.

Figure 6 shows the results when the loss function depends on the volatility of the output gap ($z = x$). A policymaker with a small weight, $\alpha_x < 0.0991$, on output gap volatility would prefer the FDx rule, while one who puts a large weight on output gap stability, $\alpha_x \geq 0.3590$, would prefer BAx. For intermediate values, the historical Smets-Wouter rule is preferred. Again, no rule dominates for all α_x.

Figures 5 and 6 illustrate a challenge in picking among alternative rules, even in the absence of model uncertainty: preferences matter. One criticism of RBP, cited for example in Federal Reserve Board of Governors (2017), is that there are many possible rules and "there is no obvious metric for favoring one rule over another." There is an obvious metric – the value obtained by the objective function – but disagreements about the objective function would make it difficult for a committee such as the FOMC to choose a single rule.

[33] Output in the Smets-Wouter model is a detrended measure. Intrepreting this as output relative to potential, it also corresponds to the measure of activity in the CHOICE Act's Reference Policy Rule.

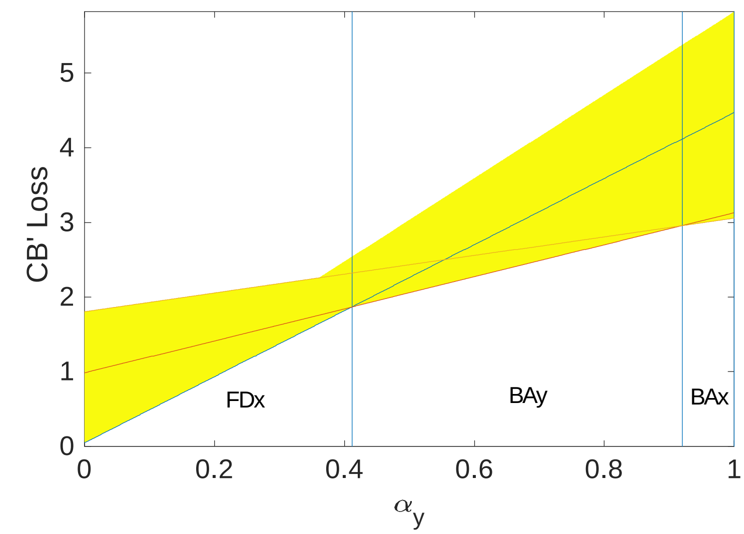

Figure 5: Loss under the rules in Table 2 as a function of the weight placed on output volatility when loss depends on the stadard deviation of inflation and output.

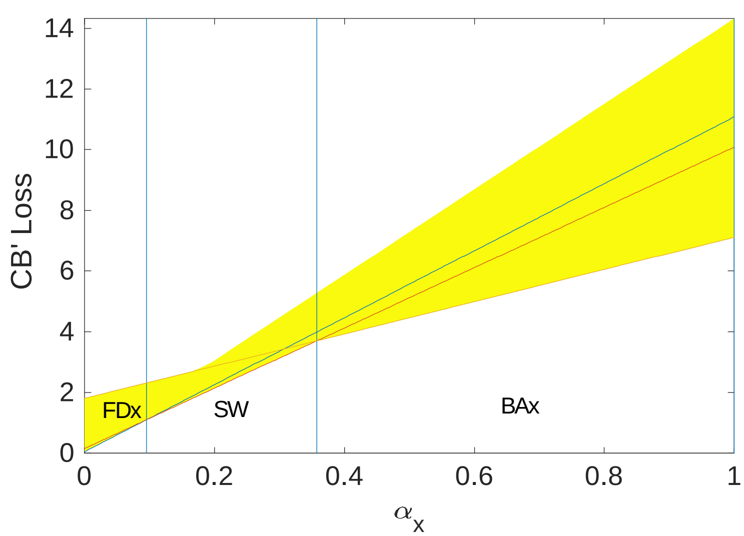

Figure 6: Loss under the rules in Table 2 as a function of the weight placed on output gap volatility when loss depends on the stadard deviation of inflation and the output gap.

5 Implementing a RBP

According to Svensson (2003), the first two steps in implementing a RBP regime involve picking the rule and picking the parameters. Each step involves choices, and therefore challenges which I avoiding in the previous section by adopting the rules in Federal Reserve Board of Governors (2017), together with their parameters. I did have to modify the variables appearing in the rule, replacing an unemployment rate gap measure with either output relative to trend or an output gap measure. The challenges of choosing variables, dealing with measurement issues ranging from data revisions to conceptual debates over how to translate theoretical concepts into measurable quantities are all significant, as are the choices necessary to determine the values of any parameters in the rule. However, if the reference rule is viewed primarily as a communications tool, the requirement that the rule contain verifiable, easily understood variables while being robust to uncertainty can help narrow the set of potential candidate rules.

5.1 Which rule, which variables, and which parameters?

The exercise using the Smet-Wouter model involved rules based on inflation and either output (relative to trend) or the output gap. These rules were all special cases of a generic instrument rule of the form

$$\begin{aligned} i_t &= \rho i_{t-1} + (1-\rho)\left(r_t^* + \pi^T\right) + \alpha\left(\pi_{t/t+h} - \pi^T\right) \\ &\quad + \beta\left(z_{t/t+k_1} - z^*_{t/t+k_1}\right) + \gamma\left[\left(z_{t/t+k_2} - z^*_{t/t+k_2}\right) - \left(z_{t/t+k_2-s} - z^*_{t/t+k_2-s}\right)\right] \end{aligned} \tag{15}$$

where i_t is the policy instrument, $\pi_{t/t+h}$ is the time i forecast of inflation at $t+h$, and $z_{t/t+k_j}$ is the time t forecast of economic activity such as output or unemployment rate at $t+k_j$.[34] The variables r^* and z^* represent the natural real rate of interest and measure of economic activity. If h, $k_j < 0$, then the rule contains lagged realizations of π and z. Notice that this rule assumes an inflation targeting regime; the central bank (or the government) has chosen π^T.

