CHAPTER THREE

Goals versus Rules as Central Bank Performance Measures

Carl E. Walsh

On December 20, 1989, the New Zealand Parliament gave unanimous approval to the Reserve Bank of New Zealand Act of 1989, thereby formally inaugurating the world's first inflation-targeting regime. The Act also launched a global wave of central bank reforms that have clarified the policy responsibilities of central banks, increased their independence, and provided clear measures of accountability against which their performance could be judged. These reforms have also promoted a greater level of transparency, transforming the way many central banks communicate their policy decisions and signal their future policy intentions. In general, accountability in inflation-targeting regimes is strengthened by the public nature of the announced target and by the requirement that the central bank produce inflation reports or otherwise explain policy actions and their consistency with the announced target. Achieving the target becomes a measure of the central bank's performance.

A central bank's performance measure—the observable variable (or variables) by which the public and elected officials can judge

This chapter is based on C. E. Walsh, "Goals and Rules in Central Bank Design," *International Journal of Central Banking*, September 2015, from which three sections are reprinted. I would like to thank participants at the Reserve Bank of New Zealand and International Journal of Central Banking Conference, "Reflections on 25 Years of Inflation Targeting," Wellington, New Zealand, December 1–2, 2014, and the Central Bank Governance and Oversight Reform Policy Conference at the Hoover Institution, May 15, 2015, as well as seminar participants at the Norges Bank, for their comments and suggestions.

whether the central bank has acted in a manner consistent with its charter—does not need to be based on an ultimate goal of monetary policy such as inflation. A central bank could be assigned and held accountable for achieving targets that are not themselves among the final goals of monetary policy. For example, in the 1970s, the US Congress required the Federal Reserve to establish target growth rates for the money supply. Money growth rates are intermediate targets, neither an ultimate goal of policy nor something directly controlled as an instrument.

Another alternative would be to judge the central bank's performance by comparing the central bank's instrument to the value prescribed by a legislated instrument rule. In fact, the US House of Representatives and Senate have recently held hearings on bills that would establish an interest rate rule, with the Fed required to justify deviations of the federal funds rate from the rule.[1] The rule plays the role of the central bank's performance measure. Taylor (2012) illustrates how an instrument rule can be used to assess *ex post* the Federal Reserve's policy.

Performance measures can differ, therefore, in terms of whether they focus on ultimate goals of macroeconomic policy while allowing for instrument independence, as is the case with inflation targeting, or whether they limit the instrument independence of the central bank, as would be the case with a legislated instrument rule. Both inflation targeting and other goal-based regimes such as price-level targeting, speed limit policies, and nominal income targeting frameworks have been extensively analyzed in the litera-

1. Hearings were held in July 2014. According to the *Financial Times* report on Janet Yellen's February 25, 2015, testimony before the US House Banking Committee, "the Fed chair swatted down calls from Republicans for the institution to be subject to mechanical rate-setting rules, saying she did not want its discretion to be 'chained'." See Sam Fleming, "Janet Yellen defends US central bank independence," *Financial Times*, Feb. 15, 2015. See also John Taylor's recent testimony before the House Subcommittee on Financial Services (July 22, 2015) in support of a rule-based strategy.

ture.[2] However, a similar analysis of regimes that base accountability on adherence to an instrument rule is absent from the literature, a gap the present paper seeks to fill.

Of course, there is a huge literature that studies the role of Taylor rules, and variants of Taylor's original rule have become a standard method of specifying monetary policy in both theoretical and empirical models. Simple rules have played a large role in the literature on policy robustness (e.g., Levin and Williams 2003 and Taylor and Williams 2010). Ilbas, Røisland, and Sveen (2012) consider model uncertainty and show that including deviations of the policy rate from a simple rule can improve macroeconomic outcomes, allowing the central bank to cross-check its policy against a rule that is potentially robust across a variety of different models. However, they ignore any distortions to the central bank's objectives over inflation and the output gap that might arise from political pressures on monetary policy. These distortions play a central role in my analysis, while I ignore model uncertainty.

Tillmann (2012) is closest to the present paper in that he considers outcomes under discretion when the central bank minimizes a loss function that differs from social loss by the addition of a term reflecting deviations of the policy rate from the rate implied by a simple Taylor-type rule.[3] He finds that some weight should be placed on this new term when inflation shocks are serially correlated, a result similar to that of Clarida, Galí, and Gertler (1999),

2. To cite just three examples, Vestin (2006) provides an early analysis of price-level targeting; Walsh (2003b) compares price level targeting, output gap growth rate (speed-limit) policies, and nominal income policies; and Billi (2013) studies nominal income policies in the face of the zero lower bound on nominal interest rates.

3. The monetary policy loss function incorporated into the Norges Bank's DSGE model (N.E.M.O.) actually includes a term of the form $(i_t - i_t^*)^2$ that penalizes deviations of i_t from a reference interest rate i_t^*. Previous versions of N.E.M.O. set i_t^* equal to the value given by a simple instrument rule. Currently i_t^* is equal to the "normal" nominal interest rate, defined as the rate consistent with inflation equal to target and a zero output gap. This term is intended to add an implicit weight on financial imbalances in policy determination. See Lund and Robstad (2012) and Evjen and Kloster (2012).

who found a role for a Rogoff conservative central banker in a new Keynesian model only when inflation shocks were serially correlated. Walsh (2003a) shows that it can be optimal to place additional weight on inflation even when shocks are serially uncorrelated in the face of political distortions that cause the central bank's objectives to differ from those of society. These distortions generate a rationale for performance measures that is absent from the work of Tillmann (2012).

The rest of the paper is organized as follows. The section on Goals, Rules, Independence, and Accountability discusses the distinction between goal-based and rule-based performance measures. An important distinction that arises is whether central bank reform is designed to constrain the central bank or to constrain the government. In the section on The Performance of Goal-Based and Rule-Based Regimes, I employ a simple model to compare two forms of reform. The first (and standard) approach emphasizes the assignment of an inflation goal; the second approach uses an instrument rule to assess the central bank's performance. The simple model allows analytic results to be derived. To evaluate the alternatives in a more realistic setting, an estimated model incorporating sticky wages and sticky prices is used in the section on Goals and Rules in an Estimated Model with Sticky Prices and Wages. The final section includes Extensions and Conclusions.

Goals, Rules, Independence, and Accountability

Central bank reforms over the past twenty-five years have been aimed at removing, or at least reducing, causes of poor monetary policy outcomes. Three causes of poor policy have been emphasized in the literature. First, short-term political pressures, often related to a country's election cycle, can distort policy decisions, resulting in an emphasis on near-term economic activity at the cost of longer-term objectives. Given that monetary policy oper-

ates with long lags, a central bank buffeted by short-term political pressures might have difficulty in achieving longer-term objectives, including low and stable inflation. And, if monetary policy has its primary effects on inflation through its influence on real economic activity, expansionary policies would first produce an economic boom, with inflation coming only later. This potentially creates an incentive for politicians to pressure central banks for expansionary policies timed to election cycles; a boom leading up to an election would benefit incumbents, while the inflationary costs would only be incurred later.[4] Such pressures would be incompatible with maintaining low and stable inflation.

Second, real economic distortions cause inefficiencies that can create a systematic bias toward expansionary policies. For example, in standard new Keynesian models, monopolistic competition in goods and/or labor markets means the economy's level of economic activity in a zero-inflation environment is too low relative to its efficient level. While monetary policy can attempt to close this gap in the short run by deviating from a policy of price stability, it cannot systematically and sustainably close it. Attempts to do so will ultimately fail, leaving the economy with excessively volatile inflation. Distortions arising from real economic inefficiencies and those due to political pressures on central banks may be related; the presence of real distortions may explain why politicians seek to pressure central banks to engage in expansionary policies.

Third, even in the absence of political pressures or attempts to use monetary policy to achieve unachievable objectives, policymakers may lack the ability to commit credibly to future policies, leading to inefficient intertemporal policy responses to distortionary shocks. Distortions resulting from discretionary policy played a large role in the academic literature seeking to explain why

4. An extensive coverage of political business-cycle models can be found in Drazen (2000).

political pressures or the pursuit of unachievable objectives would lead to undesirably high inflation.[5] In the Barro-Gordon framework used to investigate the inflation bias of discretion, removing short-term political pressures and assigning achievable goals to the central bank also succeeded in eliminating the distortion due to discretion. However, in new Keynesian models, with their emphasis on forward-looking expectations, discretion continues to produce inefficient outcomes even in the absence of political pressures or unsustainable goals.

Given these three potential sources of policy distortions, what central banking reforms might lead to improved monetary policy outcomes? I focus on two alternatives, both of which can be viewed as establishing a performance measure for the central bank that is used to assess policy outcomes. Performance measures provide metrics based on observable variables for evaluating the central bank's policy choices.[6] The definition of the performance measure is an important aspect of central bank reform; it affects the central bank's incentives and provides the basis for ensuring accountability in the conduct of policy.

Inflation targeting is the primary example of a reform that establishes a performance measure based on an ultimate goal of policy. The second type of reform emphasizes rules, with adherence to a rule the basis for assessing the central bank's performance. In either case, the power of the performance measure indicates how important the measure is in the overall assessment of policy. For example, a strict inflation-targeting regime in which the central bank is instructed to care only about achieving the target is an example of a high-powered regime.

5. See chapter 7 of Walsh (2010) for a survey of the literature on the inflation bias resulting from discretionary policies in models based on the time-inconsistency of optimal policy analysis of Kydland and Prescott (1977) as applied to monetary policy in the framework of Barro and Gordon (1983). See also Cukierman (1992).

6. For the theory of performance measures, see Baker (1992), Baker, Gibbons, and Murphy (1994), and Frankel (2014).

The model of reform provided by the 1989 Reserve Bank of New Zealand Act and the associated Policy Targets Agreement between the central bank and the government was one that focused on an ultimate goal, a goal achievable by monetary policy. It essentially created a contract between the elected government and the central bank designed to affect the policy choices of the Reserve Bank by altering the incentives of both the government and the central bank.[7] Incentives were affected by publicly establishing a clear policy goal, assigning responsibility for achieving it to the Reserve Bank, and establishing a system of accountability based on the goal. The elected government could alter the bank's goal by changing the Policy Targets Agreement, but this had to be done in a public manner, and the government could not interfere in the implementation of monetary policy. The Act, together with the Policy Targets Agreement, created a performance measure for the Reserve Bank; it was to be evaluated on the basis of the consistency between its policy actions and the achievement of its inflation target.

The public nature of the goal helped insulate the central bank from political pressures; by granting the Reserve Bank a high level of instrument independence to implement policy, the Act further limited the scope for short-term political factors to influence policy decisions. Thus, a key characteristic of the reform was to constrain elected governments from influencing the implementation of monetary policy.[8]

While greater independence may shield monetary policy from political influences, it cannot ensure policy is only directed toward

7. Walsh (1995b) and Walsh (1995a).

8. Important papers on this relationship include Bade and Parkin (1984), Cukierman, Web, and Neyapti (1992), and Alesina and Summers (1993). See also Cukierman (1992). Criticism of the view that central bank independence is a solution to high inflation is provided by Posen (1993). The negative relationship between indexes of central bank independence and inflation held only for developed economies. Carlstrom and Fuerst (2009) find increases in central bank independence can account for two-thirds of the better inflation performance among industrialized economies over the past twenty years.

achieving obtainable goals. An independent monetary authority may still face a temptation to pursue unsustainable objectives if, for example, real distortions imply steady-state output is inefficiently low.[9] Thus, the reforms instituted in New Zealand focused on an achievable goal of monetary policy—inflation—while allowing the central bank the independence to achieve this goal. In the terminology of Debelle and Fischer (1994), the Act established a central bank that lacked goal independence but enjoyed instrument independence.

This type of reform—clear specification of goals together with greater central bank independence—became common during the 1990s.[10] Making the goals public helps to promote accountability, particularly if the central bank is assigned a single policy goal such as price stability or a target for inflation. Independence also has the potential to make the central bank less accountable, so Debelle and Fischer (1994) argued that independence needed to be limited and that independence to set instruments but not to define goals offered the best blueprint for central bank reform.

Central bank reforms emphasizing goals, instrument independence, and accountability are not the only shape reforms could have taken. An alternative could define performance measures that, unlike price stability, are not among the ultimate objectives of macroeconomic policy. For example, during the 1970s and 1980s, the role of intermediate targets in monetary policy implementation was widely discussed, and proposals for establishing target growth rates for various monetary aggregates were common. In 1975, a

9. The academic literature based on the model of Barro and Gordon (1983) generally did not distinguish between politically generated pressures for economic expansions and socially efficient but unsustainable attempts by the central bank to generate expansions. Both were captured by assuming that, even with flexible prices and wages, the economy's output would be below the desired level.

10. The movement of many central banks toward greater independence and transparency is discussed by Crowe and Meade (2007) and Blinder, Ehrmann, Fratzscher, De Haan, and Jansen (2008). See Dincer and Eichengreen (2014) for an updated measure of transparency that illustrates this trend.

