Discussion of “Complexity and Monetary Policy”*

Glenn D. Rudebusch
Federal Reserve Bank of San Francisco

> “Policy always operates in an environment of uncertainty. The events of the past three years have highlighted to me yet again our limited knowledge of the dynamics of the financial system, the economy, and the interactions between them.”
>
> —Donald Kohn, April 8, 2010

1. Introduction

In the early 1990s, I had the pleasure of working with Don Kohn at the Federal Reserve Board in the Division of Monetary Affairs. It was an exciting time, in part because of a fascinating synergy between much of the practical monetary policy analysis that was being conducted and the contemporaneous academic and central bank monetary policy research. Policy questions are often considered simultaneously by central bankers and researchers, but at that time, the convergence seemed to be even greater than usual. In particular, the evaluation and use of simple interest rate monetary policy rules burgeoned during that time in both real-world policy discussions and research papers.

Since that early start, a large amount of research has examined simple policy rules in estimated macroeconomic models with explicit loss functions. Continuing in this tradition, Athanasios Orphanides and Volker Wieland have written an interesting paper that evaluates the robustness of simple interest rate monetary policy rules in different macroeconometric models. Their paper is distinguished

*The views expressed in this discussion are my own and should not necessarily be attributed to others in the Federal Reserve System. Author contact: www.frbsf.org/economists/grudebusch.

by the breadth of the euro-area models they use: eleven different models ranging from traditional Keynesian-style representations to more modern ones. Yet, their analysis clearly remains grounded in a pre-crisis research agenda. The models, loss function, and policy instrument they use would all be familiar to a researcher working a decade ago. Especially because our interest is focused on central banking "during and after the crisis," it is useful to look ahead and consider how to push this type of analysis forward in light of the recent financial and economic upheaval.

Two aspects of the recent global economic crisis highlight what I think are important shortcomings in the standard formulation of monetary policy rule evaluation employed by Orphanides and Wieland. First, one notable feature of the crisis was the extent to which central banks were willing to make swift and sizable adjustments to the stance of monetary policy. For example, after the failure of Lehman, central banks around the world did not "smooth" interest rates but dropped them quickly to a near-zero lower bound. This rapid response was in stark contrast to the assumption of very slow policy gradualism, which is common in much of the research literature and is also maintained by Orphanides and Wieland. A second notable feature—as highlighted by the epigraph above—was how inadequate existing macroeconomic and financial models were for analyzing the genesis, interactions, and repercussions of the financial crisis and Great Recession. Evidently, future analyses of monetary policy rules will need to consider a larger set of macroeconomic models and monetary policy instruments.

I will consider each of these two shortcomings in turn.

2. The Crutch of Policy Instrument Inertia

There is a curiously common assumption among researchers that central banks greatly value a very gradual or partial adjustment of the monetary policy instrument. Most researchers and central bankers would agree that a sensible simple approximation to a central bank loss function is one in which the central bank minimizes a discounted future sum of a loss function that is a weighted average of the squared inflation gap and squared output gap:

$$Loss_t = (\pi_t - \pi^*)^2 + \lambda y_t^2, \tag{1}$$

where inflation, π_t, and the output gap, y_t, are measured at a quarterly frequency, and π^* is the central bank's inflation target (e.g., Rudebusch and Svensson 1999). The non-negative parameter λ is the weight on output stabilization relative to inflation stabilization. A typical loss function used in the literature sets $\lambda = 1$, which equally penalizes a 1-percentage-point deviation of inflation from target and a 1 percent output gap. In the United States, such a loss function appears broadly consistent with the FOMC's statement (Federal Reserve Board 2012) of its balanced policy approach:

> In setting monetary policy, the Committee seeks to mitigate deviations of inflation from its longer-run goal and deviations of employment from the Committee's assessments of its maximum level. These objectives are generally complementary. However, under circumstances in which the Committee judges that the objectives are not complementary, it follows a balanced approach in promoting them.

More generally, the quadratic loss function can be viewed as a second-order approximation to a wide range of dual-mandate policy preferences.

Unfortunately, using the plausible loss function (1) to calculate the optimal setting of monetary policy in a variety of empirical macroeconomic models produces implausibly volatile swings in the policy interest rate. That is, the recommended path for the optimal policy interest rate displays extremely large movements—say, several percentage points on a quarter-by-quarter basis. Such high policy rate volatility doesn't match what is found in the real world (e.g., Rudebusch 2001) and would shock any central banker. In this calculation of optimal monetary policy, either the loss function or the macroeconomic model appears to be badly misspecified.

