

Woodford, Michael

Article

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NBER Reporter Online

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National Bureau of Economic Research (NBER), Cambridge, Mass.

Suggested Citation: Woodford, Michael (2006) : Rules for monetary policy, NBER Reporter Online, National Bureau of Economic Research (NBER), Cambridge, MA, Iss. Spring 2006, pp. 17-22

This Version is available at:

<https://hdl.handle.net/10419/61897>

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Wealth of Cohorts,” May 2003, University of Wisconsin, mimeo.

¹³ W. Kopczuk, E. Saez, and J. Song,

“Earnings Mobility in the United States, 1937–2004: Evidence from Social Security Administration Data,” work in progress.

¹⁴ L. Edlund and W. Kopczuk, “Women, Wealth and Mobility,” NBER Working Paper forthcoming.

Rules for Monetary Policy

Michael Woodford*

Much of my recent research has sought to use economic analysis to determine the consequences of alternative rules for the conduct of monetary policy, and to formulate rules that will be desirable from the standpoint of individual welfare. Interest in the study of monetary rules has increased over the past decade, for reasons having to do with progress in central banking and progress in macroeconomic theory. On the one hand, many central banks—most notably, but not only, the “inflation targeting” banks—have increasingly come to organize their policy deliberations around an attempt to conform to specific targets or objectives, sometimes explicit quantitative targets. Moreover, central banks worldwide have increased the degree to which they discuss their decisions with financial market participants and the general public, and this too has increased the importance that the banks assign to having a clear framework to guide their deliberations. At the same time, the development of a new generation of quantitative macroeconomic models—that can be estimated using macroeconomic time series and have optimizing foundations that allow an explicit evaluation of outcomes in terms of individual welfare—has allowed

modern macroeconomic analysis to be brought to bear on the evaluation of stabilization policies, in the context of models with sufficient claim to quantitative realism to be of interest to policy-making institutions. My own work has sought to extend the analysis of optimal monetary policy rules in directions that bring the theoretical literature into closer contact with the practical concerns of modern central bankers.¹

Inflation Stabilization and Welfare

One goal of my research has been to clarify which kinds of macroeconomic stabilization objectives best serve economic welfare. Grounding the objectives of policy in consumer welfare has a number of advantages: one avoids the arbitrariness otherwise attendant upon the choice of a particular definition of “price stability,” “full employment” or other conventional objectives. And, it also makes possible a natural integration of the theory of optimal monetary policy with the theory of optimal taxation. Yet it is not immediately obvious what the conventional goals of monetary stabilization policy—especially the nearly universal emphasis that central banks place on maintaining a low and stable inflation rate—have to do with consumer welfare; after all, the arguments of household utility functions generally are assumed to be the quantities of various goods and services, but not their prices. Nonetheless, I have shown that in

familiar classes of sticky-price dynamic stochastic general equilibrium (DSGE) models—models that incorporate key elements of the current generation of empirical models of the monetary transmission mechanism, and even some relatively small complete macro models—it is possible to show that the expected utility of the representative household varies inversely with the expected discounted value of a quadratic loss function, the arguments of which are measures of price and wage inflation on the one hand and measures of real activity relative to a (time-varying) target level of activity on the other.² Thus, it makes sense to rank alternative monetary policies according to how well they stabilize (an appropriate measure of) inflation on the one hand, and how well they stabilize (an appropriate measure of) the output gap on the other. The theory clarifies both the appropriate definition of these stabilization objectives, and the appropriate relative weights to assign to them when a choice must be made between them.

The answer obtained depends, of course, on the structure of the economy.³ In particular, inflation variability reduces welfare because of the presence of nominal rigidities; the precise nature of these rigidities determines the appropriate form of the inflation-stabilization objective. For example, if wages are flexible (or there are efficient contracts in the labor market), and price adjustments are staggered in the way assumed in the popular specification proposed by Guillermo Calvo⁴ (with an equal prob-

* Woodford is a Research Associate in the NBER's Programs on Monetary Economics and Economic Fluctuations and Growth and the John Bates Clark Professor of Political Economy at Columbia University. His profile appears later in this issue.

ability of any given price being revised in any time period), then inflation variation results in distortions caused by the misalignment of prices that are adjusted at different times. The resulting welfare losses are proportional to the expected discounted sum of squared deviations of the inflation rate from zero. Other assumptions about the timing of price adjustments also imply that inflation variations reduce welfare, but with a different form of loss function, and thus a different ranking of equilibria in which prices are not completely constant. For example, if the probability of adjustment of an individual price is increasing in the time since that price was last reviewed—a specification that is both intuitively plausible and more consistent than the simple Calvo specification with empirical models of inflation dynamics⁵—then welfare losses are proportional to a discounted sum of squared deviations of the current inflation rate from a moving average of recent past inflation rates, rather than deviations from zero.⁶ The goal of policy then should be to keep inflation from differing too greatly from the current “inertial” rate of inflation, which implies that inflation should not be reduced too abruptly if it has been allowed to exceed its optimal long-run level.⁷ A similar conclusion is obtained if prices are assumed to be automatically indexed to a lagged price index, as in the well-known empirical model of Christiano, Eichenbaum, and Evans⁸ and related studies, or if some prices are adjusted in accordance with a backward-looking “rule of thumb,” as proposed in the empirical model of inflation dynamics of Jordi Gali and Mark Gertler.⁹