US House of Representatives concurrent resolution called on the Federal Reserve to publicly announce monetary growth targets. The Full Employment Act of 1978 mandated publicly announced, annual growth targets for the money supply, and the Federal Reserve was required to report to Congress on its success in achieving the targets.[11] The Federal Reserve was assigned an objective—monetary growth targets—and in principle was held accountable for achieving these objectives, but the resulting targets were not among the ultimate goals of macroeconomic policy. However, the Fed was allowed to define its growth rate targets, weakening the target's role in constraining the Fed and in promoting accountability. Any constraining effect of announced monetary growth targets was further weakened by the Fed's practice of rebasing the level of the target path for monetary aggregates annually, ensuring that past target growth rate misses were compounded into the level of the monetary aggregates.[12]

Intermediate targets generally served as poor performance measures for monetary policy as the correlation between the targets and the ultimate objectives of monetary policy was often weak. In the United States, rapid monetary growth combined with falling inflation in the early 1980s made the aggregate targets poor guides for policy; the practice of base drift, while allowing the Fed greater flexibility in setting policy, weakened the usefulness of monetary growth rate targets as a means of ensuring policy accountability.[13]

Rather than using a goal such as inflation as the central bank's performance measure, the central bank could be assessed by comparing the setting of its instrument to a benchmark rule for the policy

11. See Walsh (1987).

12. For an analysis of base drift and the conditions under which it can be appropriate, see Walsh (1986). Inflation targeting leads to a similar situation in that the price level is allowed to be non-stationary. For some evidence that this is the practice in Australia, New Zealand, Sweden, and the United Kingdom, but not Canada, see Ruge-Murcia (2014).

13. In a similar manner, inflation targeting weakens accountability if price stability is the actual goal, as it is in many central bank charters.

instrument. A strict, or high-powered, rule-based system would eliminate any instrument independence and completely remove discretion from the policy process, directly solving any problems that arise from allowing policymakers discretion in implementing policy. In fact, Barro and Gordon (1983) and Canzoneri (1985) long ago argued that, absent private central bank information about the state of the economy, the central bank should have no discretion but instead be required to follow a rule that delineates the actions it should take as a function of the state of the economy.[14]

But just as an inflation targeting regime does not need to be one of strict inflation targeting, a rule-based system does not need to be a strict (high-powered) regime. A flexible rule-based regime, much like flexible inflation targeting, would establish a rule but allow the central bank to deviate from the rule. Deviations would then need to be explained, or justified, by policymakers, just as a failure to meet an inflation target requires policymakers to explain why the target was missed. The power of the rule as a performance measure would depend on the weight given to such deviations in evaluating and holding the central bank accountable. The advantage of a rule-based system is that it increases the predictability of policy, is transparent, and simplifies the process of ensuring accountability.[15]

Legislating rules for the central bank reduces both goal and instrument independence. As Tirole (1994) notes, rules are imposed when agents cannot be trusted with discretion. In a series of recent papers, John Taylor has argued that a commitment to a rule for monetary policy produces better outcomes than occur in regimes that emphasize central bank independence (Taylor 2011,

14. Walsh (1995b) showed that aligning the central bank's incentives with observables such as inflation overcame the private information problem highlighted by Canzoneri (1985). Athey, Atkeson, and Kehoe (2005) revisit the rules-versus-discretion debate in the presence of private information.

15. Taylor (2012) provides an example of how the Taylor rule can be used to assess Federal Reserve performance.

2012, 2013). He suggests overall macroeconomic performance was superior during periods in which the Federal Reserve acted in a systematic, predictable manner, and that forcing the Fed to adhere more closely to a rule would improve economic outcomes. After reviewing rules versus central bank independence, he concludes, "The policy implication is that we need to focus on ways to 'legislate' a more rule-based policy" (Taylor 2011, 16).

Given the unprecedented actions by the Federal Reserve and other central banks during the financial crisis, it is not surprising that proposals have emerged for rule-based reforms designed to limit the Fed's discretion. In July 2014, hearings were held in the United States on H.R. 5018. which would impose several rule-based requirements on the Fed. First, the Federal Open Market Committee (FOMC) would be required to identify a Directive Policy Rule, which would identify the policy instrument and "describe the strategy or rule of the Federal Open Market Committee for the systematic quantitative adjustment of the Policy Instrument Target to respond to a change in the Intermediate Policy Inputs" (section 2C(c)(2)). Intermediate Policy Inputs, defined in section 2C(a)(4), include "any variable determined by the Federal Open Market Committee as a necessary input to guide open-market operations" but must include current inflation (together with its definition and method of calculation) and at least one of (i) an estimate of real, nominal or potential GDP, (ii) an estimate of a monetary aggregate, or (iii) an interactive variable involving the other listed variables. In addition, the Directive Policy Rule must "include a function that comprehensively models the interactive relationship between the Intermediate Policy Inputs (section 2C(c)(3))" and "the coefficients of the Directive Policy Rule (section 2C(c)(4))."

Perhaps more significantly in terms of constraining the Fed's flexibility, the proposed legislation also defines a Reference Policy Rule and section 2C(c)(6) requires that the FOMC must report "whether the Directive Policy Rule substantially conforms to the

Reference Policy Rule." If it doesn't, the FOMC will need to provide a "detailed justification" for any deviation of the Directive Policy Rule and the Reference Policy Rule.

The proposed bill is quite specific about the Reference Policy Rule. Section 2C(a)(9) defines the Reference Policy Rule as the federal funds rate given by

$$i_t^{RPR} = 4 + 1.5\left(\pi_{t-1} - 2\right) + 0.5\ln\left(\frac{GDP_t}{GDP_t^{potential}}\right), \tag{1}$$

where π_{t-1} is the inflation rate over the previous four quarters. This reference policy rule is the Taylor rule (Taylor 1993). If average inflation is equal to 2 percent and the gap between GDP and potential is zero, then the policy rate will equal 4 percent. Thus, the rule assumes an inflation target of 2 percent and an average real interest rate of 2 percent.

Federal Reserve Chairwoman Janet Yellen said July 16, 2014, in testimony before the House Financial Services Committee, "It would be a grave mistake for the Fed to commit to conduct monetary policy according to a mathematical rule." In contrast, John Taylor in a July 9, 2014, *Wall Street Journal* opinion piece argued in favor of the bill. Section 2C(e)(1) does allow that the Act is not meant to require the FOMC to implement the strategy set out in the legislation if the "Committee determines that such plans cannot or should not be achieved due to changing market conditions." If such a situation occurred, the FOMC would have forty-eight hours to provide the US comptroller general and Congress with an explanation and an updated Directive Policy Rule. In turn, the comptroller general would then have forty-eight hours to conduct an audit and issue a report to determine whether the FOMC's updated Directive Policy Rule is in compliance with the bill.

Rule-based performance measures suffer from at least three potential problems. First, determining the right rule is difficult.

Even in quite simple theoretical models, the optimal instrument rule can be extremely complex (for example, see Woodford 2010). A complex rule, even if known, might be hard to explain to the public, thereby reducing the ability of a rule-based performance measure to ensure policy transparency and accountability. Second, any optimal rule is optimal only with reference to a specific model, so changes in the economy's structure or our understanding of it will produce changes in the optimal rule. Third, it may not always be possible to characterize policy in terms of a single instrument rule. A rule for a short-term policy interest rate would no longer be meaningful if interest rates were at the zero lower bound, nor would it give guidance for balance-sheet policies. Thus, instrument rules are likely to be less robust to structural changes than goal-based systems.[16] However, early work such as Levin, Wieland, and Williams (1999) and Rudebusch (2002) suggested simple rules may be robust to model uncertainty. These considerations argue for adopting a simple but robust rule such as the Taylor rule but one that also includes escape clauses.[17] Choosing which rule, and how accountability is to be maintained when the rule might not apply, must involve balancing the gains from limiting discretion against the costs of potentially forcing monetary policy to implement a bad rule.

Table 3.1 summarizes the general characteristics of goal-based and rule-based reforms. I exclude examples of reforms based on intermediate targets such as money growth rates as they are inefficient systems both for achieving ultimate goals and for restricting the central bank's instrument setting. Goal-based and rule-based

16. But alterations in the economy's structure can also affect policy goals. For example, a change in price indexation would change the definition of inflation volatility that generates inefficiencies and that should appear in the measure of social welfare.

17. See also Taylor and Williams (2010). Svensson (2003) provides a general critique of relying on Taylor rules, while Benhabib, Schmitt-Grohé, and Uribe (2001) argue Taylor rules do not rule out ZLB equilibria.

TABLE 3.1: Types of Central Bank Reforms

	Goals Based	Rules Based
Examples	Inflation targeting Price level targeting	Exchange rate pegs Gold standard Instrument rules (H.R. 5018)
CB independence		
Goal	Varied	Low
Instrument	High	Low
Constrains	Central Bank Government	Central Bank
Flexibility	Varied	Varied
Transparency	Varied	High
Accountability	High	High
Robustness	High	Low

Source: Author's calculations

reforms have different implications for a central bank and for macroeconomic outcomes. They differ in terms of the type of independence the central bank enjoys and in terms of whom they are designed to constrain. Both can allow for flexibility and both provide the public with the ability to assess policy and, in principle, hold the central bank accountable.

Under rule-based accountability, the central bank is required to specify clearly its instrument and the rule it uses to determine the setting of that instrument. Deviations from the rule are allowed, but the central bank is required to explain the rationale for any such deviations. In contrast, under goal-based accountability, the objectives of the central bank are made clear—if these are set by the government, the central bank lacks goal independence—but in the pursuit of these goals the central bank enjoys instrument independence. In this case, the central bank is required to explain how its actions are consistent with achieving the goals.

The Performance of Goal-Based and Rule-Based Regimes[18]

In this section, a simple model is used to highlight the tensions that arise between accountability and flexibility under different performance measures and to explore how these tensions are addressed by goal-based and rule-based accountability. While the model used is quite simple, it helps to illustrate the effects of different policy regimes, leaving to the following section the use of an estimated model to evaluate goal-based and rule-based systems.

Let π^* be the socially optimal steady-state inflation rate, taken as exogenous and constant for simplicity, and define $\hat{\pi}_t \equiv \pi_t - \pi^*$ as actual inflation relative to the optimal rate. Assume social loss is given by

$$L_t^s = \frac{1}{2} E_0 \sum \beta^i \left(\hat{\pi}_{t+i}^2 + \lambda x_{t+i}^2 \right), \tag{2}$$

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 possible political pressures that affect the goals the central bank pursues. Specifically, assume that absent any assignment of a performance measure, the central bank acts to minimize

$$L_t^{cb} = \frac{1}{2} E_t^{cb} \sum \beta^i \left[\left(\hat{\pi}_{t+i} - \varphi_{t+i} \right)^2 + \lambda \left(x_{t+i} - u_{t+i} \right)^2 \right] \tag{3}$$

where φ and u are mean zero stochastic shocks that represent deviations of the central bank's objectives from their socially optimal values. These can be thought of as representing unmodeled political pressures affecting the policy choices of the central bank or

18. This and the following sections are reprinted from Walsh (2015), which is available at http://www.ijcb.org/journal/ijcb15q4a10.htm and which contains an appendix that provides details on the derivations of all results.

simply as distortions introduced by the preferences of the central bank policy authorities. In keeping with the now common practice in the analysis of monetary policy, I assume a fiscal tax/subsidy policy is in place that eliminates any steady-state inefficiencies. Thus, I ignore distortions arising from attempts to systematically affect the level of steady-state output.

The economy is characterized very simply by a new Keynesian Phillips curve given by

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa x_t + e_t, \tag{4}$$

and an expectational Euler equation given by

$$x_t = E_t x_{t+1} - \left(\frac{1}{\sigma}\right)\left(i_t - E_t \hat{\pi}_{t+1} - \phi_t\right), \tag{5}$$

where ϕ_t and e_t are taken to be exogenous stochastic processes. Equation (4) is consistent with the standard Calvo model if firms who do not optimally choose their price instead index their price to π^*. Under optimal discretionary policy with i.i.d. shocks, the unconditional expected social loss is

$$L_t^s = \frac{1}{2}\left(\frac{1}{1-\beta}\right)\left[\left(\frac{\lambda}{\lambda+\kappa^2}\right)\sigma_e^2 + \left(\lambda^3+\kappa^2\right)\left(\frac{1}{\lambda+\kappa^2}\right)^2\left(\lambda^2\sigma_u^2 + \kappa^2\sigma_\varphi^2\right)\right] \tag{6}$$

In the absence of political distortions represented by u and ϕ (and maintaining the assumption of i.i.d. shocks), social loss would be

$$\frac{1}{2}\left(\frac{1}{1-\beta}\right)\left(\frac{\lambda}{\lambda+\kappa^2}\right)\sigma_e^2 \le L_t^s.$$

I next investigate whether holding the central bank accountable for achieving a goal such as the inflation rate or for adhering to a rule for setting the instrument can help lower social loss.