While (15) appears simple, at least relevant to the large amount of information policy-makers routinely consult, it does require choices over 8 dimensions: the choice of variables

[34] See, for example, Orphanides and Wieland (2013), who consider policy rules of this form optimized for various models of the euro area, as well as the optimal rule from a model-averaging perspective (on model averaging, see Brock, Durlauf, and West (2007)).

π and z, definitions and empirical counterparts to r^* and z^*, the forecast horizons (or lagged lengths) h and k, and the values for the inflation target π^T and the parameters ρ, α, β, and γ. Challenges associated with making choices about each of these aspects of the rule, and thereby ultimately deciding on "the rule" are discussed in turn.

There is a large literature that investigates the performance of various versions of (15), and this research has focused on optimal simple rules, issues of robustness in the face of uncertainty, and the role of measurement error. All these issues are extremely relevant in evaluating the ability of a simple rule to serve as a guide to policy. However, a reference rule also serves as a benchmark for ensuring policy transparency and for enforcing accountability. Considerations related to transparency and accountability are relevant for turning (15) into an operational reference rule.

5.1.1 Measuring inflation and economic activity

To begin, a choice must be made about which measure of inflation to include. The original Taylor rule measured inflation using the GDP deflator. The CHOICE Act leaves unspecified the price index used in the reference rule. Kohn (2012) argued that the choice of price index is consequential as the recommendations of the Taylor Rule can depend on which index is used to measure inflation. This argument is echoed in Federal Reserve Board of Governors (2017). Figure 7 shows four common measures of inflation, obtained from the PCE, core PCE, CPI and GDP price indexes. While one can discern common patterns, the divergences in their short-run behavior would provide conflicting signals for policy decisions, depending which was used in the RPR.

On grounds of transparency and consistency with policy goals, however, a case can be made for using PCE inflation. The FOMC's Statement on Longer-Run Goals and Monetary Policy Strategy, first adopted January 24, 2012, defines a goal of 2% inflation "as measured by the annual change in the price index for personal consumption expenditures." The policy goal is defined without excluding food and energy prices; using an alternative measure in a reference rule would not promote alignment between goals and the reference rule. Any other choice would weaken transparency and accountability.

FOMC press statements currently discuss both PCE and core PCE inflation. The FOMC's communications strategy would need to address the distinction between the two measures. For example, PCE inflation exceeded PCE core inflation consistently between 2002:4 and 2006:3. If PCE inflation is used in the rule, the rule might call for a response,

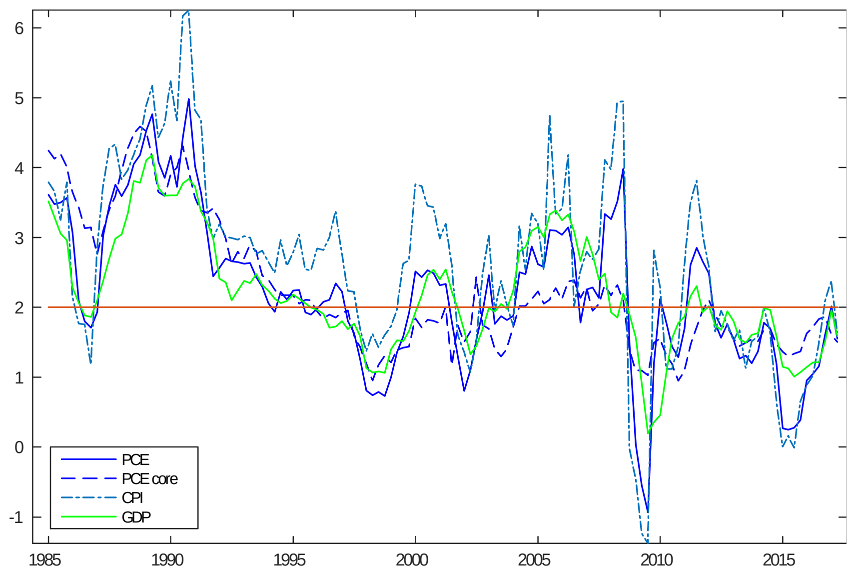

Figure 7: Four measures of inflation (4-quarter percent change).

but if the FOMC's analysis suggests based on core inflation that no reaction is required, the FOMC would need to explain carefully why they were deviating from the rule.

Additional potential problems arise because of data revisions in inflation measures. Figure 8 shows real-time and final (as of July 2017) measures of annual PCE inflation (upper panel) and the difference between the final measure and the real-time measure of PCE inflation (lower panel). These are generally small, but not negligible. Data revisions are often treated as reflecting transitory measurement error, but persistent periods of revisions of the same sign may suggest otherwise. For example, PCE inflation was revised upwards from its initial real-time value every quarter between 2011:4 and 2015:3.

The second key variable in a RPR is a measure of economic activity, and deciding which measure is a more challenging task than choosing an inflation measure. Measurement problems associated with output gaps are well known. The policy errors that arose in the 1970s due to overestimating potential output and consequently underestimating the output gap have been emphasized by Orphanides (2000). See also Rudebusch (2001) and Orphanides and Norden (2002). Boehm and House (2014) show how output gap measurement error has significant consequences for the optimal coefficients in the basic Taylor rule, while Segal (2017) uses a basic NK model to illustrate how alternative

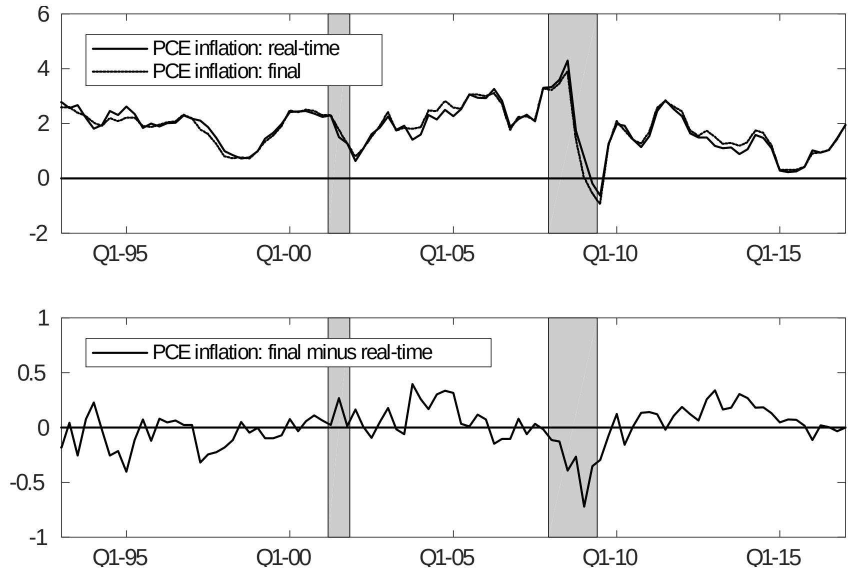

Figure 8: Top panel: PCE inflation as measured in real-time (solid line) and as of July 2017 (dashed line). Lower panel: final minus real-time PCE inflation.

