The Use of the New Macroeconometrics for Policy Formulation

John B. Taylor

The American Economic Review, Volume 83, Issue 2, Papers and Proceedings of the Hundred and Fifth Annual Meeting of the American Economic Association (May., 1993), 300-305.

The Use of the New Macroeconometrics for Policy Formulation

By JOHN B. TAYLOR*

Could a credible plan to reduce the government budget deficit stimulate the economy in the short run? If so, what speed of deficit reduction is required? Should the central bank alter its responsiveness to the state of the economy because of a credible deficit-reduction plan? Should the path of deficit reduction be contingent on the future state of the economy? These particular questions—all of which involve expectations and contingency rules for policy—are currently on the minds of policymakers in the United States, but similar questions have arisen in the past and are likely to arise again in the future.

One of the trends in macroeconomics during the past decade is the development of a new type of macroeconometric model and policy-evaluation technique to answer these kinds of policy questions. In an important sense, these models and techniques together constitute a new type of macroeconometrics that can provide a workable alternative to the traditional Keynesian econometric models which have dominated practical policy analysis for the past 30 years. The new macroeconometrics is an outgrowth of what is sometimes referred to as the "rational-expectations revolution" of the 1970's as represented, for example, in the collection of papers in Robert E. Lucas, Jr., and Thomas J. Sargent (1981). Were it not for the Lucas critique, for the research showing that rational expectations do not imply that policy is ineffective, for the time-inconsistency rationale for rules rather than discretion, or for the increased focus on expectations and credibility of policy, few researchers would have worried about the need for a new type of macroeconometric model. In the same way that the Keynesian econometric models (developed in the 1950's and 1960's) grew out of the Keynesian economic revolution of the 1930's, a new macroeconometrics (developing in the 1980's and 1990's) appears to be growing out of the rational-expectations revolution of the 1970's.

Two other outgrowths of the rational-expectations revolution are real-business-cycle models (see Bennett McCallum, 1989) and new-Keynesian models (see N. Gregory Mankiw and David Romer, 1991), although proponents of these two schools sometimes view their work as a response to, rather than an outgrowth of, the new classical models of the rational-expectations school. While related to these other two developments and sharing important methodological and theoretical innovations, the new macroeconometrics is logically distinct. It is more empirically based. Like traditional Keynesian econometric models, the new models are economy-wide and are usually fit to, and tested with, quarterly data that fluctuate over the business cycle, such as the spending components of GDP, prices, wages, and financial variables. Maximum likelihood and related methods of statistical inference are typically employed to test and obtain parameter estimates for the models. Moreover, the models are aimed directly at obtaining quantitative answers not only to fiscal policy questions like the ones mentioned above, but also to analogous monetary policy questions. More generally the models are concerned with questions relating to the optimal *design* of fiscal and monetary policy rules, the *transition* from one policy rule to another, and the *operation* of policy rules. The purpose of this paper is to

*Department of Economics, Stanford University, Stanford, CA 94305-6072. The research was supported by a grant from the National Science Foundation at the National Bureau of Economic Research and by the Stanford Center for Economic Policy Research. I am grateful to Craig Furfine, Volker Weiland, and John Williams for helpful assistance with the simulations.

provide a partial answer to the question posed by the title of this session—"What happened to macroeconometric models?" —by briefly describing this new development, showing how it applies to the policy questions mentioned above, and discussing its practical applicability.

I. Model Development

It is easiest for me to describe the new macroeconometrics in terms of my own work on the evaluation of policy rules using econometric models which feature rational expectations, temporary price and wage rigidities, efficient capital markets, and long-run classical properties (see Taylor, 1993). As the new volume by Ralph Bryant et al. (1993) makes clear, however, there are now many macroeconometric models that incorporate rational expectations as well as price and wage rigidities. These models are being used to study various aspects of policy rules. Some of the research work is being done at the Federal Reserve Board and at the International Monetary Fund.

The current research has by now gone well beyond the simple prototype macroeconometric models, such as the one described in Taylor (1979), which were used to illustrate the new approach and demonstrate its feasibility. The simplicity of the early models allowed for the estimation of parameters using econometric methods available at the time. It also permitted the analytical computation of optimal policy rules, thereby demonstrating how the new approach dealt with the policy-induced parameter changes predicted by the Lucas critique, with cross-equation constraints, and with time-inconsistency issues. Macroeconomic policy issues could be addressed by computing simple two-dimensional inflation–output trade-offs between the variance of inflation and the variance of real output. However, such a prototype model could not handle many practical macroeconomic policy problems, such as the relationship between monetary and fiscal policy or optimal rules for exchange rates.