Delegation

Government in a pre-game stage defines a performance measure for the central bank. A goal-based regime specifies the central bank's objectives in terms of π and/or *x*, the two ultimate objectives on which social welfare depends. A rule-based regime specifies that assessment of the central bank's performance is based on a comparison of the policy instrument and the value implied by a simple instrument rule. I represent each type of regime by assuming the central bank continues to have preferences over actual outcomes given by (3) but is also concerned with minimizing deviations of outcomes from the bank's assigned performance measures. The weights attached to these additional performance measures represent the power of the respective measure. Nesting both regimes, the central bank is assumed to set policy under discretion to minimize

$$L_t^{cb} = \frac{1}{2} E_t^{cb} \sum \beta^i \left[\left(\hat{\pi}_{t+i} - \varphi_{t+i} \right)^2 + \lambda \left(x_{t+i} - x_{t+i}^* \right)^2 + \tau \hat{\pi}_{t+i}^2 + \delta \left(i_{t+i} - i_{t+i}^r \right)^2 \right], \quad (7)$$

where τ is the implicit weight placed on achieving the inflation target (equivalently, the degree of central bank conservatism in the terminology of Rogoff 1985) and δ is the weight placed on setting the interest rate equal to i^r, the rate implied by the rule.[19] We can rewrite L_t^{cb} as

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

where terms independent of policy have been dropped.[20]

19. For simplicity, I only consider goal-based regimes defined in terms of inflation and not the output gap.

20. For evidence that the Fed has implicitly placed some weight on the Taylor rule, see Kahn (2012) and Ilbas, Røisland, and Sveen (2013).

Since private agents are forward-looking in making decisions, optimal policy under discretion will result in lower social welfare than would the fully optimal commitment policy. The distortionary shocks φ_{t+i} and u_{t+i} also reduce welfare. The question for central bank design is whether a goal-based system with $\tau > 0$ or a rule-based system with $\delta > 0$ can, in an environment of discretionary decision-making, improve welfare. In other words, in a pre-game stage, would the government choose non-zero values of τ and/or δ if it wished to minimize (2)?

I first consider the case of a goal-based regime in which $\delta = 0$ but τ is chosen optimally. Then the case of a rule-based regime with $\tau = 0$ and δ chosen optimally is analyzed. Finally, the case in which both τ and δ are jointly chosen is considered.

The Assignment of Goals

When the government assigns objectives to the central bank based on realized inflation, we have the case studied in Walsh (2003a). The analysis in that paper only considered distortionary shocks affecting the output objective of policy (i.e., $u \neq 0$ but $\varphi \equiv 0$) and also assumed the central bank had imperfect information about cost shocks, an extension I ignore here.

With $\delta = 0$, the central bank's problem under discretion can be written as

$$\min_{\hat{\pi}_t, x_t, i_t} \frac{1}{2}(1+\tau)\hat{\pi}_t^2 - \varphi_t \hat{\pi}_t + \frac{1}{2}\lambda x_t^2 - \lambda u_t x_t$$

subject to (4) and (5). The nominal interest rate i is the instrument of monetary policy. Shocks are assumed to be i.i.d.[21] It is straightforward to show that equilibrium inflation and the output gap are given by

21. The case of serially correlated shocks is dealt with in the numerical analysis of section 4 based on an estimated model.

$$\hat{\pi}_t = \left[\frac{\kappa\lambda u_t + \kappa^2 \varphi_t + \lambda e_t}{\lambda + \kappa^2 (1+\tau)} \right]$$

$$x_t = \left[\frac{\lambda u_t + \kappa\varphi_t - \kappa(1+\tau) e_t}{\lambda + \kappa^2 (1+\tau)} \right].$$

The central-bank-design problem is to pick τ to minimize the unconditional expectation of social loss. The optimal value of τ is given by

$$\tau^* = \left(\frac{\lambda + \kappa^2}{\lambda^2} \right) \left(\frac{\lambda^2 \sigma_u^2 + \kappa^2 \sigma_\varphi^2}{\sigma_e^2} \right) \geq 0. \tag{8}$$

If $\varphi_t \equiv 0$, (8) reduces to the case considered in Walsh (2003a). In this case, $\tau^* = (\lambda + \kappa^2)(\sigma_u^2 / \sigma_e^2)$ increases linearly in λ and in the volatility of the distortionary shock to policymakers' goals (σ_u^2) relative to the volatility of cost shocks (σ_e^2). In the absence of both distortionary shocks u and φ, $\tau^* = 0$, consistent with the findings of Clarida, Galí, and Gertler (1999), who showed there is no gain from appointing a Rogoff conservative central banker when the cost shock is serially uncorrelated. When distortionary shocks are present, τ^* is positive even when shocks are serially uncorrelated. The greater the variability of the political distortions represented by u and φ, the larger is the optimal τ and the more the central bank needs to be made accountable based on $\hat{\pi}_t$. Equivalently expressed, the more variable the wedge between social objectives and goals pursued by the central bank, the more high-powered (or the stricter) the inflation-targeting regime needs to be.

A rise in the volatility of cost shocks increases the potential value of stabilization policy and so τ^* falls, as a more flexible inflation targeting regime is desirable. With more potential gain from flexibility, the optimal regime assigns less weight to achieving the inflation target. Importantly, τ^* is independent of aggregate demand shocks operating through the expectational IS relationship, as the

central bank always has an incentive to neutralize the impact of such shocks on inflation and the output gap.

The Assignment of Rules

Now suppose a legislated instrument rule is used to assess the central bank's performance. In contrast to objectives based on an ultimate goal such as inflation, the central bank's objectives are distorted based on how it sets its actual policy instrument. In terms of (7), $\tau = 0$ but δ may be non-zero. The central bank's problem takes the form

$$\min_{\hat{\pi},x,i}\left[\frac{1}{2}\hat{\pi}_t^2 - \varphi_t\hat{\pi}_t + \frac{1}{2}\lambda x_t^2 - \lambda u_t x_t + \frac{1}{2}\delta(i_t - i_t^r)^2\right]$$

subject to (4) and (5). Because the central bank is judged in part on how it sets its instrument, the expectational IS equation becomes relevant for its policy choice. Assume that the reference rule is defined by

$$i_t^r = \psi_\pi\hat{\pi}_t + \psi_x x_t.$$

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

$$i_t = i_t^r + \frac{1}{a\delta}\left[\kappa\left(\hat{\pi}_t - \varphi_t\right) + \lambda\left(x_t - u_t\right)\right],$$

where

$$a \equiv \sigma + \psi_x + \kappa\psi_\pi.$$

In the absence of the rule-based performance measure, the central bank would set the term in brackets 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 equaling the benchmark rule value.

For the case of serially uncorrelated shocks, equilibrium inflation and the output gap are equal to

$$\hat{\pi}_t = \left[\frac{\kappa\alpha\delta\phi_t + \kappa\lambda u_t + \kappa^2\varphi_t}{\lambda + \kappa^2 + a^2\delta}\right] + \left[\frac{\lambda + a\delta(\sigma + \psi_x)}{\lambda + \kappa^2 + a^2\delta}\right] e_t$$

$$x_t = \frac{\alpha\delta\phi_t + \lambda u_t + \kappa\varphi_t - (\kappa + a\delta\psi_\pi)e_t}{\lambda + \kappa^2 + a^2\delta},$$

and social loss is

$$\mathcal{L} = \frac{1}{2}a^2(\lambda + \kappa^2)\left[\frac{\delta}{\lambda + \kappa^2 + a^2\delta}\right]^2 \sigma_\phi^2 + \frac{1}{2}\lambda^2(\lambda + \kappa^2)\left[\frac{1}{\lambda + \kappa^2 + a^2\delta}\right]^2 \sigma_u^2$$
$$+ \frac{1}{2}\kappa^2(\lambda + \kappa^2)\left[\frac{1}{\lambda + \kappa^2 + a^2\delta}\right]^2 \sigma_\varphi^2 + \frac{1}{2}\left\{\frac{[\lambda + a\delta(\sigma + \psi_x)]^2 + \lambda[\kappa + a\delta\psi_x]^2}{[\lambda + \kappa^2 + a^2\delta]^2}\right\}\sigma_e^2.$$

Minimizing $\mathcal{L}$ with respect to δ implies the optimal weight on the rule-based objective is

$$\delta^* = \frac{(\lambda + \kappa^2)(\lambda^2\sigma_u^2 + \kappa^2\sigma_\varphi^2)}{(\lambda + \kappa^2)^2\sigma_\phi^2 + \Lambda\sigma_e^2}, \tag{9}$$

where

$$\Lambda \equiv = \left[(\sigma + \psi_x)\kappa - \lambda\psi_\pi\right]^2. \tag{10}$$

To help interpret the expression for δ^*, assume initially that there are no aggregate demand shocks ($\phi \equiv 0$). In this special case,

$$\delta^* = \left(\frac{\lambda + \kappa^2}{\Lambda}\right)\left(\frac{\lambda^2\sigma_u^2 + \kappa^2\sigma_\varphi^2}{\sigma_e^2}\right). \tag{11}$$

Comparing (11) to (8) shows that both depend on $(\lambda + \kappa^2)(\lambda^2\sigma_u^2 + \kappa^2\sigma_\varphi^2)/\sigma_e^2$; as the variability of distortionary shocks u and φ

increases relative to the variability of cost shocks *e*, the optimal τ^* and the optimal δ^* both increase. They do so for the same reason: allowing the central bank less flexibility becomes desirable when distortionary shifts in goals are more variable. The optimal τ^* and δ^* are both decreasing in the volatility of inflation shocks; as the scope for welfare-improving stabilization policy increases, the cost of distorting the central bank's objectives by requiring it either to place more weight on inflation variability or to match the benchmark instrument rule becomes more costly.

The expression for δ^* given in (11) was derived for arbitrary policy response coefficients ψ_x and ψ_π. Suppose instead that these were optimally chosen. For example, continuing with the special case of no demand shocks and serially uncorrelated cost and distortionary shocks, the optimal interest rate rule can be expressed in terms of a reaction to either the output gap or to inflation; that is, only one response coefficient is needed. Let $\psi_x = 0$; the optimal response to inflation is then equal to $\psi_\pi^* = \sigma\kappa/\lambda$. One can show that

$$\lim_{\psi_\pi \to \psi_\pi^*} \delta^* \to \infty.$$

When the benchmark rule is equal to the optimal rule and there are no aggregate demand shocks, the central bank should not be allowed any flexibility.

Equation (11) applied when there were no shocks to the Euler equation, corresponding to the case of a constant equilibrium real interest rate. In the presence of shocks to the equilibrium real interest rate (i.e., $\phi \neq 0$), the optimal penalty on deviations from the rule can be written as

$$\delta^* = \left(\frac{\lambda + \kappa^2}{\Delta}\right)\left(\frac{\lambda^2\sigma_u^2 + \kappa^2\sigma_\varphi^2}{\sigma_e^2}\right) = \left(\frac{\lambda^2}{\Delta}\right)\tau^*,$$

where

$$\Delta \equiv \Lambda + \left(\lambda + \kappa^2\right)^2 \left(\frac{\sigma_\phi^2}{\sigma_e^2}\right) \geq \Lambda.$$

Thus, demand shocks ($\sigma_\phi^2 > 0$) call for putting less weight on deviations from the rule. This result is very intuitive—the specified rule does not allow for interest rate movements directly in response to demand shocks; an optimal policy would. Therefore, as demand shocks become a larger source of volatility, the optimal δ falls. If $\psi_x = 0$ and $\psi_x = \psi_x^*$ so that the assigned rule is consistent with the optimal response to inflation shocks, $\Lambda = 0$ and

$$\delta^* = \left(\frac{1}{\lambda + \kappa^2}\right)\left(\frac{\lambda^2\sigma_u^2 + \kappa^2\sigma_\varphi^2}{\sigma_\phi^2}\right) \geq 0.$$

In this case, the optimal value of δ is non-negative, independent of inflation shocks, but decreasing in the variance of demand shocks.

Jointly Optimal Goal- and Rule-Based Regimes

The special cases just considered showed how setting τ and δ both involve a similar trade-off between the benefits of reducing flexibility to limit distortions and the costs of reducing the ability of the central bank to pursue socially desirable stabilization policies. The dependence of the power of goal-based and rule-based measures on the relative volatility of underlying shocks is reminiscent of the classic Poole results on instrument choice (Poole 1970). Poole showed that an interest rate instrument performed better than a monetary aggregate instrument in the face of financial market shocks, while the reverse was true in the face of aggregate demand disturbances. In a similar manner, equations (8) and (9) suggest a goal-based performance measure may be best if shocks to aggregate demand dominate, while a rule-based measure may have advantages if shocks to inflation dominate. In general, Poole's

analysis implies optimal simple rules will depend on the relative variances of the model's underlying shocks.[22] Similarly, one might expect that the weight to give to a goal-based performance measure relative to a rule-based measure may depend on the relative volatility of the model's shocks. The fact that, as shown by (8) and (9), the optimal τ is independent of demand shock volatility but decreasing in cost shock volatility while δ is decreasing in the volatility of demand shocks suggests there might be potential gains from using both forms of performance measures.

To assess the joint determination of the optimal values of τ and δ, I set $\kappa = 0.172$, consistent with a Calvo model of price adjustment with the fraction of non-optimally adjusting firms equal to 75 percent per quarter combined with log utility ($\sigma = 1$) and a Frisch elasticity of labor supply of 1. For the baseline, I set the standard deviations of all the shocks equal to 0.025. The parameters of the rule are set equal to their Taylor-values of $\psi_x = 1.5$ and $\psi_x = 0.125$. I then solve numerically for the values of $\tau^\star$ and $\delta^\star$ that minimize the unconditional expectation of social loss, given by (2). I set λ equal to the value appropriate if (2) is interpreted as a second-order approximation to the welfare of the representative household.[23] The analytic results for the optimal values of τ and δ taken individually showed that the variances of demand and cost shocks played a key role, so I investigate how variations in these variances affect the optimal power of the goal-based versus rule-based regimes.