measures of an output gap based on alternative detrending methods (HP, linear) can be weakly correlated (or even negatively) with the true model-based output gap.[35]

These measurement issues provide one rationale for using a measure of cyclical fluctuations in economic activity based on unemployment; its use avoids the major measurement issues associated with output gap measures. All 5 rules in Federal Reserve Board of Governors (2017), for example, are based on inflation and an unemployment rate gap u_t^{gap}.[36] The unemployment rate gap is defined as the total civilian unemployment rate minus an estimate of the long-run unemployment rate u_t^L. The latter, like measures of potential output or flexible-price output, is not directly measured. However, the Congressional Budget Office provides an estimate (former called the NAIRU). Because u_t^L is produced by an agency independent of the Federal Reserve which makes its data easily available, it provides a transparent, rulable variable on which a reference rule could be based. It is, however, subject to revision, and so the real-time estimate of long-run unemployment

[35] Output in DSGE models is often measured by real GDP detrended using an HP-filter. The title of Hamilton (2017) makes clear his conclusion that it is inappropriate to employ the HP-filter to uncover the cyclical component of GDP. Thus, it is not just the output gap that causes measurement issues, but output as well.

[36] A number of papers have utilized rules based on unemployment. See, for example Orphanides and Williams (2007). See also Rudebusch (2010) and Nechio and Rudebusch (2016).

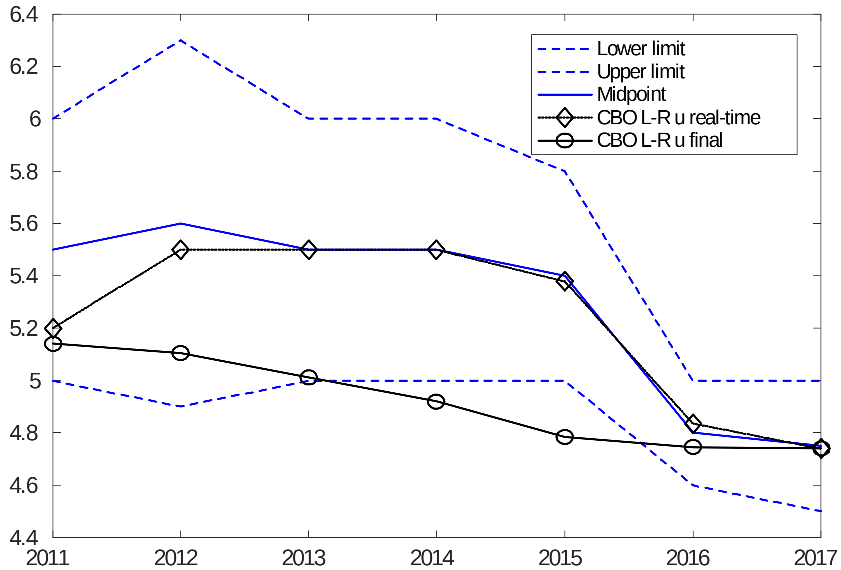

Figure 9: The upper, lower, and midpoint of FOMC projections for the unemployment rate in the longer run. Real-time CBO estimates of the longer-run unemployment rate are shown by diamonds; final (as of Jan. 2017) estimates indicated by circles.

can provide a misleading performance measure when used to assess monetary policy.

Figure 9 shows the mid-point, together with the upper and lower limits, of FOMC members' projections of the unemployment rate in the longer-run. The mid-point tracks the CBO real-time estimate (the line with diamonds) closely, but significant revisions in u_t^L have occurred, and the estimates of u_t^L based on the January 2017 CBO estimates are shown as circles. For example, the average downward revision in the estimate of the longer-term unemployment rate from its initial real-time estimate averaged just under a half percentage point in each year between 2012 and 2015.

Figure 10 shows the real-time and final estimates of the unemployment rate gap. During the run up to the dot-com crash and the recession of 2001, the COB's real-time estimate of the underlying long-run unemployment rate was subsequently reduced down. As a consequence, the real-time estimate of u^{gap} was below the final estimate. The root mean square errors between the initial and final values are small (root mean square revision is almost 14 basis points), but on occasion, revisions have been large and persistent. For example, the unemployment rate gap was revised upwards between 2012 and 2015 due to downward revisions of the estimated long-run employment rate as seen

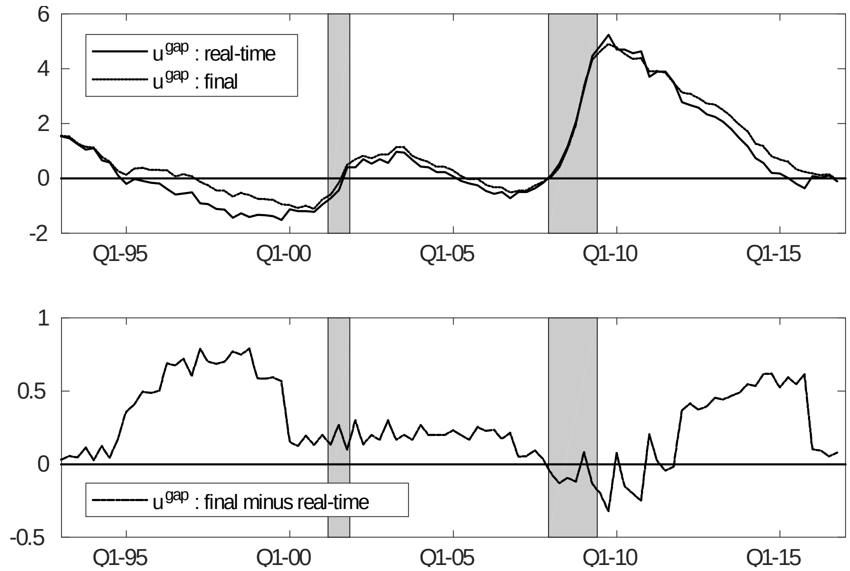

Figure 10: Upper panel: u^{gap} based on real-time data (solid line) and final data (dashed line) as of July 2017. Lower panel: The difference between the final and real-time estimates of u^{gap}.

in figure 9.