A more realistic model requires a computationally tractable theory of wage and price determination consistent with long-run neutrality and rational expectations, but detailed enough to explain wage–price and business-cycle dynamics. The early formulations of price or wage rigidities in rational-expectations models found in Edmund S. Phelps and Taylor (1977) or Stanley Fischer (1977), in which prices and wages were set so as to equate expected supply and expected demand, could not explain the persistence of either wage–price movements or real output without the imposition of a large amount of exogenous serial correlation. For this reason, some version of the staggered-price or wage-setting model, which can explain these dynamics endogenously with verifiable assumptions about the length of wage- or price-setting intervals, came to provide the link between short-run changes in real variables and monetary variables in most econometric models with rational expectations. Simple uniform-length intervals between price changes have been generalized to variable lengths with different degrees of synchronization so they could fit wage data from different countries with a wide variety of wage-setting institutions (see Andrew Levin, 1991). More recently Jeff Fuhrer and George Moore (1992) have proposed modifying the staggered-wage-setting theory in order to better fit their measures of the persistence of inflation, and they have incorporated it into a rational-expectations econometric model.

Large-scale, nonlinear models with rational expectations require rapid solution algorithms and estimation techniques. Stochastic simulations are essential for macroeconomic policy evaluation. Ideally the stochastic simulations are undertaken by drawing random shocks from large estimated variance-covariance matrices of the shocks to the equations and seeing how different policy rules perform over a number of years. Without fast solution algorithms, the large number of required replications would be computationally infeasible even with supercomputers. Although procedures to solve large general linear models have been available since the late 1970's, it is the nonlinear extended path method described in Ray C. Fair and Taylor (1983)

that seems to have been most useful thus far. This method is now used to solve and simulate many econometric rational-expectations models. Recently Kenneth L. Judd (1991) and others have developed a host of new methods to solve and simulate nonlinear rational-expectations models, and progress in using these methods is proceeding rapidly (see Taylor and H. Ulhig, 1990). Without the improvement in solution techniques in the 1980's, it would not be possible to do most of the policy research now done routinely with rational-expectations econometric models. Similar methodological improvements in econometric estimation have made it easy to estimate the nonlinear models with limited information techniques (see Lars Peter Hansen, 1982), though it is still fairly expensive to estimate rational-expectations models with full-information methods without some approximations (see Fair and Taylor, 1990).

International linkages between countries are also features of many of the new rational-expectations models. Neither the small open-economy model nor the closed-economy model makes much sense for empirical research on monetary and fiscal policy in the United States. Modeling exchange rates seems particularly well-suited to the rational-expectations analysis. Moreover, the appropriate choice of an exchange-rate regime is integrally related to the optimal choice of monetary and fiscal policy rules. Hence, many empirical rational-expectations models of the United States are actually parts of multicountry models. Usually these models assume perfect capital mobility, as in the Mundell-Fleming model, and sometimes they allow for time-varying risk premia in foreign exchange and capital markets.

In sum, in most of the new macroeconometric models, links between policy variables and the short-run performance of the economy are due to microeconomic price and wage rigidities; links between policy and the long-run performance of the economy are as in the classical model; and financial links between the United States and other developed countries are based on perfect capital mobility.

II. Policy Evaluation: Deficit Reduction

The new macroeconometrics has thus far focused almost entirely on policy evaluation rather than forecasting. Policy evaluation, for example, is the exclusive concern of the analysis found in Bryant et al. (1993) and Taylor (1993). It remains to be seen whether the new macroeconometric models have much to offer forecasters, and this is a fruitful area for future research.

Of the policy research studies that have been conducted with these models, most have considered the *design* of alternative policy rules, such as whether a fixed or flexible exchange-rate system provides better macroeconomic stability, or whether a nominal GDP rule or a price rule is a better guide to monetary policy decisions. Relatively little research has been conducted on the problem of transition between one policy rule and another or on how a policy rule should be operated.

To illustrate the use of the models for policy evaluation, I focus here on one example of a transition from one policy rule to another. In particular, I consider some of the questions raised at the start of this paper concerning a shift in fiscal policy from a policy rule with a deficit of 3 percent of GDP at full employment to a policy rule with budget balance at full employment.