To assess the relative roles of τ and δ when both are chosen optimally, I report the ratio of their optimal values as the variances of the disturbances vary. Figure 3.1 plots $\tau^\star/\delta^\star$ as a function of the variances of the fundamental demand and cost shocks σ^2_ϕ and σ^2_e.

22. See Walsh (2010), pp. 513–521.

23. This implies a value of λ equal to $(\kappa/\theta^p)(1 + \eta)/(1 - a)$, where θ^p is the price elasticity of demand faced by firms, η is the inverse wage elasticity of labor supply, and $1 - a$ is the elasticity of output with respect to labor. For $\theta^p = 9$, $\eta = 1$ and $a = 0.3$, this implies $\lambda = 0.0545$. See (21).

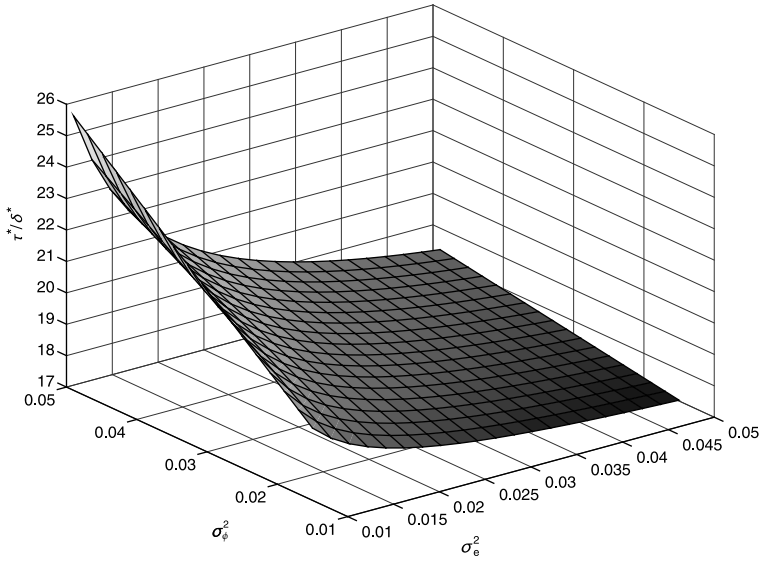

FIGURE 3.1: Ratio of optimal τ to optimal δ when jointly optimized as function of the variances of demand (σ_ϕ^2) and cost (σ_e^2) shocks.

Source: Author's calculations.

Both τ^* and δ^* are positive, indicating a role for goals and rules, but, as suggested by (8) and (9), the relative weight on goals as measured by τ rises as demand shocks increase in volatility, while the weight on rules as measured by δ rises as cost shocks become more volatile. For the parameters considered here, however, the weight given to deviations from the inflation target in assessing the central bank's performance is much larger than the optimal weight placed on deviations from the Taylor rule.

According to (8) and (9), an increase in $\lambda^2\sigma_u^2 + \kappa^2\sigma_\varphi^2$ —that is, an increase in the volatility of the distortionary shifts in objectives—would increase τ^* when $\delta = 0$ and δ^* when $\tau = 0$. In fact, these two equations imply the ratio between τ^* and δ^* is independent of the volatility of the distortionary shocks *u* and φ but depends on the relative variances of demand and cost shocks:

$$\frac{\tau^*}{\delta^*} = \left(\frac{\lambda + \kappa^2}{\lambda^2}\right)\left(\frac{\sigma_\phi^2}{\sigma_e^2}\right) + \frac{\Lambda}{\lambda^2}.$$

This continues to be true when τ and δ are optimally chosen jointly; they both increase with the volatility of the distortionary shocks u and φ, rising proportionately so that their ratio remains constant as $\lambda^2\sigma_u^2 + \kappa^2\sigma_\varphi^2$ increases. Thus, figure 3.1 is independent of $\lambda^2\sigma_u^2 + \kappa^2\sigma_\varphi^2$. While the optimal measure of performance places some weight on deviations from the inflation goal and deviations from the interest rate rule, the fundamental choice between a goal-based and a rule-based performance measure depends on the relative importance of the underlying shocks to private sector consumption and price-setting behavior.

Conclusions from the Simple Model

The simple model utilized in this section suggests that when political (or other) pressures cause transitory distortions to the objectives the central bank pursues relative to society's goals, there can be a role for both goal-based reforms and rule-based reforms. Both establish performance measures that affect the central bank's incentives and therefore affect policy choices. When each type of reform is considered in isolation, analytical expressions could be obtained for the optimal weight to place on achieving stable inflation and for punishing deviations from the Taylor rule. These expression for τ^* and δ^* showed that increases in the variance of shocks that distorted the central bank's objectives called for increasing the power of both types of accountability measures. Increased volatility of cost shocks reduces the weight that should be placed on inflation goals as limiting the flexibility to respond to these shocks becomes more costly. Under goal-based accountability, demand shocks do not affect the optimal power as the central bank already has an incentive to neutralize demand shocks. In contrast, demand

shocks reduce the optimal power of the rule-based system since the Taylor rule does not allow for shifts in the equilibrium real rate of interest.

Goals and Rules in an Estimated Model with Sticky Prices and Wages

The previous section considered the use of goal-based and rule-based policy regimes using a very simple model in which some analytical results could be obtained and some results required a calibrated version of the model. In this section I consider the effects of τ and δ in an estimated new Keynesian model of sticky prices and wages based on Erceg, Henderson, and Levin (2000). As was clear from the expressions for τ^* and δ^* obtained in the previous section, their values will depend importantly on the relative volatility of different shocks. Thus, obtaining these values from an estimated model will provide a more realistic assessment of the performance of goal-based versus rule-based incentive systems.

The basic model is standard and details of its derivation can be found in Erceg, Henderson, and Levin (2000) or chapter 6 of Galí (2008). The model takes the following form:

$$y_t = E_t y_{t+1} - \left[i_t - E_t \pi_{t+1} - \left(1 - \rho_\chi\right)\chi_t \right] \tag{12}$$

$$\left(1 + \beta\delta_p\right)\pi_t = \beta E_t \pi_{t+1} + \delta_p \pi_{t-1} + \kappa_p \left(\omega_t - mpl_t + \mu_t^p\right) \tag{13}$$

$$\left(1 + \beta\delta_w\right)\pi_t^w = \beta E_t \pi_{t+1}^w + \delta_w \pi_{t-1}^w + \kappa_w \left(mrs_t + \mu_t^w - \omega_t\right) \tag{14}$$

$$\omega_t = \omega_{t-1} + \pi_t^w - \pi_t + e_{z,t} \tag{15}$$

$$mpl_t = -ah_t \tag{16}$$

$$mrs_t = y_t + \eta h_t - \chi_t \tag{17}$$

$$y_t = (1-a)h_t \tag{18}$$

$$g_t = y_t - y_{t-1} + e_{z,t}, \tag{19}$$

where y is output, ω the real wage, π inflation, π^w wage inflation, *mpl* the marginal product of labor, *mrs* the marginal rate of substitution between leisure and consumption, h hours, and g the growth rate of output. Aggregate productivity is assumed subject to a random walk process with innovation $e_{z,t}$, so output, the real wage, the marginal product of labor, and the marginal rate of substitution between leisure and consumption are all defined as log deviations from the permanent component of productivity. Other variables are expressed as log deviation from their steady state values (including zero steady-state rates of price and wage inflation). χ, μ^p, and μ^w are stochastic shocks to the marginal utility of consumption, price markups, and wage markups, all assumed to follow AR(1) processes with, for example, ρ_x denoting the AR(1) coefficient for χ and $e_{x,t}$ denoting its innovation. The first equation is a standard Euler condition linking the marginal utility of consumption in periods t and $t+1$. The next two equations are reduced-form expressions for price and wage inflation, where δ_p and δ_w are the degrees of indexation in price- and wage-setting. The parameter η is the inverse wage elasticity of labor supply; $1 - a$ is the elasticity of output with respect to hours, the only variable input to production. To be consistent with the assumed unit root process in productivity, the elasticity of intertemporal substitution in consumption is set equal to one.

The elasticity of inflation with respect to real marginal cost is equal to

$$\kappa_p = \frac{(1-\varphi^p)(1-\beta\varphi^p)}{\varphi^p}\frac{1-a}{1-a+a\theta^p}$$

where $1-\varphi^p$ is the fraction of firms optimally adjusting price each period and θ^p is the price elasticity of demand facing individual

firms. Similarly, the elasticity of wage inflation with respect to the gap between the marginal rate of substitution between leisure and consumption and the real wage is

$$\kappa_w = \frac{\left(1-\varphi^w\right)\left(1-\beta\varphi^w\right)}{\varphi^w}\frac{1}{1+\eta\theta^w},$$

where $1 - \varphi^w$ is the fraction of wages optimally adjusting each period and θ^w is the wage elasticity of demand for individual labor types.

For estimation purposes, the model is closed with a specification of monetary policy, where the nominal interest rate *i* is treated as the policy instrument. I assume a standard Taylor rule with inertia of the form

$$i_t = \rho_i i_{t-1} + \left(1-\rho_i\right)\left(\phi_\pi \pi_t + \phi_g y_t\right) + v_t$$

where *v* is an exogenous policy shock.

Estimation

The model is estimated by Bayesian methods over the period 1984:1–2007:4, corresponding to the Great Moderation. A similar version of the Erceg, Henderson, and Levin model has been estimated over 1984:1–2008:2 by Casares, Moreno, and Vázquez (2011). I base my priors partially on their results, but I follow Chen, Curdia, and Ferrero (2012) in choosing prior distributions of beta for parameters constrained to be between 0 and 1 and gamma for parameters that should be positive. Output growth, inflation, wage inflation, and the nominal interest rate are treated as observables. Output is measured by chained real GDP deflated by the civilian population age sixteen and over. Inflation is measured by the log change in the GDP deflator, while wage inflation is the log change in hourly compensation in the non-farm business sector. The

TABLE 3.2: Prior and posterior distributions: Structural parameters

	Priors prior dist.	mean	s.d.	Posterior mean	5%	95%
Structural parameters						
η	gamma	4.34	0.25	3.7812	2.6792	4.6645
δ_p	beta	0.5	0.15	0.3690	0.3090	0.4410
δ_w	beta	0.5	0.15	0.2325	0.2000	0.2606
φ_p	beta	0.75	0.1	0.2081	0.0914	0.3218
φ_w	beta	0.75	0.1	0.1891	0.0703	0.2946
Monetary policy						
ρ_i	beta	0.83	0.1	0.5144	0.5000	0.5329
ϕ_π	gamma	2	0.25	2.7303	2.4659	2.9993
ϕ_g	gamma	0.35	0.05	0.4404	0.3822	0.5000
Disturbances						
ρ_χ	beta	0.9	0.2	0.9015	0.8692	0.9350
ρ_{μ^p}	beta	0.9	0.2	0.9886	0.9646	0.9999
ρ_{μ^w}	beta	0.9	0.2	0.1421	0.0100	0.2937
ρ_ν	beta	0.3	0.2	0.4634	0.3611	0.5595
σ_z	invg	1.0	0.2	0.6567	0.5766	0.7324
σ_χ	invg	1.0	0.2	1.1921	0.9488	1.3864
σ_ν	invg	1.0	0.2	0.4412	0.4109	0.4705
σ_{μ^p}	invg	1.0	3	1.2011	1.0027	1.3801
σ_{μ^w}	invg	1.0	3	4.9443	3.9333	5.9998

Source: Author's calculations

interest rate is the effective federal funds rate. All four observables are measured at quarterly rates. The values $\sigma = 1$, $\beta = 0.99$, $a = 0.36$, $\theta^p = 9$, and $\theta^w = 4.5$ were fixed, where the latter two values follow Galí (2013). Table 3.2 reports the prior distribution, means, and standard deviations, together with the posterior means and confidence intervals of the estimated parameters.[24]

24. The estimation period is chosen to exclude the post-2008 period during which the federal funds rate was effectively at zero. The implications of the zero lower bound for goal-based and rule-based performance measures are discussed in the concluding section.

Welfare Measures

In viewing central bank design as an issue of delegation, the objectives pursued by the central bank may differ from those of society, either because the central bank's evaluation of economic outcomes differs inherently from society's or because the central bank has been assigned objectives that differ from those of society. The former case corresponds to Rogoff's conservative central banker, a policymaker whose preference for low and stable inflation is greater than that of the public. The latter is the case considered in this paper, in which policymakers share society's preferences but have been assigned objectives that may differ from those of society. In either case, it is necessary to specify two sets of preferences: those taken to represent society's and those that underlie the central bank's policy choices.