Differencing is a method that can reduce measurement error, a point made with respect to the output gap by Walsh (2009) and consistent with policy rules that include changes in the output gap or changes in output relative to potential as in, for example, Orphanides and Wieland (2013). The first-difference rule in Table 2 includes the 4-quarter change in the unemployment rate gap. This significantly reduces the effects of data revisions, as can be seen in figure 11. The lower panel shows the revisions, using the same scale as used in figure 10, illustrating how differencing ameliorates the problem of data revisions (The root mean square revision is less than 1 for the four-quarter change in the unemployment rate gap).

The fact that an unemployment rate gap (or its change) may be subject to smaller measure errors and revisions than output gap measures does not mean it is the correct measure of economic activity. The underlying long-term unemployment rate is not the correct theoretical welfare gap measure as it does not capture short-run fluctuations in unemployment that may be the result of real factors and to which it may be inappropriate for monetary policy to respond. Levin (2014) has suggested the employment gap rather

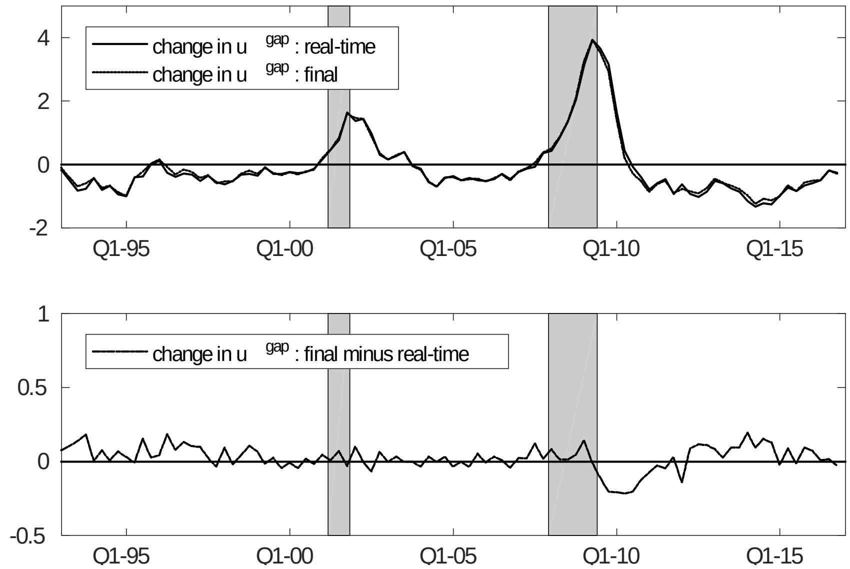

Figure 11: Upper panel: $u_t^{gap} - u_{t-4}^{gap}$ based on real-time data (solid line) and final data (dashed line) as of July 2017. Lower panel: The difference between the final and real-time estimates of $u_t^{gap} - u_{t-4}^{gap}$.

than the unemployment gap may be a better measure of economic slack, while Ravenna and Walsh (2011) show that a labor market tightness gap is the correct welfare measure. If the purpose of the reference rule is to promote transparency to the general public, however, the unemployment rate has the advantage of being already widely used to gauge the state of the labor market.

If transparency points towards a PCE measure of inflation and the unemployment rate gap as a measure of economic activity in (15), a key decision must be made before this generic rule could serve as a reference rule; should the rule include unobservables such as such as r_t^*? As discussed earlier, including such variable is problematic in term of transparency and accountability. Yet the Fisher equation highlights the importance of r_t^* for getting the level of the policy rate right.

Orphanides and Williams (2002) found that increased uncertainty about r_t^* calls for a more inertial instrument rule, one that becomes a first-difference rule with $\rho = 1$ such as

$$i_t - i_{t-1} = \alpha \left(\pi_t - \pi^T\right) + \gamma \left[(z_t - z_t^*) - \left(z_{t-s} - z_{t-s}^*\right)\right], \; s > 0, \tag{16}$$

when uncertainty becomes very high. Hamilton, Harris, and West (2015) also conclude

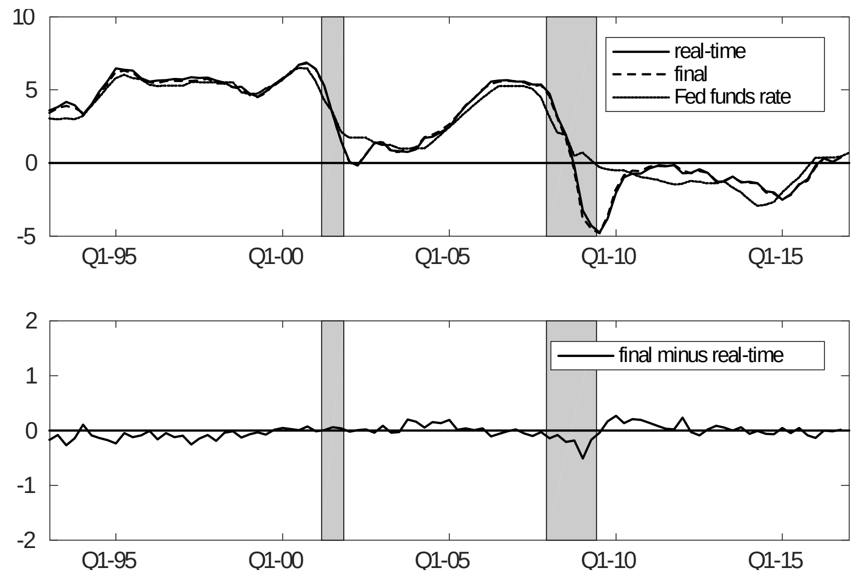

Figure 12: Upper panel: The funds rate implied by the first-difference rule (17) based on real-time (dashed line) and final data (solid line). The black solid line is the funds (shadow) rate. Lower panel: The deviation between the final and real-time values from the rule. Wu-Xia shadow rate is used for 2009-2015.

