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Macroeconomic Models for Monetary Policy

This Economic Letter *summarizes the papers presented at the conference "Macroeconomic Models for Monetary Policy" held at the Federal Reserve Bank of San Francisco on March 1–2, 2002, under the joint sponsorship of the Federal Reserve Bank of San Francisco and the Stanford Institute for Economic Policy Research. The papers are listed at the end and are available at http://www.frbsf.org/economics/conferences/0203/index.html.*

Models of the economy are valuable tools for monetary policymakers for at least two reasons. First, such models can help produce forecasts of future inflation, output, and other variables, which are crucial for a forward-looking central banker who takes into account lags in the effects of monetary policy. Second, macroeconomic models can help quantify the amount of uncertainty that central bankers face in making their policy choices—particularly through the use of alternative model simulations. The research and discussion at this conference considered which macroeconomic models would be most useful in guiding monetary policy. Some of the relevant issues included the role of explicit expectations in models, the use of multiple models, the importance of judgmental adjustments to models, identifying model structural change, and the appropriate size and amount of detail in models.

There are three broad categories of macroeconomic models currently being considered for monetary policy analysis, and this conference had examples and proponents of all three. One category contains calibrated or estimated general equilibrium (GE) models, which are closely based on a detailed theoretical structure that features explicitly optimizing businesses and consumers. The paper by Smets and Wouters formulates such a model with sticky prices and wages for the euro area to investigate business cycle fluctuations and optimal monetary policy.

The papers by Sbordone and by Neiss and Nelson also start with a dynamic stochastic GE model as motivation; however, their analyses focus on the single issue of the appropriate econometric specification of the determination of wages and prices, the subject of the paper by Rudd and Whelan as well. Such a focus on the empirical estimates of a structural equation is the hallmark of the second type of model used to analyze monetary policy: the structural macroeconometric model. As was made clear in the conference panel discussion by Adrian Pagan and David Stockton, such structural macroeconometric models are the most common type of model used at central banks. These models, which continue a line of research over 50 years old, have been updated during the past decade or so with explicit expectations and better long-run properties, but another panel discussant, Larry Christiano, suggested that GE models could be a useful alternative.

The third category of models contains those that are almost purely statistical in nature, particularly Vector Autoregressions (VARs). The paper by Leeper and Zha uses a VAR to consider the plausibility of various monetary policy actions, and the paper by Sims and Zha uses a VAR to examine changes in the variances of shocks that buffet the economy.

Monetary policy in an estimated GE model of the euro area

Smets and Wouters develop a dynamic stochastic GE model with sticky prices and wages for the euro area. The model is theoretically quite intricate, with features such as monopolistically competitive markets, costs to adjusting the capital stock, habit formation by consumers, and a variable rate of capacity utilization. Smets and Wouters attempt to estimate this model and analyze the relative contributions of eight different kinds of shocks to business cycle fluctuations in the euro area. They find that productivity shocks account for only 10% of the long-run variability in output, contrary to what so-called Real Business Cycle models would predict.

The estimated model is also used to show that historical monetary policy in the euro area has apparently deviated from the way an optimal monetary policy should have been set in response to various structural shocks. An important caveat to this analysis is that the unified euro area did not exist historically, so the analysis pertains to a synthetic history of reconstructed euro area data. (For a complementary analysis with a very simple macroeconometric model, see Rudebusch and Svensson 2002.)

An optimizing model of U.S. wage and price dynamics

The Phillips curve, which links inflation with an unemployment or output gap from trend, has pro-

vided perhaps the most popular empirical description of wage and price dynamics for the past half century; however, the theoretical foundations of this model are considered weak and have been the subject of almost constant debate. In her paper, Sbordone uses a GE optimizing model to derive a theoretical "New Keynesian" Phillips curve, which relates inflation to future expected inflation and marginal costs. The output gap in such a model should be measured as the deviation from potential output with a stochastic trend (i.e., incorporating actual aggregate demand and supply shocks) rather than the usual deterministic trend.

Sbordone also argues that incorporating labor cost dynamics is crucial to a model of price dynamics. She derives the joint dynamics of wages and prices implied by a sticky-price model with a perfectly competitive, flexible-wage labor market and, alternatively, with a monopolistically competitive, sticky-wage labor market. Sbordone compares the implied dynamics with actual postwar U.S. data, and concludes that the model performs quite well in predicting the inflation process using the real wage. The real output gap, when measured as deviations from a stochastic trend potential output, also performs well in matching inflation dynamics.

Should monetary policy target labor's share of income?

In a closely related paper, Rudd and Whelan challenge the empirical results in Woodford (2001) and Sbordone (2002), which also suggested that marginal costs or wages worked better in predicting inflation than the output gaps used in the traditional Phillips curve literature. Specifically, Woodford (2001) presented evidence that using real unit labor costs (labor's share of income) as a driving variable in the Phillips curve yields a superior fit for inflation than a model that uses deterministically detrended real GDP as the driving variable. For his empirical work, expectations of the driving variables were obtained from a reduced-form VAR. However, Rudd and Whelan find that Woodford's result is not robust and that the evidence in favor of using the labor's income share is highly sensitive to small changes in the specification of the VAR.