In specifying these preferences, much of the monetary policy literature, including work on inflation targeting, takes the objectives of the central bank to be represented by a quadratic loss function in inflation squared (or squared deviations of inflation from target) and an output gap squared. These objectives are then also implicitly identified with those of society. Under a delegation scheme, society's and the central bank's objectives could each be represented by ad hoc quadratic loss functions, but the two loss functions may differ. Alternatively, in models based on the preferences of the individual agents populating the economy, outcomes can be evaluated in terms of their implications for the welfare of the representative household. If a welfare-based measure is used to represent society's preferences, the objectives of the central bank could take one of two basic forms. One could still represent the central bank's objectives by a standard quadratic loss function augmented by the performance measures assigned to the bank. Or one could assume the policymaker cares about the welfare of the

TABLE 3.3: Alternative welfare measures

		Society	
		Ad hoc	**Welfare based**
Central bank	Ad hoc	x	x
	Ad hoc w/ distorted output gap	x	x
	Welfare based		x
	Welfare based w/ distorted output gap		x

Source: Author's calculations

representative household, in addition to the performance measures that have been assigned. Each of these alternatives could then allow for distortionary shocks to the policymaker's output objective. Table 3.3 summarizes the combinations of objective functions that could be used to measure society's welfare and to represent the central bank's objectives. In the analysis of this section, six of the eight possible combinations of objectives will be considered; these combinations are indicated in the table. I have excluded the cases in which society's preferences are given by an ad hoc loss function while the central bank uses the welfare of the representative household to evaluate outcomes, as these combinations of preferences seem of limited relevance.

The ad hoc measure used to evaluate outcomes from society's perspective is taken to be

$$L_t^{s,adhoc} = \frac{1}{2} E_t \sum_{i=0}^{\infty} \beta^i \left(\hat{\pi}_{t+i}^2 + \lambda_x x_{t+i}^2 \right), \tag{20}$$

while the welfare-based measure is taken to be a second-order approximation to the welfare of the representative household, where the approximation is taken around the economy's zero-inflation efficient equilibrium.[25] In the context of the sticky-price, sticky-wage model, Erceg, Henderson, and Levin (2000) show that

25. I assume fiscal taxes and/or subsidies are in place to ensure the steady-state allocation is efficient.

$$L_t^{s,welf} = \frac{1}{2} E_t \sum_{i=0}^{\infty} \beta^i [(\hat{\pi}_{t+i} - \delta_p \hat{\pi}_{t+i-1})^2 + \lambda_x x_{t+i}^2 + \lambda_w (\hat{\pi}_{t+i}^w - \delta_p \hat{\pi}_{t+i-1}^w)^2], \quad (21)$$

where

$$\lambda_x = \left(\frac{\kappa_p}{\theta^p}\right)\left(\frac{1+\eta}{1-a}\right)$$

$$\lambda_w = (1-a)\left(\frac{\kappa_p}{\kappa_w}\right)\left(\frac{\theta^w}{\theta^p}\right).$$

Since the weight on output gap volatility in $L_t^{s,adhoc}$ is ad hoc, I employ the same value for λ_x in (20) as for λ_x in (21). Based on the estimated parameters reported in table 3.1, $\lambda_x = 0.1486$ and $\lambda_w = 0.4061$.

The central bank is assumed to minimize a loss function that is augmented by the performance measures which place additional weight on inflation volatility and deviations from an instrument rule:

$$L_t = L_t^{cb} + \frac{1}{2} E_t \sum_{i=0}^{\infty} \beta^i \left[\tau \hat{\pi}_{t+i}^2 + \delta \left(i_{t+i} - i_{t+i}^r \right)^2 \right],$$

where L_t^{cb} is the central bank's loss function in the absence of performance measures. Four alternative specifications for L_t^{cb} are used. These differ according to whether an ad hoc quadratic loss function or the welfare approximation is used and whether, for each of these loss functions, the central bank is concerned with x_{t+i}^2 or with the distorted gap $(x_{t+i} - u_{t+i})^2$. For example, if $u_t \equiv 0$ and the central bank employs an ad hoc quadratic loss function, policy will aim to minimize

$$\frac{1}{2} E_t \sum_{i=0}^{\infty} \beta^i \left[\hat{\pi}_{t+i}^2 + \lambda_x x_{t+i}^2 + \tau \hat{\pi}_{t+i}^2 + \delta \left(i_{t+i} - i_{t+i}^r \right)^2 \right]. \quad (22)$$

If the central bank's gap objective is distorted, policy will minimize

$$\frac{1}{2}\mathrm{E}_t\sum_{i=0}^{\infty}\beta^i\left[\hat{\pi}^2_{t+i}+\lambda_x\left(x_{t+i}-u_{t+i}\right)^2+\tau\hat{\pi}^2_{t+i}+\delta\left(i_{t+i}-i^r_{t+i}\right)^2\right]. \tag{23}$$

A similar distinction will arise if the central bank is concerned with minimizing (21) or (21) with x_t^2 replaced by $(x_t - u_t)^2$.

Finally, the reference policy rule defining i_t^r is given by

$$i_t^r = 1.5\pi_t + 0.125z_t, \tag{24}$$

where z_t is a measure of real activity. Two alternatives for z_t will be considered: x_t, the gap between output and the efficient level of output, and y_t, output relative to the permanent component of output, interpreted as corresponding to output relative to trend.

Results

As a starting point, consider the case in which social loss is measured by the standard quadratic loss function given by (20), and the central bank's objective is (22). Assume $z_t = y_t$ in (24) so the reference policy rule includes inflation and the gap between output and potential as in the Reference Policy Rule proposed in H.R. 5018. The model given by (12) – (19) is solved over a grid of values for τ and δ under the optimal discretionary policy designed to minimize (22). For each combination, social loss measured by (20) is evaluated to obtain the values τ^* and δ^* that minimize social loss.

Row 1, column 1, of table 3.4 shows that $\tau^* > 0$ but $\delta^* = 0$ when a standard quadratic loss function in inflation and the efficiency output gap is used to represent both social loss and the central bank's preferences. Because there is no distortion appearing directly in the central bank's loss function, i.e., $u_t \equiv 0$ and the central bank cares about $\hat{\pi}_t^2$ and x_t^2, the only role for the performance measures is to address the dynamic inefficiency of discretionary

TABLE 3.4: Optimal τ and δ, Taylor Rule in π and y

		Social loss			
		(1) Ad hoc (eq. 20)		(2) Welfare (eq. 21)	
	Central bank loss	τ*	δ*	τ*	δ*
(1)	ad hoc: π, x	4.04	0	1.37	0
(2)	ad hoc: π, $x-u$	12.95	0	6.15	0
(3)	welfare			0.33	0
(4)	welfare in $x-u$			1.54	0

Source: Author's calculations

policy. Recall that Clarida, Galí, and Gertler (1999) showed that in the presence of serially correlated cost shocks, as is the case here, having the central bank place more weight on its inflation goal (relative to the true social loss function) would lead to improved outcomes.[26] In contrast, the rule-based performance measure receives zero weight.

Now suppose the distortionary shock u_t that affects the output goal pursued by the central bank is added, so that the central bank seeks to minimize (23). Since shocks to the central bank's preferences were not incorporated into the estimated model, I arbitrarily set $\sigma_u \equiv 1.0$ (1 percent). Going from row 1, column 1, of table 3.4 to row 1, column 2, shows that the optimal value of τ* increases. As discretionary policy now suffers from the distortions in the central bank's output goal and those arising from discretion, the optimal power of the goal-based performance measure rises. As expected from the results from the simple model, adding this distortion significantly increases τ* (from 4.04 to 12.95). The optimal δ* is still equal to zero.

Results are similar when the welfare loss (21) is used to evaluate outcomes. Whether the central bank's objectives are based on the ad hoc loss function (22) (row 1, column 2) or (23) that

26. See also Tillmann (2012).

includes a distorted output gap objective (row 2, column 2), it is optimal to rely solely on the goal-based performance measure ($\tau^* > 0, \delta^* = 0$).

Now suppose the central bank cares about social welfare as well as its assigned performance measures. That is, the central bank attempts to minimize

$$\frac{1}{2}\mathrm{E}_t \sum_{i=0}^{\infty} \beta^i [(\hat{\pi}_{t+i} - \delta_p \hat{\pi}_{t+i-1})^2 \lambda_2 x_{t+i}^2 + \lambda_w (\hat{\pi}_{t+i}^w - \delta_w \hat{\pi}_{t+i-1}^w)^2 + \tau \hat{\pi}_{t+i}^2 + \delta (i_{t+i} - i_{t+1}^r)^2]. \quad (25)$$

When the central bank cares about the welfare-based measure of loss, whether distorted by shocks to its output objective or not (rows 3 and 4, column 2), $\tau^* > 0$ and $\delta^* = 0$. Notice that the optimal power of the performance measure (τ^*) falls when the central bank cares about the welfare-based loss (compare row 1 and 2 to rows 3 and 4).

Figure 3.2 shows how τ and δ affect welfare-based social loss when the central bank also cares about the welfare-based loss function but with distortions to its output objective (corresponding to row 4, column 2, of table 3.5). Loss quickly becomes extremely large as δ increases above zero. It increases so quickly that the scale of the figure obscures the way loss varies with τ when δ is fixed at its optimal value of zero, making it hard to discern that $\tau^* = 1.54$. While setting τ equal to its optimal value reduces loss by 16 percent relative to the $\tau^* = \delta^* = 0$ case, increasing δ from 0 to just 0.05 when $\tau = 0$ leads to an increase in social loss by a factor of almost fifty.

The results reported in table 3.4 can be summarized briefly: for all combinations of loss functions for the central bank and the measure of social loss, whether the central bank's output target is distorted or not, the optimal weight to place on the goal-based performance measure (τ) is positive while the optimal weight to place on the rule-based performance measure (δ) is zero.

Now assume $z_t = x_t$ in (24) so that the reference policy rule includes inflation and the gap between output and its efficient

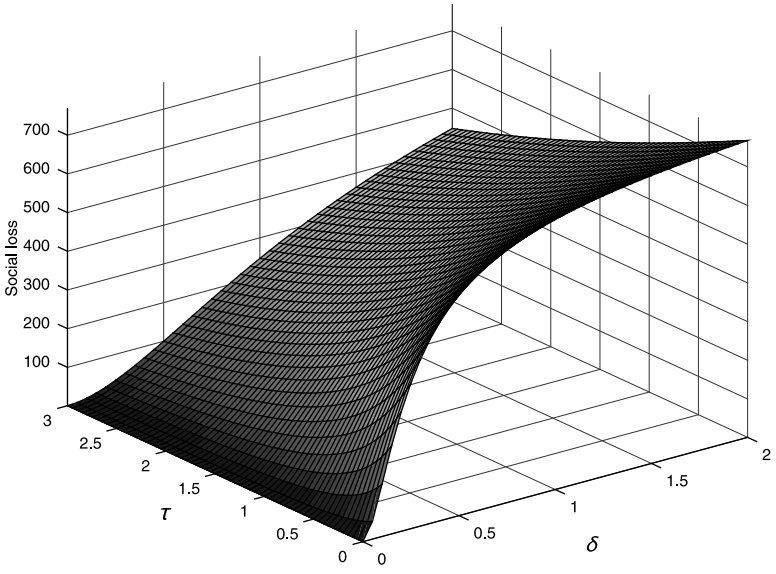

FIGURE 3.2: Loss rises quickly with δ when the reference policy rule depends on *y* (social loss given by (21) and central bank loss by (25) distorted by presence of *u* shocks to output gap objective).

Source: Author's calculations

TABLE 3.5: Optimal τ and δ, Taylor rule in π and *x*

		Social loss			
		(1) Ad hoc (eq. 20)		(2) Welfare (eq. 21)	
	Central bank loss	τ*	δ*	τ*	δ*
(1)	ad hoc: π, *x*	6.44	1.19	0.24	0.70
(2)	ad hoc: π, *x*−*u*	11.26	2.38	0	1.50
(3)	welfare			26.21	11.36
(4)	welfare in *x*−*u*			36.05	12.22

Source: Author's calculations

level. In this case, the reference rule is defined in a manner that is more consistent with the underlying model. Results are shown in table 3.5. Now, $\delta^* > 0$ for all six different combinations considered. Row 1, column 1, of table 3.5 shows that when a standard quadratic loss function in inflation and the efficiency output gap is used to

represent social loss and the central bank's preferences, it is optimal to employ both a goal-based system (i.e., $\tau^* > 0$) and a rule-based system ($\delta^* > 0$). Both performance measures are used in this case to address the dynamic inefficiency of discretionary policy. Adding the distortion to the central bank's output goal (row 2, column 1) increases the power of both performance measures. For this case with two distortions, the two performance measures serve to some degree as substitutes. For example, if either τ or δ is set to zero, there is a large reduction in social loss as the other increases from zero. The gain from setting τ optimally when $\delta = 0$ is approximately the same as that obtained by setting δ optimally when $\tau = 0$. However, if either is set at its optimal value, the further gain from employing the other performance measure is relatively small.

Rather than using an ad hoc loss function to assess outcomes as τ and δ vary, suppose the welfare-based loss function (21) is used to evaluate social loss. Assume policy is still determined by the central bank to minimize the ad hoc quadratic loss function (22) in $\hat{\pi}_t^2$ and x_t^2. Optimal values of τ and δ for this case are shown in rows 1 and 2, column 2, of table 3.5. The weights on both the goal-based and the rule-based performance measures fall relative to the case when the ad hoc loss function was used to measure social loss. The reduction in τ^* when welfare is measured by (21) rather than the ad hoc (20) is large, from 6.44 to 0.24 when $u_t \equiv 0$, while δ^* falls by over 40 percent. But perhaps more interesting is the result in row 2, column 2. If the central bank's output gap target is subject to stochastic distortion as in (23), the optimal scheme involves only the rule-based performance measure ($\tau^* = 0$). This result is consistent with the idea that a rule-based performance measure is a means of restricting central bank discretion. Figure 3.3 shows the percent reduction in social loss as a function of τ and δ. Loss clearly declines as δ rises from zero; in contrast, the reduction in loss is relatively flat as τ varies for a fixed δ.