that greater inertia is called for when uncertainty about r_t^* increases. (16) is the first-difference rule in Federal Reserve Board of Governors (2017) with the change in $z_t - z_t^*$ measured by the 4-quarter change in the unemployment rate gap, $\alpha = 0.5$ and $\gamma = 1$:

$$i_t = i_{t-1} + 0.5\left(\pi_t - 2\right) - \left(u_t^{gap} - u_{t-4}^{gap}\right). \tag{17}$$

The upper panel of figure 12 shows the nominal rate given by (17) using the real-time date (solid line) and the final data (dashed line). The deviation between the two is shown in the lower panel. Even the persistent over-estimate of long-run unemployment and therefore under-estimate of the unemployment rate gap between 2012 and 2015 seen in figure 10 results in only a small difference in the rate implied by the rule.

While choosing a reference rule is a challenge in a RBP regime, a rule such as (17) would be a leading candidate, based on grounds of transparency and the relative small effect of real-time measurement errors. The definition of inflation is consistent with the FOMC's longer run goals, and the unemployment rate gap is likely to be more easily explained to the public than model-based notions of output gaps. The first-difference form has been shown to be appropriate as uncertainty about r_t^* increases.

First-difference rules such as (16) that incorporate the change in the unemployment rate (or an unemployment rate) have been found to be robust by several authors, for example, Levin, Wieland, and Williams (1999) and Orphanides and Williams (2002). This conclusion is supported by the findings of Tetlow (2015), who investigates the robustness of various rules across different generations of the FRB/US model. Orphanides and Wieland (2013) find that first-difference rules (based on output) perform well across a variety of euro-area models.

In addition, the first-difference form introduces inertia in a manner that offsets to some degree the stabilization bias of discretion, a topic I on which have not focused.

A first-difference rule would also facilitate communicating policy decisions to the public, as much of the media coverage of FOMC meetings focuses on whether the policy rate will be raised, lowered, or left unchanged. Fischer (2017) notes that the FOMC's "decision is typically whether to raise or reduce the federal funds rate or to leave it unchanged." (p. 2) Thus, for ease of communications and transparency a rule of the form given by (17) has several advantages.

What lessons can be drawn from this discussion? A role of a reference rule is to promote transparency about policy; the variables in the rule need to be linked to the ultimate goals of policy and to be understandable to the general public. These considerations, together with a recognition of the unverifiable and uncertain nature of critical variables such as the equilibrium real interest rate suggest a rule like (17) might be a plausible candidate for a reference rule. But even if one accepts the form of such a rule, or some alternative, the challenge of picking the parameters still remains.

5.2 Which parameters?

There are three options for picking the parameters in the rule: 1) pick parameter values to maximize an objective function; 2) used values estimated from historical data, perhaps from a period during which policy was viewed as successful; or 3) calibrate the parameter values.

5.2.1 Optimized parameters

Several challenges arises when optimized parameters are considered. First, an optimal rule can only be defined with respect to an objective function and a model or set of models. Second, rules optimized for one model often are not robust, performing poorly in alternative models. Third, even if there is agreement on the correct model and objectives, optimized parameters depend on the exogenous processes assumed to characterize disturbances (simple rules do not satisfy certainty equivalence), and these processes may well vary over time. Fourth, they will depend on measurement error which is likely to vary over time. Fifth, they depend on the definition of the variables in the rule. And sixth, optimal responses to inflation and the measure of economic activity may not be unique.

The first five issues are well known. Rules optimized for a specific model can do very poorly in alternative models. Levin and Williams (2003) provided an early example of this result. Orphanides and Wieland (2013) provides an analysis of how model-specific optimal instrument rules lead to poor results if the true model differs from the one for which the rule is optimized. They adopt a model averaging approach to seek robustness to obtain an optimal simple rule. Tetlow (2015) also finds optimized rules are often not robust across vintages of the same model.

The 3rd and 6th issues can be illustrated using a basic NK model, following the analysis of Boehm and House (2014). They study the optimal coefficients in a Taylor rule that includes inflation and the output gap when the economy is subject to demand and cost shocks as well as measurement error. The objective of policy is to minimize a quadratic loss function in inflation and the output gap.

Boehm and House (2014) show that when only r_t^* shocks are present, its effects on inflation and the output gap can be neutralized if the rule response coefficients go to infinity.[37] In the presence only of cost shocks, Boehm and House (2014) show that the efficient trade-off between inflation and the output gap in the face of cost shocks is achieved if

$$\psi_\pi = \rho_u + \frac{\kappa \left[\sigma\left(1-\rho_u\right)+\psi_x\right]}{\lambda\left(1-\beta\rho_u\right)}, \tag{18}$$

where ψ_z is the policy response to variable z, and ρ_u is the serial correlation coefficient for the cost shock. Thus, the optimal response coefficients are not unique. The optimal coefficients are also model dependent and are functions of the structural equations and their parameters. They also depend on policy preferences through λ, the relative weight placed on output gap volatility relative to inflation volatility in the objective function.

[37] Equivalently, absent cost shocks and productivity shocks, an inflation nutter succeeds in stabilizing inflation and the output gap.

In this same model, suppose that cost shocks and productivity shocks are present, both are i.i.d., and the rule calls for reacting to output rather than the output gap. In this case, (18) is replaced by

$$\psi_\pi = \frac{\kappa\left(\sigma + \psi_y\right)}{\lambda}\left[1 + a^2\left(\lambda + \kappa^2\right)\frac{\sigma_z^2}{\sigma_u^2}\right], \tag{19}$$

where σ_z^2 and σ_u^2 are the variance of productivity and cost shock innovation. An increase in the variance of shocks to productivity require, for given ψ_y, that the response to inflation increase. Optimal responses depend on the characteristics of exogenous stochastic processes which may vary over time.