Rudd and Whelan also show that the principal reason for the good fit obtained by Sbordone (2002) is not the use of the labor income share as a driving variable, but rather an additional—and unrealistic—assumption that the nominal marginal cost evolves independently of the price level. Indeed, after imposing a similar assumption that nominal output evolves independently of the price level, Rudd and Whelan find that the New Keynesian Phillips curve with a traditional output gap (defined using a deterministically trended potential output) performs just as well as the labor income share version. Furthermore, the reason that both models obtain fairly good results is that both estimation equations include lagged inflation as one of the explanatory variables. Because inflation is highly persistent, the lagged inflation term helps explain a lot of the variation in inflation. Accordingly, the use of the labor income share does not improve the inflation prediction performance.

Inflation dynamics, marginal cost, and the output gap

The Neiss and Nelson paper also focuses on the structural modeling of inflation dynamics and argues that the output gap obtained using a smooth deterministic trend for potential output is not appropriate, because potential output should be stochastic and correspond to the output level that would prevail if there were no nominal rigidities in the economy (i.e., if prices and wages are flexible). In other words, potential output should be affected by real shocks over the business cycle and should not follow a smooth path, as typically assumed. However, rather than replacing the output gap with a marginal cost measure based on labor costs (as in the Sbordone paper), Neiss and Nelson advocate a new output gap that is constructed to be consistent in theory with a dynamic stochastic GE model.

Neiss and Nelson start by formulating a GE model characterized by habit formation and capital investment adjustment costs. They calibrate this model and discuss procedures for constructing an empirical potential output gap series that is consistent with the model. Using post-war data for the U.S., the U.K., and Australia, they find that output gaps defined in a manner consistent with their model perform as well as unit labor costs in predicting inflation. Therefore, they conclude that there is little evidence to support the recent emphasis on the role of labor market rigidities for modeling inflation.

Empirical analysis of policy interventions

Leeper and Zha attempt to provide a methodology for analyzing the response of the economy to changes in monetary policy. Such analyses are hindered by the Lucas critique, which states that changes in policy also affect the behavior of rational agents, and such behavioral changes can invalidate the model relationships estimated under the previous policy regime. As also described by Rudebusch (2002), the Lucas critique complicates the assessment of proposed policy actions.

Leeper and Zha first formulate a six-variable monthly structural VAR model and show that the monetary policy shocks identified have a fairly stable impact on the economy from 1959 to 1998, which suggests that there have been no substantive changes in agents' beliefs about the policy regime. Therefore, this estimated structural VAR model can be used to analyze the effects of hypothetical changes in policy as long as those changes are not too different

from historical actions (and thus avoid the Lucas critique). Leeper and Zha propose a statistical metric for judging whether the hypothetical policy interventions are large enough to be considered changes in the policy regime. They apply this metric to judge whether hypothetical policies represent a recognizable break from past policy in two different contexts: first, in assessing the usual central bank forecasting assumption of constant nominal interest rates and, second, in examining various policy actions that the Federal Reserve could have taken in the 1990s.

Macroeconomic switching

Sims and Zha formulate a six-variable structural VAR in which they allow for certain types of parameter variation over time. In estimating the VAR, they first allow both the policy rule and the variances of the structural shocks to change over time, and then they compare the fit of this model to one in which only the shock variances are allowed to change. From their estimates, Sims and Zha conclude that allowing for changing shock variances over time is more important for improving model fit than allowing for a changing policy rule. Furthermore, counterfactural exercises suggest that, even without the presence of a "Volcker regime," inflation in the U.S. after 1979 would have declined and the recession in the early 1980s would have been smaller, although inflation would have fallen less rapidly in this alternative and output growth would have been much slower after 1984. In contrast, the conventional wisdom on this subject (described in Rudebusch 2002) is that the systematic component of Federal Reserve monetary policy has changed dramatically over time and has at least partly accounted for the rise and fall of the historical U.S. inflation rate.

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Conference Papers

Leeper, Eric, and Tao Zha. "Empirical Analysis of Policy Interventions." Indiana University and Federal Reserve Bank of Atlanta.

Neiss, Katharine, and Edward Nelson. "Inflation Dynamics, Marginal Cost, and the Output Gap: Evidence from Three Countries." Bank of England.

Rudd, Jeremy, and Karl Whelan. "Should Monetary Policy Target Labor's Share of Income?" Federal Reserve Board.

Sbordone, Argia. "An Optimizing Model of U.S. Wage and Price Dynamics." Rutgers University.

Sims, Christopher, and Tao Zha. "Macroeconomic Switching." Princeton University and Federal Reserve Bank of Atlanta.

Smets, Frank, and Raf Wouters. "Monetary Policy in an Estimated Stochastic Dynamic General Equilibrium Model of the Euro Area." European Central Bank and National Bank of Belgium.

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Sbordone, Argia. 2002. "Prices and Unit Labor Costs: A New Test of Price Stickiness." *Journal of Monetary Economics* 49(2), pp. 265–292.

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