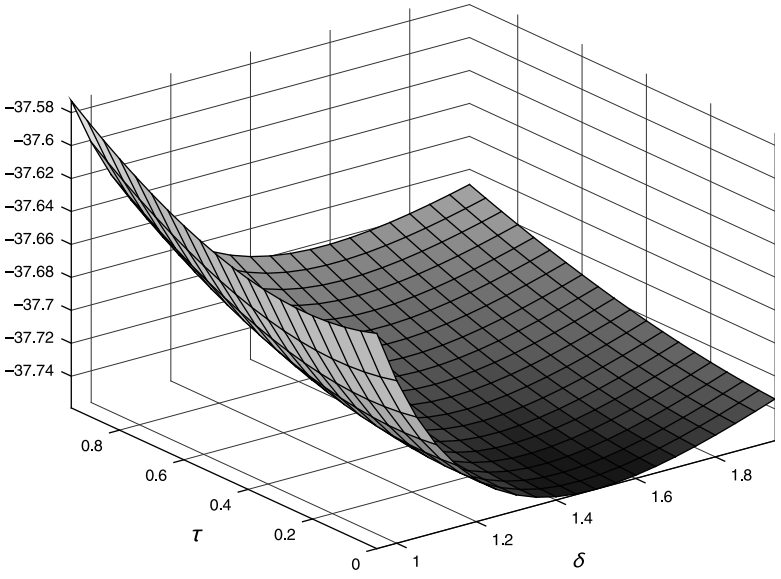

FIGURE 3.3: When the reference policy rule is based on $\hat{\pi}$ and x, social loss is given by (21) and the central bank's loss is (23), $\tau^* = 0$ and $\delta^* > 0$. (Compare with figure 3.2.)

Source: Author's calculations

In any case, the effects on loss as τ and δ vary are small. The results from the simple model indicated τ^* and δ^* would depend on the relative volatilities of the underlying shocks. Redoing the case corresponding to row 2, column 2, of table 3.5 with the standard deviation of aggregate demand shocks doubled causes τ^* to rise from 0 to 2.70 while δ^* falls to 0.70. The percent reduction in social loss as τ and δ vary for the case of more volatile demand shocks is shown in figure 3.4. Now, it is optimal to rely on both the goal-based measure and the rule-based measure of performance. This suggests the optimal performance measure may be highly dependent on the properties of the model's stochastic disturbances.

Rows 3 and 4 report results when the central bank cares about the welfare-based loss function (25). In the absence of a distorted

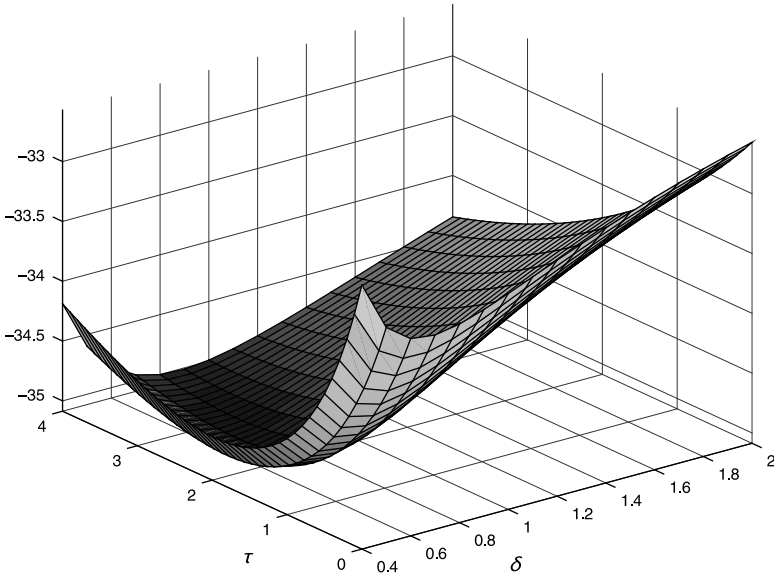

FIGURE 3.4: When the reference policy rule is based on $\hat{\pi}$ and x, social loss is given by (21) and the central bank's loss is (23), an increase in the volatility of aggregate demand shocks increases τ^* and reduces δ^*. (Compare with figure 3.3.)
Source: Author's calculations

output gap objective, both τ^* and δ^* are positive (table 3.5, row 3, column 2), and both are large. If the output gap target the central bank focuses on is distorted by u shocks so that $x_t - u_t$ rather than just x_t appears in the central bank's loss function, the optimal values of τ^* and δ^* both increase (see row 4, column 2), and in the case of τ^*, it increases quite significantly. Interestingly, when each performance measure is considered in isolation, the optimal weights are relatively small. For example, if $\delta = 0$ so that only the inflation measure is employed, the optimal weight to place on the goal-based measure is 1.45; when δ is also set optimally, $\tau^* = 36.05$. Similarly, if $\tau = 0$, the optimal value of δ is only 0.40; it increases to 12.22 when τ is set optimally. This is shown for δ in figure 3.5, which plots the change in social welfare as a function of δ for $\tau = 0$

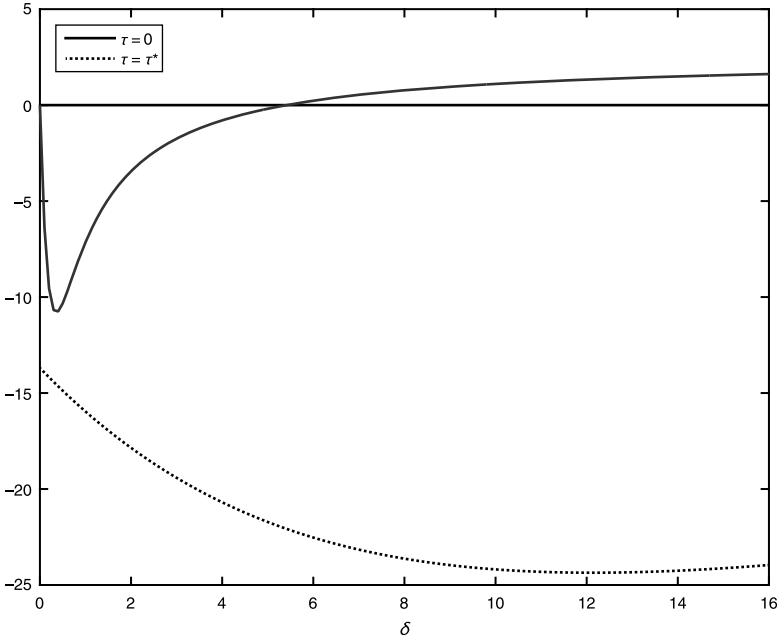

FIGURE 3.5: Percent change in social loss defined by (21) as a function of δ for $\tau = 0$ and for $\tau = \tau^* = 36.05$. Central bank's objective given by (25) distorted by presence of *u* shocks to output gap objective. Output measure in instrument rule is *x*.

Source: Author's calculations

and $\tau = \tau^*$. Notice that if only the rule-based performance measure is employed (i.e., $\tau=0$), social loss is higher than would occur with no performance measure ($\tau = \delta = 0$) for all $\delta > 5.4$.

In general, the findings in table 3.5 suggest a role for both types of performance measures. However, in evaluating these results, an important consideration to bear in mind is that the rule-based performance measure analyzed here was taken to be the basic Taylor rule, with the coefficients on inflation and the output measure set equal to Taylor's original values. If these coefficients were optimized for the specific model used, it is likely that the optimal weight to put on the rule-based performance measure would rise.

Extensions and Conclusions

The central banking reforms initiated by the Reserve Bank of New Zealand Act of 1989 emphasized the importance of defining clear and sustainable goals for the central bank, combined with instrument independence in the conduct of policy. Such a system promotes accountability by establishing goals that are clearly defined and by giving the central bank the responsibility and ability to achieve these goals. Goal-based performance measures for central banks were motivated, in part, by a desire to constrain governments in their ability to influence monetary policy while allowing flexibility in the actual implementation of policy.

An alternative approach to reform focuses on constraining the central bank by establishing instrument rules as the means of measuring the central bank's performance. Requiring a central bank to justify its policy actions with reference to a specific instrument rule is a means of strengthening accountability by limiting the central bank's flexibility.

In a simple analytical exercise, I compared an inflation target and the Taylor rule as alternative performance measures. I showed that stochastic distortions to the central bank's goals, which could arise either from pressures external to the central bank or from the pursuit by the central bank of goals that differ from society's, justify a role for goal-based *and* rule-based performance measures. In using either performance measure, the need to limit distortionary shifts in objectives from affecting output and inflation must be balanced against the cost of reducing the bank's ability to engage in stabilization policies. Using a calibrated version of the simple model, I showed that an increase in the volatility of demand shocks relative to cost shocks increased the optimal weight to place on the goal-based performance measure relative to the rule-based measure.

The two approaches to central bank design were then evaluated using an estimated DSGE (dynamic stochastic general equilibrium) model with sticky prices and wages. Using the basic Taylor rule as the reference policy rule in the rule-based performance measure, along with Taylor's original coefficients, the definition of real activity used in the rule is crucial. When the rule is based on output deviations from potential, as in the recent proposal in the US House of Representatives, the optimal weight to place on deviations from the rule-based performance measure was always zero. In contrast, it was always optimal to employ a goal-based inflation performance measure. When the measure of real activity in the reference policy rule was the gap between output and its efficient level, it was generally optimal to place weight on both the goal-based and the rule-based measures of performance.

An important consideration in establishing any performance measure is its robustness. A reference policy rule that does not allow for shifts in the equilibrium real rate of interest, such as the one analyzed in this paper, is likely to produce poor outcomes if such shifts are an important source of macroeconomic volatility. An optimal rule would overcome this particular problem, but operational rules must be based on observable variables if they are to be of practical relevance, and the equilibrium real interest rate consistent with efficient production is unobservable. Optimal rules are also unlikely to be robust to model misspecification, an issue not addressed here. A reference policy rule that is optimal for a given model will presumably serve as a good performance measure within that model but may lead to poor results if the model is wrong or if the economic structure changes over time. Rule-based performance measures based on a rule optimized for a specific model would need, therefore, to be of low power. Of course, a simple rule, such as the Taylor rule, may be more robust across models and in the face of structure change than rules optimized

for a specific model, and so a simple rule may serve as a useful, robust reference rule.

To simplify the analysis of the paper, I have ignored the constraint imposed by the zero lower bound (ZLB) on nominal interest rates.[27] The presence of the ZLB poses difficulties for both the goal-based and the rule-based performance measures. Neither provides a clear metric for what the central bank should be doing, or for how its performance should be judged, when the policy rate is at zero. This difficulty may, however, be less significant for the goal-based measure. A goal-based regime such as inflation targeting establishes a goal for the central bank but does not tie the hands of policymakers in terms of how policy is implemented to achieve the goal. For example, if the policy rate were at its lower bound with inflation below target, then a goal-based performance measure creates an incentive for the central bank to seek out new policy instruments in an effort to achieve its goal. A rule-based system may not be as effective in creating such incentives. A reference rule defined in terms of a single instrument may be of limited value during extended periods at the ZLB, as it does not provide any guidance to policymakers when the instrument value implied by the rule is unachievable. If the reference rule called for a negative interest rate, the central bank might seek to close the gap between i_t and i_t^r by directly focusing on the variables that affect i_t^r in an attempt to raise i_t^r above zero. In this case, either type of performance measure could promote policy innovations. However, because the rule-based measure is defined in terms of a specific policy instrument, and because it offers no guidance for how performance should be measured if that instrument is constrained, it may prove less likely to lead to the types of unconventional policies implemented by the Federal Reserve, the Bank of England,

27. I adopt the standard practice of referring to a zero lower bound for nominal interest rates, but the recent experience with negative nominal interest rates in Denmark, Sweden, and the eurozone suggests the effective lower bound may be below zero.

the Bank of Japan, and the European Central Bank during the past several years.

The focus in this paper has been on assessing policy performance in the presence of inefficient shifts in the central bank's objectives that potentially distort policy. Deviations of inflation from target or the policy interest rate from the recommendation of a Taylor rule were used as performance measures, creating incentives for the central bank to trade off minimizing these deviations against achieving other objectives. This is not the only role deviations from the Taylor rule can play. In the face of model uncertainty, Ilbas, Røisland, and Sveen (2012) show how appending deviations from the Taylor rule to the central bank's (non-distorted) loss function can contribute to policy robustness. In addition, the distortions considered in the present analysis do not affect the economy's steady-state equilibrium. Thus, policy objectives that create steady-state inefficiencies are ignored. Rogoff (1985) showed how placing additional weight on an inflation target could help overcome a systematic inflation bias under discretionary policy; a rule-based performance measure might play a similar role in addressing any systematic policy bias that affects steady-state inflation.