Arguments of transparency argue against parameters that are optimized, either for a single model or for any models. The resulting parameter values will be difficult to explain to the public and so cuts against the use of a rule for communicating policy to the public. Of course, model specific, optimized rules would be among the rules policymakers might employ as inputs into the policy process. But they would be too difficult to explain and rationalize to the public to serve as reference rules.

5.2.2 Estimated rules

If optimized rules are too model dependent, lack robustness and are unverifiable by the public, an alternative is to use rules estimated over a period that was characterized by successful monetary policy. The estimated response coefficients would capture the systematic response of the policy rate to movements in a small set of macroeconomic variables.

Correlations among the policy rate and the variables in the rule, and so therefore the estimated coefficients, will depend on the nature of the shocks that occurred during the sample period as well as on the policy objectives being pursued. And unfortunately, coefficients obtained by estimating simple rules are unlikely to capture good policy behavior except in very special circumstances.. A simple example will illustrate this.

Consider a basic new Keynesian model, and suppose monetary policy has implemented the optimal discretionary policy. Assume the policymaker's objectives are not distorted, so that the only inefficiency associated with the policy is the stabilization bias imparted by discretion. In this case, if e_t is an inflation shock given by $e_t = \rho e_{t-1} + u_t$, with u_t a white noise innovation, and r_t^* is the stochastic natural real interest rate with sample mean r^*, the equilibrium behavior of the nominal rate can described by

$$i_t = r_t^* + \left[\sigma\left(1-\rho\right)\frac{\kappa}{\lambda} + \rho\right]\hat{\pi}_t.$$

Suppose one used data from this economy and estimated

$$i_t = a + b\hat{\pi}_t. \tag{20}$$

The estimate of a will capture the sample mean of r_t^*, b will be a consistent estimate of $\sigma\left(1-\rho\right)\left(\kappa/\lambda\right) + \rho$ because $\hat{\pi}_t$ and r_t^* are uncorrelated (optimal policy insulates $\hat{\pi}_t$ from r_t^* shocks), and the regression residual will be a consistent estimate of $r_t^* - r^*$.

But now suppose the residual from the estimated rule is interpreted as "discretionary unsystematic" policy and the policymaker is instructed to follow only the systematic part of the estimate rule, i.e., to set $i_t = a + b\hat{\pi}_t$. In this case, the response coefficient on inflation is correct in that it will lead to the same effects of cost shocks on inflation and the output gap as under the optimal policy, but overall outcomes are unambiguously worse under the rule, as both inflation and the output gap will now be affected by shocks to r_t^*. It may in fact be the deviations from the rule that were responsible for much of the contribution of policy to ensuring good macro outcomes by offsetting the effects of shocks such as r_t^* during the sample period.[38]

There is another problem with estimated policy rules. Suppose the sample period had not experienced any shocks to r_t^*. In this case, the estimated equation (20) may have a good in-sample fit and therefore appear to match actual policy quite well. However, relying on such an estimated rule in an era in which r_t^* shocks become important would lead to avoidable fluctuations in inflation and the output gap.

The dangers of interpreting regressions involving a policy variable and other macro variables have been known since the debates between Friedman and Meiselman (1963) and Modigliani and Ando (1976), though in that case, the issue involved regressing macro outcomes on policy variables rather than the reverse. If the policy instrument is adjusted to insulate the macro variable from shocks, the regression coefficient on the policy variable will be systematically biased towards zero. In estimating an equation such as (20), one may fail to capture the entire reason the sample period exhibited good macro outcomes.

[38] Because, under the policy assumed to be conducted during the sample period, the output gap and inflation would be perfectly (negatively) corelated, adding the output gap to the estimation equation adds no additional information.

5.2.3 Calibrated rules

Given problems with optimized rules and estimated rules, it is not surprising that the parameters in simple rules are often calibrated. For example, the parameters in the rules considered in Federal Reserve Board of Governors (2017) are all calibrated, as was (17) used to construct figure 12. Coefficients are often assigned to capture some sense of the relative importance of inflation and employment objectives in the views of policymakers. For example, the rule described as a "balanced approach" rule assigns greater weight to the output gap than does the original Taylor rule. However, whether adjusting the relative weights on inflation and the measure of economics activity is a means of reflecting their relative importance in policy objectives depends on the nature of the economic disturbances facing the economy. For example, in the model of Boehm and House (2014), suppose r_t^* shocks are the only source of fluctuations. Then $\sigma_\pi^2/\sigma_x^2 = \left[\kappa/\left(1-\beta\rho_r\right)\right]^2$, so the relative volatility of inflation and the output gap is independent of the parameters in the Taylor rule.

To investigate further the consequences of alternative calibrations, consider the effects in the Smets-Wouter model with a first-difference rule of the form

$$i_t = i_{t-1} + 0.5\left(\pi_t - 2\right) + \gamma\left(y_t - y_{t-4}\right). \tag{21}$$

Okun's Law would suggest that $\gamma = 0.5$ would correspond roughly to the rule (17) expressed in terms of an unemployment rate gap. Table 4 shows the effects in the Smets-Wouter model of setting $\gamma = 0.25$, 0.5, and 1.[39]

[39] The $\gamma = 0.5$ case corresponds to the FD rule in Table 3.