To my mind, the blame for the excessive volatility of the calculated optimal policy path falls on the macroeconomic models, which appear to underestimate in a fundamental way the nature of the uncertainty faced by real-world policymakers. If you ask a central banker why he or she typically does not advocate moving the policy interest rate by, say, 100 basis points at policy meetings, the answer would most likely focus on the lack of solid new information that would justify a policy move of that size. In particular, uncertainty about even the current state of the economy and the nature of the shocks buffeting the economy is enormous (to say nothing of forecast uncertainty). For example, the latest spending and output estimates will invariably be revised, the latest unemployment data are clouded by some combination of cyclical and structural influences, and the latest inflation fluctuations reflect some unknown degree of permanent and transitory factors. In the real world, there is only a slow accretion to policymakers of actionable information regarding the key macroeconomic variables driving monetary policy. Similarly, there is a painfully slow learning process about the size and variety of the economic shocks. The persistence of the policy rate stemming from this gradual inflow of information reflects an inertia that is *extrinsic* to the central bank and can be labeled "policy information inertia."

In contrast, the literature on optimal monetary policy has veered in a different direction. Instead of correcting or better calibrating the policymaker's information set in the model, the response has been to adopt a "policy instrument inertia" in which the persistence of the policy interest rate reflects an inertia that is *intrinsic* to the central bank. Under this view, there is a slow, intentionally drawn-out adjustment of the policy rate in response to economic news. Such inertia in policy action implies that the central bank knowingly distributes desired changes in the policy interest rate over an extended period of time. The resulting smooth persistent path of the policy rate is thought to reflect deliberate "interest rate smoothing" or "partial adjustment" or "gradualism" on the part of the central bank.

Such policy instrument inertia is evident in the commonly used loss function

$$Loss_t = (\bar{\pi}_t - \pi^*)^2 + \lambda y_t^2 + \nu(\Delta i_t)^2, \tag{2}$$

where i_t is the quarterly average level of the short-term policy interest rate and $\Delta i_t = i_t - i_{t-1}$. The non-negative parameter ν is the weight on interest rate movements relative to inflation stabilization. Furthermore, a common parameterization in the literature is $\lambda = \nu = 1$, which equally penalizes a 1-percentage-point inflation gap, a 1 percent output gap, and a 1-percentage-point change in the quarterly average policy interest rate.[1] (This is precisely the one-period loss function used by Orphanides and Wieland.) Real-world policymakers would find such a representation of their preferences bizarre. The penalty on interest rate changes is implausibly high given the overwhelming emphasis among central banks on the first two objectives relative to the third. The implausibility of equation (2) was demonstrated during the financial crisis, when central banks made large changes to policy interest rates with little or no evident "cost" associated with those changes. Any central banker would gladly raise the policy interest rate by 100 basis points if that action drove inflation 1 percentage point closer to the target inflation rate.

Although it is far less realistic than equation (1), the loss function (2) is widely used in models because it can produce optimal monetary policy recommendations that look similar to real-world policy settings. For example, the optimal coefficients calculated for a particular policy rule are much closer to the estimated coefficients of that rule. However, the use of the incorrect loss function (2) together with the inadequate standard macroeconomic model is simply an attempt to combine two wrongs to make a right. The use of policy instrument inertia and an interest rate volatility augmented loss function are a crutch to avoid confronting the shortcomings in modeling policymakers' information set inertia.

A belief in sluggish monetary policy adjustment in the real world is often reinforced by a misinterpretation of estimated inertial policy rules. The most commonly estimated variants of these rules have been dynamic forms of the Taylor rule. In such rules, the actual interest rate partially adjusts to a desired interest rate that depends on the inflation and output gaps,

$$i_t = (1-\rho)(\bar{\imath} + g_\pi(\pi_t - \pi^*) + g_y y_t) + \rho i_{t-1} + \xi_t, \tag{3}$$