Finally, I have only considered traditional monetary policy objectives associated with controlling inflation and stabilizing an appropriate measure of real economic activity. As a consequence of the global financial crisis, central banks are now frequently tasked with responsibilities for macroprudential policies. An interesting question is whether a goal-based performance measure or a rule-based measure would best serve to promote accountability and good macroprudential outcomes. One significant difficulty in designing a goal-based performance measure in the case of macroprudential policies is the absence of a clear measure of the ultimate goal of policy. Inflation is both an ultimate goal of macroeconomic policy and an indicator that can be measured frequently to provide an ongoing assessment of policy. Achieving financial stability

may also be an ultimate goal of policy, but there is no agreed-upon way to measure it. An index such as the ratio of credit-to-GDP may be a useful measure in this context, but it corresponds to an intermediate target. Assessing policy on the basis of movements in the credit-to-GDP ratio is much like using a monetary growth rate to assess the central bank's inflation performance. The usefulness of intermediate targets suffers if the link between the intermediate variable and the ultimate objective of policy is either uncertain or not well-understood. While it may be difficult to develop a goal-based performance measure for macroprudential policy, difficulties also arise in defining a rule-based measure. Macroprudential policies may involve the use of multiple instruments. In this case, basing accountability on how one particular instrument is used can easily distort policy by causing undue attention to that one instrument at the neglect of others. And even when attention is restricted to a single instrument—the setting of capital buffer requirements, for example—the state of research is such that there is no benchmark rule that has been extensively studied, is well understood, and could serve as a reference policy rule. The lack of the equivalent to a Taylor rule for macroprudential policy instruments is a severe limitation on the usefulness of a rule-based performance measure in the context of macroprudential policies.

COMMENTS BY ANDREW LEVIN

I'm very glad to serve as a discussant for this paper. In fact, I was looking back at my computer files, and I think the first time I discussed one of Carl's papers was at the Carnegie-Rochester conference in 2004. Like all of Carl's other papers, I really enjoyed reading this one. I like the fact that Carl always thinks of the international context, not just focused on what the United States does, but what we can learn from other central banks around the world in a very practical way. Carl also provides a very clear, elegant analysis, oftentimes using small, Keynesian models where it's possible to understand what's going on pretty clearly. In fact, I think that a major challenge in central banking is that the models that are intended to be reasonably realistic are so large as to become black boxes, which poses significant difficulties for central bank communication, transparency, and accountability. (In fact, one notable step forward recently was that the Federal Reserve Board has started publishing the FRB/US model that's often served as a benchmark for its analytical work.) At any rate, Carl's work is much more straightforward to grasp because it's typically focused on smaller, more stylized models. Moreover, I really appreciate that Carl includes some careful discussion of qualifications and limitations of his analytical results, rather than claiming to have solved everything in one paper as academic economists sometimes do.

So let me just highlight three of Carl's assumptions. First, there's no persistence anywhere in his model. There's no persistence in dynamics, and there's no persistence in the shocks, and that's what makes the analysis so elegant and the solution so simple. It effectively becomes a static problem. Moreover, there are no conditional commitments, because Carl's analysis is focused on the discretion problem, so there's no history dependence in the path of monetary policy. And there's no learning at all. In fact, that's the assumption

that seems most limiting in this analysis, because the world just isn't that simple. We don't really understand the structure of the economy or the shocks that are hitting the economy in real time. And I think that's part of the reason why there's a lot of suspicion about central banks, because they're making such complex decisions under imperfect information, and there's a potential for the outcomes to be influenced by what's happening in the back room. And so the more that central banks can explain what they're doing, I think, the better. But again, the fact that we don't have complete information is really the fundamental rationale for central banks to be as transparent as possible.

Now let's turn more specifically to Carl's analytic framework. In this model, it's straightforward to determine the optimal targeting rule. And a key characteristic of that rule is it completely insulates the economy from aggregate demand shocks. The central bank directly observes any shift in the equilibrium real interest rate, because there's no imperfect information here, so policymakers can respond to such shifts by initiating a parallel shift in the actual real interest rate. Indeed, that characteristic of optimal monetary policy has been pointed out in John Taylor's work over the past several decades. By contrast, aggregate supply shocks do create policy trade-offs, and the optimal targeting rule balances those trade-offs appropriately.

The interpretation of the policy distortions in this model is a bit vague. But the basic premise is that the central bank's decisions may reflect "back room" influences such as having politically motivated conversations with the president that might not be revealed until many decades later. But these influences are purely transient, which makes the optimization problem static rather than dynamic. Now in reality, I think we're actually much more concerned about cases where these sorts of distortions are indeed persistent and induce markedly suboptimal deviations in the path of policy, of

the sort that David Papell and Mike Dotsey discussed earlier. And then the central bank in effect has a distorted targeting rule, where those distortions essentially act like policy shocks and generate undesirable variability.

Now Carl considers two alternative approaches for the government—or, using Paul Tucker's terminology, "elected officials"—to influence the central bank's decisions. One approach is to incorporate an additional term into the central bank's loss function to give the central bank an incentive to place greater weight on putting inflation close to target and less weight on the central bank's own distorted objectives. The problem with this approach, as Carl has pointed out, is that this form of delegation doesn't place any weight on the economic activity goal, even though the output gap also matters for social welfare. And therefore, this approach is not ideal: at the same time that it diminishes some of the distortions resulting from back-room politics, this approach also skews the central bank's decisions away from the output gap toward a single-minded focus on inflation. I wonder if that defect could be solved by establishing what might naturally be called a dual mandate, that is, explicitly delegate both the inflation goal and the employment goal. After all, that's exactly the same as the form of the social welfare function. So then just delegate both goals, and let the weight go to infinity, and you can completely get rid of the distortions, and you're back to the fully optimal targeting rule.

Likewise with the delegation of benchmark policy rules, Carl's implementation skews the central bank's policy toward an instrument rule that doesn't fully offset aggregate demand shocks. But that problem can also be solved, because if you choose the rule carefully, you can fully replicate the optimal targeting rule. (In fact, Ben McCallum has made this point in numerous interchanges with Lars Svensson that many of you may recall.) Now the point is, by replicating the optimal targeting rule, and letting the weight, v, go

to infinity, then this approach can also eliminate the policy distortions without skewing the policy stance in one undesirable direction or another.

Now moving on to some of the broader issues, I would assert that the real problem is not so much trying to restrict central bankers and put them into chains; rather, what's critical is the degree of transparency. And you see this in the very first sentence of the FOMC's Statement on Longer-Run Goals and Policy Strategy that was adopted in 2012 and that's been reaffirmed each year since then. The opening sentence of that statement reads as follows: "The FOMC seeks to explain its decisions to the public as clearly as possible." And I view that declaration as a binding commitment that the FOMC has an ongoing challenge to fulfill.

One specific issue, by the way, is that the FOMC has clarified its inflation goal as 2 percent in terms of the PCE (personal consumption expenditure) price index, so that's more or less a settled issue, at least for the time being. However, the FOMC is still not very transparent about its assessments of the maximum sustainable level of employment, and I think it's very important to start doing that. This is the $x - x^*$ that Carl emphasizes in his paper. Unfortunately, we don't even find out about the Fed staff's assessments of labor market slack until those documents are released after a five-year lag. I don't see why those assessments can't be made available in real time, because then, if analysts want to examine the implications of any particular policy rule, they can do so using the Fed's real-time assessments of the output gap, as well as making comparisons with the implications of other assessments such as those published by the CBO, the IMF, and the Organisation for Economic Co-operation and Development.

So the key premise is that policymakers need to explain their decisions in terms of a coherent policy strategy. In that regard, it's worth noting that the FOMC's Statement on Longer Run Goals and Policy Strategy is almost exclusively aimed at clarifying its

longer-run goals. In fact, there's really only one clause in one sentence, namely, the indication that the FOMC "follows a balanced approach." In effect, what's still missing—and what's desired by the general public as well as academic economists, market investors, and members of Congress—is for the FOMC to explain its policy strategy more clearly.

Now there are two ways to do that. One of them is using forecasts, and that's the part where the FOMC regularly provides a substantial amount of information four times a year in the Summary of Economic Projections, including the outlook for GDP growth, unemployment, inflation, and the federal funds rate. I'll just highlight here that the essential problem is that forecasts depend crucially on the use of macroeconomic models. It might be a single model or a cluster of models, and the forecast might involve some judgmental adjustments (which tend to be remarkably opaque). Moreover, as we all know very well, such forecasts can be systematically and persistently wrong. Indeed, for the past five years in a row, the FOMC's projections for GDP growth have been much too optimistic. And it looks like that might happen yet again this year. Likewise, the trend for inflation has generally been downward over the past five years. But at every juncture, the FOMC's projections have been overly optimistic in predicting that inflation over the subsequent year or two would be coming back upward to its 2 percent target. And that was their outlook yet again in March of this year. I sincerely hope that outlook materializes, but it's not at all clear from the latest inflation data whether that will actually happen.

That track record simply underscores the pitfalls of relying too heavily on forecast targeting as the tool for determining and explaining the stance of monetary policy. The salient alternative, as John Taylor has emphasized, is to use simple policy benchmark rules that are designed to be reasonably robust in the face of model uncertainty. Of course, each of these tools—model-based forecasts

and simple policy rules—have merits as well as shortcomings. Consequently, a sensible and prudent approach to monetary policy involves using both types of tools in making policy decisions and explaining those decisions. I hope that the FOMC would see the benefits of moving in that direction voluntarily, since that would likely be a better outcome than for Congress to adopt legislation with specific edicts about the FOMC's deliberative process and communications. However, if the Congress does decide that new legislation is warranted, then such legislation should be focused on ensuring that the FOMC provides sufficient information to the public to explain its decisions as clearly as possible.

GENERAL DISCUSSION

JOHN WILLIAMS: I really like this paper. I was one of the organizers of the conference in New Zealand. It's great to go to New Zealand in December. And it was a great opportunity to revisit the amazing accomplishments of the Reserve Bank of New Zealand in charting this course of inflation targeting twenty-five years ago all on their own as part of a much larger reform package in New Zealand.

I think though that the paper goes through kind of thinking through: Where are the distortions and what are the optimal policy taxes or subsidies? You have a distorted equilibrium and you're trying to come up with some countervailing distortions in terms of the penalty or the loss function the central bankers face.

I do go back to this twenty-five years ago in the invention of inflation targeting and think: What was the problem they were trying to solve? Here today, and we talked a lot about this, there's a perceived problem—I think George Shultz laid it out very nicely—about central bankers exceeding what they should be doing, and as a result making bad decisions. But if you do go back to twenty-five years ago, the problem was very high inflation in many countries, governments not holding central banks accountable, and central banks not taking responsibility or accountability for the high inflation. So in thinking about Carl's paper, we don't want to somehow lose that context in that discussion. In many ways, this goal-based approach was designed to make the central bank formally accountable for the one thing that a central bank actually can for sure do, and that's control inflation over the medium to long term. Central banks may want to be able to do a lot of other things, and sometimes they can, but that's the one thing that they should own, and that's one

of the things I think that inflation targeting clearly did accomplish. And so if you think about all the costs and the damage to economies from very high and variable inflation in the US and Canada and Britain and New Zealand and in Australia and in every country you can think of, and basically the accomplishment of inflation targeting, of the accountability that's built around inflation targeting around the goal, I just think that thinking about any future kind of ways to put more accountability on a central bank that we don't lose sight of that, because that is something that I think was hugely successful and when we didn't have that accountability for a goal, it had a significant cost to society.

MICHAEL DOTSEY: OK, I want to say something that relates to both this paper and what Paul Tucker said before. It's sort of in defense of monetary rules of the past that were discarded.

So—the gold standard. Actually, the gold standard was not that bad of a rule, and if it really worked, it was a contingent rule. And if you had some huge shock come up, you could bail out. In fact, it's better than what the eurozone's got, because they don't have the contingency.

And the other one is monetary aggregates. Actually, it really wasn't tried. In fact, if they had done something like Ben McCallum's rule, which was discussed quite a bit fifteen to twenty years ago, that might have worked. So there are these events in history that became path-dependent, that said, "No, we're not going to do that. We're going to go toward using interest rates, but we're not going to use the gold standard." So you have to be more careful when you talk about it and assume these are dead ghosts that didn't work. Actually, one did work, and one could have worked better.

DAVID PAPELL: I think you need to be careful about drawing too much of a dichotomy between goal-based and instrument-based rules. The Taylor rule includes an inflation target which

feeds into the intercept, and that intercept feeds into whether you would have deviations or not. Since you're embedding an inflation target, you're looking at—to my mind, at least—more accountability because you're seeing quarter-to-quarter whether what you're doing is going to move you toward that inflation target. And I think that's something you should think about in terms of the dichotomy between the rules.

JOHN TAYLOR: So, Carl, I see from your paper that when you have the right rule, you put all the weight on that rule. To me, that's really what we're talking about in the discussion of legislation. We do have a sense of what rules have worked pretty well—not optimal, exactly—and the Fed could base its strategy on those. And I think there are advantages also to having predictability, a strategy, and all that. Also, the legislation doesn't require the Fed to follow a particular rule, but a reference rule could help achieve predictability.