Table 1 shows the estimated impact on several key variables of a credible plan to eliminate the structural budget deficit gradually over five years starting in 1994, but first announced in the first quarter of 1993. The estimates come from the simulations of the estimated quarterly multicountry rational-expectations model described in Taylor (1993), which is an example of the type of new econometric model described in the preceding section. I assume that reduced government purchases make up the entire deficit reduction (similar calculations could be made with other deficit-reduction proposals).

As shown in Table 1, according to this model, such a deficit-reduction program, if credible, would actually stimulate the economy slightly in the short run: real GDP

TABLE 1—ESTIMATED EFFECTS OF A CREDIBLE DEFICIT-REDUCTION PLAN

	Federal funds rate	Long-term bond rate	Exchange rate (yen)	Real GDP	GDP deflator
1993	0.18	0.26	14.1	0.15	0.00
1994	0.36	0.24	14.9	0.55	0.15
1995	0.16	−0.07	16.1	0.28	0.16
1996	−0.23	−0.49	17.3	0.09	0.00
1997	−0.69	−0.92	18.0	−0.10	−0.25
1998	−1.09	−1.22	18.3	−0.31	−0.51
1999	−1.34	−1.35	18.0	−0.49	−0.70
2000	−1.36	−1.34	17.6	−0.18	−0.79

Notes: A decline in U.S. government purchases of 3 percent of GDP is phased in over five years beginning in 1994. Figures are percentage differences from baseline values (or percentage-point differences for interest rates) during the first quarter of the year.

increases by up to 1/2 percent in the first few years following the announcement of the program. As the actual budget reduction takes hold and the initial stimulus wears off, there is a slight decline in real GDP. After the budget cutting ends in 1999, the economy returns to the baseline path.

The mechanism through which this stimulus in the first few years occurs is perhaps surprising and may help answer some questions about the role of monetary policy during such a fiscal transition. In the first year, neither short-term nor long-term interest rates change very much. Short-term interest rates rise slightly. The Federal Reserve is assumed to be following a policy rule that calls for an increase in the federal funds rate when real GDP or the price level rises, and for a decline in the federal funds rate when real GDP or the price level falls relative to a target. With the slight improvement in the economy relative to baseline in 1993 and 1994, this policy rule entails an increase in short-term interest rates (relative to baseline) in 1993 and 1994. Because the term structure of interest rates is forward-looking, this causes the long-term interest rate to rise as well in 1993. Eventually (by 1996) the monetary policy rule calls for a decline in short-term interest rates, and anticipation of this decline results in a decline in the long-term rate starting in 1995. Clearly the model of the term structure is affecting this behavior of long-term and short-term interest rates. In this case the long-term rate is a weighted average of future short rates, but the weights, estimated empirically, decline rather rapidly. Thus the expected decline in short-term interest rates in the mid- to late 1990's has little impact on the long-term rates in 1993. However, sensitivity analysis with different assumptions (not reported here) indicates that a term structure in which long-term rates depend more heavily on future short-term rates only changes these results slightly.

The Fed's policy response is clearly crucial. If, instead of following the assumed rule, the Fed simply keeps money growth constant, then long- and short-term interest rates fall immediately. Long-term rates fall by 25 basis points in 1993 and by 50 basis points in 1994, according to the model. Because with the assumed policy rule there is little change in interest rates, all of the stimulus to the economy which comes from the anticipated decline in the budget deficit, is initiated by the depreciation of the exchange rate. The dollar depreciates by about 14 percent against the yen (shown in Table 1) and other currencies. The depreciation occurs because the future reduction in the deficit brings about an expectation of an exchange-rate depreciation in the future. This depreciation is what "crowds in" net exports. The expectation of future depreciation in turn brings about an immediate depreciation at the time the deficit reduction plan is announced because of the model's assumptions of *ex ante* interest-rate parity and rational expectations in the model.

III. Credibility Issues During a Transition

The increase in real GDP associated with the anticipated cuts in the budget deficit so evident in Table 1 raises questions about the rational-expectations assumption itself during a transition from one policy rule to another. The rational-expectations assumption is more reasonable for examining the design of policy rules that are assumed to be in operation for a long time because

people get used to how the policy works. In fact, it is for this type of policy evaluation, rather than for the transition from one policy rule to another, that this type of model was explicitly designed. For the budget-deficit reduction path to have the effects reported in Table 1 the policy must be completely credible. If it is less than fully credible, then some adjustment must be made in the results.