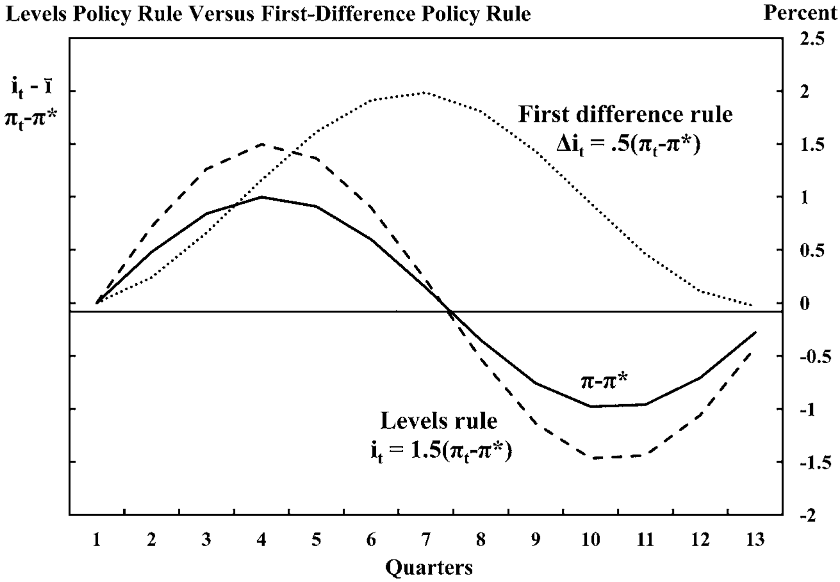
[1]The use of a quarterly frequency, which is the relevant one for the empirical monetary policy rules literature, is important. At a higher frequency—weekly or even monthly—there is a *short-run* smoothing of policy rates by central banks, which involves, for example, cutting the policy rate by two 25-basis-point moves in fairly quick succession, rather than reducing the rate just once by 50 basis points (see Rudebusch 1995, 2006). However, short-term partial adjustment *within a quarter* is essentially independent of whether there is monetary policy instrument inertia *over the course of several quarters.*

where $\bar{\imath}$ is a neutral policy rate that depends on the equilibrium real rate and the inflation target, and g_π and g_y are the central bank response coefficients to inflation and output gaps. In an empirical regression of equation (3), the estimate of the partial adjustment coefficient ($\hat{\rho}$) is typically around 0.8, which is often considered evidence of monetary policy instrument inertia. Under this interpretation, if a central bank knew it wanted to increase the policy rate by a percentage point, it would raise the rate by only about 20 basis points in the first three months and by about 60 basis points after one year. Such very slow convergence of the policy rate to its desired level seems implausible. Indeed, Rudebusch (1998, 2002b, 2006) argues that the monetary policy rule $\hat{\rho}$ estimates are misleading and provide the illusion of monetary policy instrument inertia. In particular, if the desired policy interest rate depends on persistent factors other than the current output and inflation in the Taylor rule, then such a misspecification could result in a spurious finding of partial adjustment. Indeed, based solely on simple policy rule estimates, it would be easy to incorrectly infer that a central bank's policy adjustment was sluggish when, in fact, it followed a rule with no policy inertia but sometimes deviated from the rule for several quarters at a time in response to other factors.

In this respect, it is interesting to consider the first-difference rule resurrected in Orphanides and Wieland from Judd and Motley (1992). First-difference rules have never gained much attention because the timing of their policy rate recommendations is often considered at odds with reality. In the past, I frequently heard Don Kohn and other policymakers worry about being "behind the curve." In some economic scenarios, first-difference rules appear to be a recipe for lagging behind the economic cycle.[2] Figure 1 compares the policy interest rate recommendations over an inflation cycle from a levels policy rule—where $i_t = 1.5(\pi_t - \pi^*)$, like a simple Taylor rule response—and a first-difference policy rule—where $\Delta i_t = 0.5(\pi_t - \pi^*)$, as in Orphanides and Wieland. The levels rule responds promptly by raising the real interest rate higher than its neutral value when inflation is higher than the target and lowering it below the neutral value when inflation is below its target. (That

[2]Timing problems are also common in nominal income targeting rules (Rudebusch 2002a).

Figure 1. Responses of Two Policy Rules to an Inflation Cycle



is, $i_t > \bar{\imath}$ when $\pi_t > \pi^*$, and $i_t < \bar{\imath}$ when $\pi_t < \pi^*$.) Accordingly, the real interest rate is high when inflation is high and low when inflation is low. In contrast, the first-difference rule is out of phase and is very slow to lower the policy rate even when inflation is too low.[3] Thus, in this situation, relative to the usual way real-world central bankers talk about the stance of policy, first-difference rules are very counterintuitive.

3. Expanding the Set of Models and Policy Instruments

The financial crisis has also highlighted a variety of important new elements that should be incorporated in model-based monetary

[3]This figure assumes the path of inflation is exogenous. If, instead, inflation is determined via a forward-looking model with central bank credibility, the first-difference rule can perform well. The first-difference rule (which is a levels rule for the price level) commits the central bank to hold the nominal interest rate above neutral until the price level returns to target, so the arc of the nominal interest rate in figure 1 is one-half the arc of the price level. This is a very different commitment than real-world central banks have made so far.