Another issue relates to the idea of "constrained discretion." As described in Carl's paper, the goal-based approach is a way to constrain not the central bank, but the government. And so it leaves no constraint on the central bank. And that's the problem with so-called constrained discretion. The terms may sound good, but it doesn't constrain discretion in any way, and so policy becomes a whatever-it-takes philosophy to get to the goals. That's what worries a lot of us now. It seems like it's completely up for grabs what the Fed and some other central banks will do. It's like Andy's reference to the Fed: strategy is mentioned, but there's no discussion of strategy. It's almost as if the focus on those long-run goals has let central bankers say, "Hey, don't worry about it. We've got those goals. Let us do whatever we want. It will be OK." And you get this highly discretionary setup.

CARL WALSH: Let me just respond to a couple of the comments. The framework of the paper is very simple to allow some analytical

expressions to be obtained and to get a sense of what sort of factors would push you toward trying to put either more or less weight on the performance measures. The role of the shocks to the central bank preferences was to exactly get at—or at least have a channel for—the types of things that I think you're worried about, John. The central bank's preferences aren't, in some sense, tied down. If the central bank is potentially pursuing things that really are not in their mandate, one needs some way of judging their performance to hold them accountable.

But in the setup I've used, the big sources of bad policy, such as unachievable goals that lead to high rates of inflation, are absent. In some sense the model presumes you've solved the first-order problem, and now you're worrying about the second-order problem associated with getting stabilization policies right. And actually if you go back to either the classic Barro-Gordon paper on the time inconsistency of optimal monetary policy or Matt Canzoneri's paper on the inflation bias in the face of private information, you'll see they both concluded that with perfect information, you could just assign a specific rule to the central bank and tell them, "This is what you should do."

I think that the perfect information case is an environment in which we wouldn't be worried about things like performance measures and policy discretion. You could just say to the central bank, "Here is the list of contingencies, and in this contingency, you do this." But, that's the world of the model, where you can specify what all the contingencies are. In the real world, you can't, and then the issue is, what works best? Can you simply set out the overarching goals? Or, do you want to be more specific, and say, "We're going to evaluate you on the basis of how your instrument is moved relative to a benchmark rule?"

Now, as Andy pointed out, in the examples I examined, I didn't use an optimal rule. I just used the rule in the House legis-

lation. If you design the optimal rule, then you'd want the power of the performance measure (the *delta*) to be very high. That is, if you know the optimal rule and if everything is observable, you can write down exactly what the central bank should do, and you hold them accountable for implementing that rule. The simple model is trying to capture the idea that we don't really believe we're in a world in which we know the best rule. In that environment, the question is: Which sorts of factors push you toward relying more on a rule to evaluate policy? And which factors push you more in a direction of focusing on the goals of policy to evaluate the central bank?

JOHN COCHRANE: I'd like to follow up with John Taylor's comment here. I think the model left out two of the most important considerations of goals. First, suppose the Fed just has an inflation goal, so its instructions are basically: do whatever you want to produce the desired inflation. Then the central bank can wake up and say, "We're buying stock in Paul Tucker's company, and we're going to mandate lending over here, because this is our macroprudential way to achieve the inflation goal." Do-what-it-takes with no limit on how is dangerous.

Second, an inflation target is also a commitment by the rest of the government, not just the central bank. I read this as the great success of New Zealand. Its inflation target was a joint monetary and fiscal policy accord. It said that fiscal policy would back up a 2 percent inflation, and only a 2 percent inflation.

DOTSEY: I think John raised an interesting point, but I'm not sure the paper actually addresses the point he raised. He sort of talked about how we get rid of some of the time inconsistency by designing these things. But I think you would want to solve—which I don't think you did—the full commitment problem, and then ask: What would I append in the time-inconsistent problem to sort of get me closer to that? I don't think you did that exercise.

WALSH: Well, in the estimated model I compare outcomes under alternative regimes by evaluating the combination of price inflation, wage inflation, and output gap volatility that the model implies is the correct measure of social welfare. I don't compare how well the performance measures do or how poorly they do relative to the fully optimal commitment policy.

REFERENCES

Alesina, Alberto, and Lawrence Summers. 1993. "Central Bank Independence and Macroeconomic Performance." *Journal of Money, Credit, & Banking* 25, no. 2: 157–162.

Athey, Susan, Andrew Atkeson, and Patrick J. Kehoe. 2005. "The Optimal Degree of Discretion in Monetary Policy." *Econometrica* 73, no. 5: 1431–1475.

Bade, Robin, and Michael Parkin. 1984. "Central Bank Laws and Monetary Policy." University of Western Ontario.

Baker, George P. 1992. "Incentive Contracts and Performance Measurement." *Journal of Political Economy* 100, no. 3: 598–614.

Baker, George, Robert Gibbons, and Kevin Murphy. 1994. "Subjective Performance Measures in Optimal Incentive Contracts." *Quarterly Journal of Economics* 109, no. 4: 1125–1156.

Barro, Robert. J., and David B. Gordon. 1983. "A Positive Theory of Monetary Policy in a Natural-Rate Model." *Journal of Political Economy* 91, no. 4: 589–610.

Benhabib, Jess, Stephanie Schmitt-Grohe, and Martin Uribe. 2001. "The Perils of Taylor Rules." *Journal of Economic Theory* 96: 40–69.

Billi, Roberto M. 2013. "Nominal GDP Targeting and the Zero Lower Bound: Should We Abandon Inflation Targeting?" Sveriges Riksbank working paper no. 270, June.

Blinder, Alan S., Michael Ehrmann, Marcel Fratzscher, Jakob De Haan, and David-Jan Jansen. 2008. "Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence." *Journal of Economic Literature* 46, no. 4: 910–945.

Canzoneri, Matthew B. 1985. "Monetary Policy Games and the Role of Private Information." *American Economic Review* 75: 1056–1070.

Carlstrom, Charles T., and Timothy S. Fuerst. 2009. "Central Bank Independence and Inflation: a Note." *Economic Inquiry* 47, no. 1: 182–186.

Casares, Miguel, Antonio Moreno, and Jesus Vazquez. 2011. "Wage Stickiness and Unemployment Fluctuations: An Alternative Approach." *SERIEs* 3, no. 3: 395–422.

Chen, Han, Vasco Curdia, and Andrea Ferrero. 2012. "The Macroeconomic Effects of Large-Scale Asset Purchase Programmes." *Economic Journal* 122 (September): F289–F315.

Clarida, Richard, Jordi Galí, and Mark Gertler. 1999. "The Science of Monetary Policy: A New Keynesian Perspective." *Journal of Economic Literature* 37, no. 4: 1661–1707.

Crowe, Christopher, and Ellen E. Meade. 2007. "The Evolution of Central Bank Governance around the World." *Journal of Economic Perspectives* 21, no. 4: 69–90.

Cukierman, Alex. 1992. *Central Bank Strategies, Credibility and Independence.* Cambridge, MA: MIT Press.

Cukierman, Alex, Steven B. Webb, and Bilin Neyapti. 1992. "Measuring the Independence of Central Banks and Its Effect on Policy Outcomes." *World Bank Economic Review* 6, no. 3: 353–398.

Debelle, Guy, and Stanley Fischer. 1994. "How Independent Should a Central Bank Be?" *Carnegie Rochester Conference Series on Public Policy* 38: 195–225.

Dincer, N. Nergiz, and Barry Eichengreen. 2014. "Central Bank Transparency and Independence: Updates and New Measures." *International Journal of Central Banking* 10, no. 1: 189–253.

Drazen, Allan. 2000. *The Political Economy of Macroeconomics.* Princeton, NJ: Princeton University Press.

Erceg, Christopher, Dale W. Henderson, and Andrew T. Levin. 2000. "Optimal Monetary Policy with Staggered Wage and Price Contracts." *Journal of Monetary Economics* 46, no. 2: 281–313.

Evjen, Snorre, and Thea B. Kloster. 2012. "Norges Bank's New Monetary Policy Loss Function: Further Discussion." Norges Bank research working paper no. 11.

Frankel, Alexander. 2014. "Aligned Delegation." *American Economic Review* 104, no. 1: 66–83.

Galí, Jordi. 2008. *Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework.* Princeton, NJ: Princeton University Press.

——— 2013. "Notes for a New Guide to Keynes (I): Wages, Aggregate Demand, and Employment." *Journal of the European Economic Association* 11, no. 5: 973–1003.

Ilbas, Pelin, Øistein Røisland, and Tommy Sveen. 2012. "Robustifying Optimal Monetary Policy Using Simple Rules as Cross-Checks." Norges Bank research working paper no. 2012–22: 30.

——— 2013. "The Influence of the Taylor Rule on US Monetary Policy." Norges Bank research working paper, 2013–04: 34.

Kahn, George A. 2012. "The Taylor Rule and the Practice of Central Banking." In *The Taylor Rule and the Transformation of Monetary Policy*. Edited by Evan F. Koenig, Robert Leeson, and George A. Kahn. Stanford, CA: Hoover Institution Press: 63–102.

Kydland, Finn E., and Edward C. Prescott. 1977. "Rules Rather than Discretion: The Inconsistency of Optimal Plans." *Journal of Political Economy* 85, no. 3: 473–91.

Levin, Andrew T., Volker Wieland, and John C. Williams. 1999. "Robustness of Simple Monetary Policy Rules under Model Uncertainty." In *Monetary Policy Rules*. Edited by John B. Taylor. Chicago: Chicago University Press.

Levin, Andrew T., and John C. Williams. 2003. "Robust Monetary Policy with Competing Reference Models." *Journal of Monetary Economics* 50, no. 5: 945–975.

Lund, Kathrine, and Ørjan R. Robstad. 2012. "Effects of a New Monetary Policy Loss Function in N.E.M.O." Norges Bank research working paper no. 10.

Poole, William. 1970. "Optimal Choice of Monetary Policy Instrument in a Simple Stochastic Macro Model." *Quarterly Journal of Economics* 84, no. 2: 197–216.

Posen, Adam. 1993. "Why Central Bank Independence Does Not Cause Low Inflation: There is No Institutional Fix for Politics." *Finance and the International Economy* 7: 40–65.

Rogoff, Kenneth. 1985. "The Optimal Degree of Commitment to an Intermediate Monetary Target." *Quarterly Journal of Economics* 100, no. 4: 1169–1189.

Rudebusch, Glenn D. 2002. "Term Structure Evidence on Interest Rate Smoothing and Monetary Policy Inertia." *Journal of Monetary Economics* 49, no. 6: 1161–1187.

Ruge-Murcia, Francisco J. 2014. "Do Inflation-Targeting Central Banks Implicitly Target the Price Level?" *International Journal of Central Banking* 10, no. 2: 301–326.

Svensson, Lars E. Ø. 2003. "What Is Wrong with Taylor Rules? Using Judgment in Monetary Policy through Targeting Rules." *Journal of Economic Literature* 41, no. 2: 426–477.

Taylor, John B. 1993. "Discretion versus Policy Rules in Practice." *Carnegie Rochester Conference Series on Public Policy* 39, no. 1: 195–214.

——— 2011. "The Rules-Discretion Cycle in Monetary and Fiscal Policy." *Finnish Economic Papers* 24, no. 2: 78–86.

——— 2012. "Monetary Policy Rules Work and Discretion Doesn't: A Tale of Two Eras." *Journal of Money, Credit, & Banking* 44, no. 6: 1017–1032.

——— 2013. "The Effectiveness of Central Bank Independence vs. Policy Rules." *Business Economics* 48 (July 2013): 1–21.

Taylor, John B., and John C. Williams. 2010. "Simple and Robust Rules for Monetary Policy." In *Handbook of Monetary Economics,* vol. 3. Edited by Benjamin Friedman and Michael Woodford: 829–859.

Tillmann, Peter. 2012. "Cross-Checking Optimal Monetary Policy with Information from the Taylor Rule." *Economic Letters* 117, no. 1: 204–207.

Tirole, Jean. 1994. "The Internal Organization of Government." *Oxford Economic Papers* 46, no. 1: 1–29.

Vestin, David. 2006. "Price-Level Targeting versus Inflation Targeting." *Journal of Monetary Economics* 53, no. 7: 1361–1376.

Walsh, Carl E. 1986. "In Defense of Base Drift." *American Economic Review* 76, no. 4: 692–700.

——— 1987. "Monetary Targets and Inflation: 1976–1984." Federal Reserve Bank of San Francisco *Economic Review*, Winter.

——— 1995a. "Is New Zealand's Reserve Bank Act of 1989 an Optimal Central Bank Contract?" *Journal of Money, Credit, & Banking* 27, no. 4, part 1: 1179–1191.

——— 1995b. "Optimal Contracts for Central Bankers." *The American Economic Review* 85, no. 1: 150–167.

——— 2003a. "Accountability, Transparency, and Inflation Targeting." *Journal of Money, Credit, & Banking* 35, no. 5: 829–849.

——— 2003b. "Speed Limit Policies: The Output Gap and Optimal Monetary Policy." *American Economic Review* 93, no. 1: 265–278.

——— 2010. *Monetary Theory and Policy*. 3rd. ed. Cambridge, MA: MIT Press.

———2015. "Goals and Rules in Central Bank Design." *International Journal of Central Banking* 11, no. S1: 1–45.

Woodford, Michael. 2010. "Optimal Monetary Stabilization Policy." In *Handbook of Monetary Economics*, vol. 3. Edited by Benjamin M. Friedman and Michael Woodford, chap. 14: 723–828.