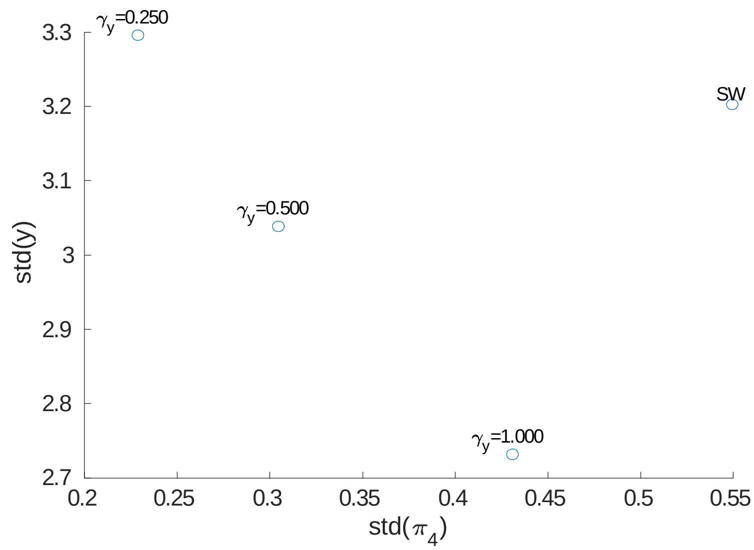

Figure 13: Standard deviation of output and inflation for different values of γ_y in the 1st-difference rule.Values under the SW policy rule are also shown.

Table 4: Standard deviations* with (21)

Rules	MP shock	$std(r_t)$	$std(\pi_{4,t})$	$std(x_t)$	$std(y_t)$
SW	With MP shock	1.000	1.000	1.000	1.000
	No MP shock	0.863	0.953	1.023	0.924
$\gamma = 0.25$	With MP shock	0.511	0.396	1.203	0.951
	No MP shock	0.814	0.562	1.213	1.108
$\gamma = 0.5$	With MP shock	0.626	0.528	1.148	0.877
	No MP shock	0.859	0.674	1.135	0.985
$\gamma = 1$	With MP shock	0.810	0.747	1.081	0.788
	No MP shock	0.987	0.885	1.058	0.855

*STDs relative to historical STDs

Figure 13 plots the standard deviations for inflation and output under (21). A larger weight on the output term in the rule reduces σ_y and increases σ_π. Different calibrations of γ lead to the expected trade-off between stabilizing output and stabilizing inflation. Thus, the choice of γ will depend on preferences. Note also that when $\gamma = 0.5$ or 1, the first-difference rule dominates the SW estimated rule.

Theory suggests it is the output gap that is relevant for welfare. Figure 14 plots σ_x

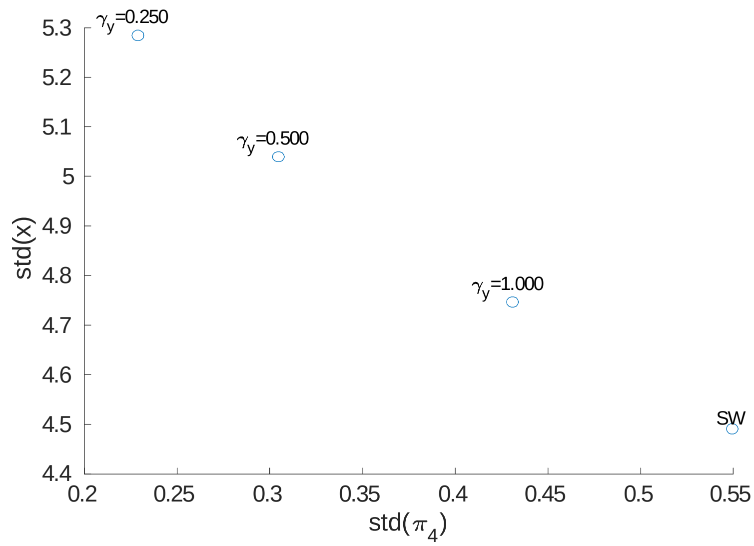

Figure 14: Standard deviation of the output gap and inflation for different values of γ_y in the 1st difference rule. Values under the SW policy rule are also shown.

and σ_π outcomes under (21). No rule dominates, and the historical estimated rule SW would be preferred by a policymaker who places a large value on stabilizing the output gap.

Another perspective on the choice of parameters is provided by figure 15. It shows the unemployment rate gap rule (17) for the baseline coefficient of 1 on $u_t^{gap} - u_{t-4}^{gap}$ as well as a for a smaller coefficient (0.5) and a larger one (2). the solid line in each panel is the change in the funds rate implied by the rule. This change is decomposed into the component based on inflation relative to 2% (the blue bars) and the component due to the change in the unemployment rate gap. Since the coefficient on $\pi_t - 2$ is fixed at 0.5, the blue bars are the same in each panel. It is interesting to look at the differences in 2015 and 2016. With a small weight on the unemployment gap terms (top panel), the rule calls for interest rate cuts during this period as inflation was consistently below the 2% target. In contrast, the bottom panel, which employs a much larger weight on the unemployment term, has consistently recommended rate increases since 2011 as the unemployment rate gap was shrinking over this period. In other words, the choice of a rule imbeds policy preference; it is not independent of those preferences.

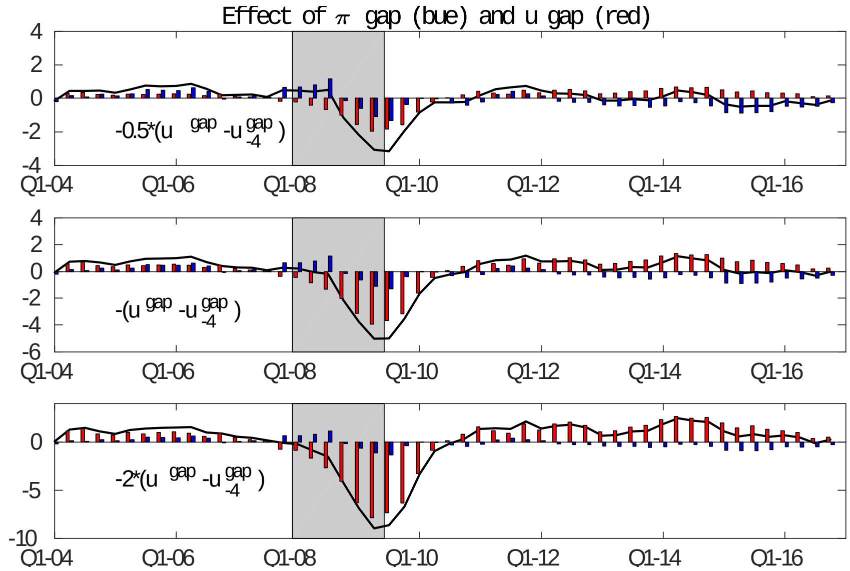

Figure 15: Solid line: change in the funds rate implied by the first-difference rule for different coefficients on the change in the unemployment gap. Based on real-time data.