policy evaluations. In particular, a key feature of recent events has been the close feedback between the real economy and financial conditions. In many countries, the credit and housing boom that preceded the crisis went hand in hand with strong spending and production. Similarly, during the crash, deteriorating financial conditions helped cause the recession and were in turn exacerbated by the deep declines in economic activity. Such macro-finance linkages pose a significant challenge to both macroeconomists and finance economists because of the long-standing separation between the two disciplines. To understand important aspects of the recent intertwined financial crisis and economic recession, a joint macro-finance perspective is likely necessary (e.g., Rudebusch 2010). Certainly, it seems important to consider models in which a bubble in house prices is at least conceivable, along with potential misalignments of other asset prices. In addition, given the experience of the recent crisis, channels to connect macroeconomic outcomes and financial stresses in both the banking and non-banking sectors (the latter including, say, a partial freezing of the commercial paper market) would be desirable. Creating economic and financial models that respect the zero lower bound on nominal interest rates should be another priority.

The recent recession and sluggish recovery have also reaffirmed the importance of various long-standing issues in macroeconomic modeling. The large degree of uncertainty involved in the real-time measurement of potential output has been reemphasized. Orphanides and Wieland, as in Rudebusch (2001, 2002a), consider a reasonable persistent output-gap mismeasurement process; however, the ability of multivariate measures of slack—including, say, information in the unemployment gap—to reduce this uncertainty should be explored.[4] Given the international scope of the recent crisis, a reemphasis on global linkages in trade and financial markets in the model analysis is warranted. Finally, the recent behavior of inflation has exposed inadequacies in our understanding of price dynamics.

Just as the set of macroeconomic models needs to be enlarged, optimal policy exercises should consider the expanded scope of

[4] In any case, the nominal income rule advocated by Orphanides and Wieland is not a satisfactory solution to this issue; see Rudebusch (2002a).

monetary policy actions. The set of monetary policy instruments used to address the crisis has grown considerably beyond the short-term interest rate. Central banks have used a variety of credit-easing actions, including discount window operations, lending of “last resort,” and long-term refinancing. New programs of quantitative easing and large-scale bond purchases have been instituted (see Christensen and Rudebusch 2012). Finally, overcoming its traditional reticence to discuss future policy settings (see Rudebusch and Williams 2008), the Federal Reserve has also employed forward policy guidance in an attempt to influence public expectations about future short-term interest rates. Actions concerning financial stability also remain squarely in the purview of central banks. Most, and perhaps all, of these new tools are unlikely to be used on an ongoing basis in the future, but they are permanent additions to the central banker’s toolbox and are worthy of careful analysis.

References

Christensen, J. H. E., and G. D. Rudebusch. 2012. “The Response of Interest Rates to U.S. and U.K. Quantitative Easing.” *Economic Journal* 122 (564): F385–F414.

Federal Reserve Board. 2012. “Federal Reserve Issues FOMC Statement of Longer-Run Goals and Policy Strategy.” Press Release, January 25.

Judd, J. P., and B. Motley. 1992. “Controlling Inflation with an Interest Rate Instrument.” *Economic Review* (Federal Reserve Bank of San Francisco) (3): 3–22.

Kohn, D. L. 2010. “The Economic Outlook.” Speech presented at the Federal Reserve Bank of San Francisco, San Francisco, California, April 8.

Rudebusch, G. D. 1995. “Federal Reserve Interest Rate Targeting, Rational Expectations, and the Term Structure.” *Journal of Monetary Economics* 35 (2): 245–74.

———. 1998. “Do Measures of Monetary Policy in a VAR Make Sense?” *International Economic Review* 39 (4): 907–31.

———. 2001. “Is the Fed Too Timid? Monetary Policy in an Uncertain World.” *Review of Economics and Statistics* 83 (2): 203–17.

———. 2002a. "Assessing Nominal Income Rules for Monetary Policy with Model and Data Uncertainty." *Economic Journal* 112 (479): 402–32.

———. 2002b. "Term Structure Evidence on Interest Rate Smoothing and Monetary Policy Inertia." *Journal of Monetary Economics* 49 (6): 1161–87.

———. 2006. "Monetary Policy Inertia: Fact or Fiction?" *International Journal of Central Banking* 2 (4): 85–135.

———. 2010. "Macro-Finance Models of Interest Rates and the Economy." *The Manchester School* (University of Manchester) 78 (s1): 25–52.

Rudebusch, G. D., and L. E. O. Svensson. 1999. "Policy Rules for Inflation Targeting." In *Monetary Policy Rules*, ed. J. B. Taylor, 203–46. Chicago: Chicago University Press.

Rudebusch, G. D., and J. C. Williams. 2008. "Revealing the Secrets of the Temple: The Value of Publishing Interest Rate Projections." In *Asset Prices and Monetary Policy*, ed. J. Campbell, 247–89. Chicago: Chicago University Press.