There is no agreed-upon way to adjust these new econometric models to deal with credibility. Bayesian learning assumptions have been tried, but these usually assume that people passively learn about events without paying any attention to what the policymakers say they will do. This is an area for future research.

The actual policy experience in 1990 may provide some guide. At the time of the 1990 budget agreement, considerable effort was made to estimate the effects of a credible program to reduce the budget deficit. The agreement was intended to affect the structural budget deficit in a way similar to the calculations in Table 1, though without a full year delay. There was also considerable effort to make the deficit-reduction program credible through the institution of new budget rules, limits on discretionary spending, more tightly focused and thus more credible sequesters, and the allowance of cyclical effects of the economy on the deficit. Some commentators, including the chairman of the Fed, stated publicly that the deal had considerable credibility. However, perhaps because of difficulties in passing the 1990 law, there is not much evidence that the financial community was convinced. Although those new budget rules remained in place, the structural deficit did not decline as projected because of the growth in existing entitlement programs and the decline in tax revenue relative to what was forecast. Careful study of this event could give some guidance about similar efforts to reduce credibly the deficit in the rest of the 1990's.

IV. Conclusion

This brief review of the new macroeconometrics provides at least a partial answer to the question posed by this session. Some will be skeptical that there is all that much new in the new macroeconometrics, arguing for example, that it is just adding rational expectations to traditional models. My own experience—in research, in doing policy, and in interacting with traditional modeling groups in model-comparison exercises—is that it is much more than this. Clearly, further research on credibility, on forecasting and on the microfoundations of these new macroeconometric models will determine how differently they evolve in the future.

REFERENCES

Bryant, Ralph, Hooper, Peter and Mann, Catherine, eds., *Evaluating Policy Regimes: New Research in Empirical Macroeconomics*, Washington, DC: Brookings Institution, 1993.

Fair, Ray C. and Taylor, John B., "Solutions and Maximum Likelihood Estimation of Dynamic Nonlinear Rational Expectations Models," *Econometrica*, July 1983, *51*, 1169–85.

_____ **and** _____, "Full Information Estimation and Stochastic Simulation of Models with Rational Expectations," *Journal of Applied Econometrics*, October-December 1990, *5*, 381–92.

Fischer, Stanley, "Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Rule," *Journal of Political Economy*, February 1977, *85*, 191–205.

Fuhrer, Jeff and Moore, George, "Inflation Persistence," working paper, Board of Governors of the Federal Reserve System, 1992.

Hansen, Lars Peter, "Large Sample Properties of Generalized Methods of Moments Estimators," *Econometrica*, July 1982, *50*, 1029–54.

Judd, Kenneth L., "Numerical Methods in Economics," unpublished manuscript, Hoover Institution, Stanford University, 1991.

Levin, Andrew, "The Macroeconomic Significance of Nominal Wage Contract Duration," Department of Economics Dis-

cussion Paper No. 91–08, University of California, San Diego, 1991.

Lucas, Robert E., Jr. and Sargent, Thomas J., *Rational Expectations and Econometric Practice*, Minneapolis: University of Minnesota Press, 1981.

Mankiw, N. Gregory and Romer, David, *New Keynesian Economics*, Cambridge, MA: MIT Press, 1991.

McCallum, Bennett, "Real Business Cycle Models," in R. J. Barro, ed., *Modern Business Cycle Theory*, Cambridge, MA: Harvard University Press, 1989, pp. 16–50.

Phelps, Edmund S. and Taylor, John B., "Stabilizing Powers of Monetary Policy Under Rational Expectations," *Journal of Political Economy*, February 1977, *85*, 163–90.

Taylor, John B., "Estimation and Control of a Macroeconomic Model with Rational Expectations," *Econometrica*, September 1979, *47*, 1267–86.

_____, *Macroeconomic Policy in a World Economy: From Econometric Design to Practical Operation*, New York: Norton, 1993.

_____ **and Uhlig, H.,** "Solving Nonlinear Stochastic Growth Models: A Comparison of Alternative Solution Methods," *Journal of Business and Economic Statistics*, January 1990, *8*, 1–17.