6 Conclusions

Inflation targeting in practice means flexible targeting, and flexible rule-based regimes should be the way RBP regimes are viewed. A challenge is determining how flexible the regime should be. The stricter the regime, the more stabilization policy is potentially distorted, the less distortionary preference shocks affect inflation and economic activity, and the more the rule frames policy debates. These can be positive developments, or negative ones if there is an important role for stabilization that is not captured by the small set of variables in a rule or if policy biases are small. Empirical estimates of the gains from stabilization policies and the costs of unconstrained discretion are needed if RBP regimes are to be properly evaluated.

Under a flexible RBP, policymakers can still consult the same wide range of information as is done by inflation targeting central banks. Deviations from the rule were shown to themselves follow a rule, which was derived for the basic NK model. The reference rule can serve as one input into the decision making process, but it would need to be the primary communications tool of the central bank. If it is to promote transparency, the rule cannot include model dependent variables such as forecasts or unobservable theoretical concepts such as the natural equilibrium real rate of interest. Such variables are non-rulable.

Importantly, the choice of a rule cannot be made independent of a clear specification of objectives. If a committee such as the FOMC must pick the rule, different members will favor different rules if the weights they place on policy objectives differ. Members might agree on the longer run objectives of policy, allowing them to reach consensus on the target rate of inflation, but choosing a rule would be more of a challenge as it forces members to make an explicit choice about short-run trade-offs. If members also have different preferred models, the possibility of reaching agreement would be even more difficult. Research into committee decision making would be useful to better understand whether a committee such as the FOMC (a) could agree on a rule that would aid in promoting transparency and public understanding of policy decisions, and (b) whether attempting to agree on a rule would result in a sensible rule that aggregates policymakers' preferences and disagreements over model.

Assessing the credibility of the central bank's commitment is likely to be more difficult in a RBP regime than it is under inflation targeting. If non-rulable variables such as the equilibrium real interest rate are subject to permanent shifts, then under a rule for the level of the policy rate, either expectations of the future policy rate will converge to the rule or expected inflation will converge to the target. If the inflation goal is paramount, then convergence to the rule is not credible; the rule must change. A process for evaluating and changing the rule in a public and transparency manner must be a part of any RBP regime – a rule for changing the rule is needed. And if shocks to the equilibrium real rate are persistent yet ultimately transitory, then a stricter RBP regime increases the volatility of expected future inflation around its target.

Rule-based systems focus attention on the rule and away from the goals of policy. Yet clarity on the goals is required to evaluate any rule. During the early 1980s, the FOMC faced a conflict between a rule and a goal. The FOMC first began to announce growth rate targets for M1 following the passage of House Concurrent Resolution 133 in 1975. It continued to announce M1 growth rate targets until 1984. This earlier attempt to impose a rule on the FOMC as a means of achieving the goal of lowering inflation is instructive for illustrating the challenges of rule-based policy regimes. Critics of the Fed argued that the Fed effectively undercut the intent of Congress's attempt to rein in money growth by engaging in practices such as base drift, regardless of whether the

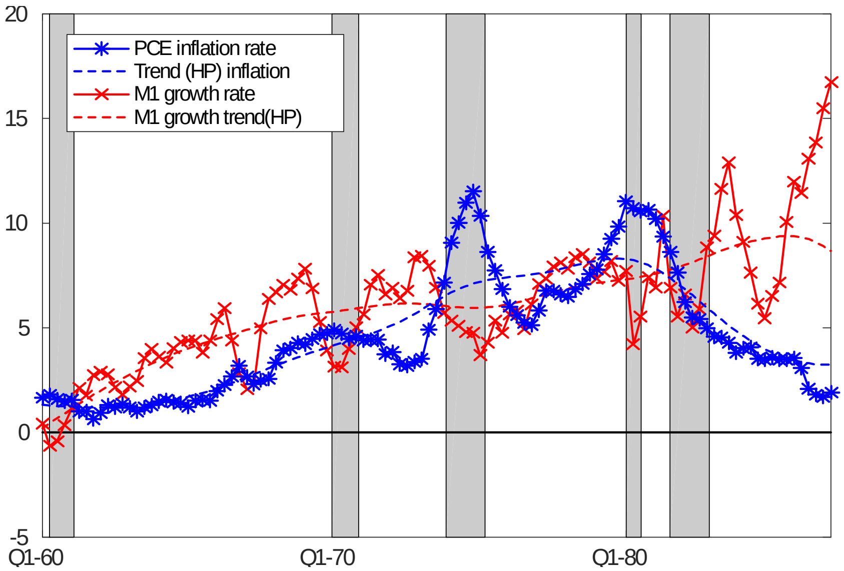

Figure 16: PCE inflation (blue line) and M1 growth rate (red dashed line). Dashed lines are HP trends, showing how trend money growth and trend inflation diverged in the early 1980s.

previous growth path had been exceeded or fallen short of target.[40] The Fed was thus able to avoid responsibility for controlling medium-term money growth. More importantly, the empirical relationship between money growth and inflation broke down, as shown in figure 16. Between January 1982 and January 1987, M1 grew at an average annual rate of 9.8%, PCE inflation average just 3.8%. The FOMC, fortunately, abandoned any pretence of targeting M1 growth in 1984, marking the beginnings of the Great Moderation.

The episode of the early 1980s is a reminder of the dangers of focusing on an instrument (or an intermediate target variable) rule rather than on the actual goals of policy. With a level rule, shifts in the equilibrium real interest rate alter the longer-run connection between the level of the nominal policy rate, inflation, and economic activity. This was exactly the problem with monetary growth targeting, as the linkage between money growth and inflation was subject to random shifts. And medium-term accountability is not achieved because a RBP regime lacks the direct connection between the performance measure – adhering to the rule – and the ultimate goals of monetary policy.

[40] See Walsh (1986).

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