The theory also provides important insights into the question of *which* price index or indexes it is more important to stabilize. Again, the answer depends on the nature of the nominal rigidities. If prices are adjusted more frequently in some sectors of the economy than in others, then the welfare-theoretic loss function puts more weight on variations in prices in the sectors where prices are stickier, as first shown by Kosuke Aoki.¹⁰ This provides a theoretical basis

for seeking to stabilize an appropriately defined measure of “core” inflation rather than an equally weighted price index. Pierpaolo Benigno has used reasoning of this kind to argue that a monetary union would maximize welfare by seeking to stabilize an index that does not weight the different countries’ inflation rates strictly in proportion to the size of their economies,¹¹ as is true of the inflation measure used in the European Central Bank’s definition of its price stability objective. Similarly, if wages are sticky as are goods prices, as implied by many empirical DSGE models, then instability in the rate of growth of a broad index of nominal wages results in distortions similar to those created by variations in goods price inflation. If wages are staggered in accordance with the Calvo specification, then the welfare-theoretic loss function includes a term proportional to the squared rate of goods price inflation and another term proportional to the squared rate of wage inflation each period. In this case, optimal policy involves a tradeoff between inflation stabilization, nominal wage growth stabilization, and output-gap stabilization, as first shown by Chris Erceg, Dale Henderson, and Andy Levin.¹²

Analysis of these questions has required careful consideration of the conditions under which a linear-quadratic (LQ) stabilization policy problem (minimization of a quadratic loss function subject to constraints that represent the log-linearized structural relations of a DSGE model) yields a correct local approximation to optimal policy in the exact DSGE model. In fact, it is not generally sufficient that the loss function be a correct quadratic local approximation to household utility—if that local approximation involves non-zero linear terms, then a correct second-order approximation to utility cannot be obtained by substituting into the approximate objective a solution for the equilibrium under a given policy that is accurate only to *first* order.¹³ For this reason, much of the recent literature seeking to evaluate policy rules in DSGE models has found it necessary to compute sec-

ond-order perturbation expansions as an approximate characterization of equilibrium outcomes under a given rule.

But Benigno and I have shown that it is possible, in the case of quite a broad class of optimal policy problems in DSGE models, to find a quadratic loss function that correctly approximates expected utility under any policy, yet involves no non-zero linear terms. In that way, welfare can be evaluated to second order using only a first-order (log-linear) solution for the equilibrium under a candidate policy.¹⁴ Essentially, our method incorporates into the loss function itself the second-order effects of stabilization policy on the average levels of endogenous variables in a second-order perturbation solution of the model. This allows us to consider how the existence of steady-state distortions (attributable either to market power or, more importantly, to taxes) affects the relative weights that should be placed on alternative stabilization objectives. Under the specifications that we regard as most empirically realistic, the importance of inflation stabilization relative to output-gap stabilization is *increased* the more distorted is the economy’s steady-state level of output; this is because stabilization of inflation does more to increase the *average* level of output than does stabilization of output, and this consideration is more important for welfare the more sub-optimal is the steady-state level of output.¹⁵

Expectations and Optimal Policy

My research has emphasized that, when choosing a policy to best serve the goal of stabilization, it is crucial to take account of the effects of the policy’s systematic component on people’s expectations of future policy. For this reason, my work has focused largely on the study of policy *rules*: this forces one to think about the systematic patterns that one can expect to be anticipated by sufficiently sophisticated market participants.

Taking account of the effects of systematic policy on policy anticipations

has important consequences for the conclusions one reaches about optimal policy, some of which are counter-intuitive. One fairly general result is that optimal policy will not be purely forward-looking; that is, it will not depend solely upon what can be achieved with respect to the stabilization objectives now, or in the future, but also on *past* conditions that no longer affect what is currently possible to achieve. A history-dependent policy can improve stabilization outcomes, to the extent that it is correctly anticipated, by changing people's expectations about subsequent policy at the time that economic disturbances occur. And, an appropriate shift in expectations often can mitigate the degree to which the disturbances interfere with macroeconomic stability.¹⁶

For example, I have shown that when one takes account of forward-looking behavior, it can be desirable for a central bank to only gradually adjust its operating target for overnight interest rates when underlying fundamentals change, rather than jumping immediately to a new level that depends only on current conditions. This kind of policy inertia—often argued to characterize actual central bank behavior, but frequently assumed to indicate a failure of central bankers to fully optimize—can reduce the amplitude of the swings in short-term interest rates required to stabilize inflation and real activity in response to real disturbances. It allows market participants to anticipate that the movements in short rates that occur will be more persistent, resulting in a larger effect on long rates and other asset prices, which are what matter for the effect of policy on aggregate demand.¹⁷ Hence calls for central bankers to respond more promptly to changes in conditions in order to avoid “getting behind the curve” may actually be counter-productive.

Prescriptions for purely forward-looking policy in the name of optimization also characterize many normative discussions of inflation-forecast targeting. Central banks that base their interest-rate decision on projections of the future evolution of inflation and other

variables often are directed to choose among alternative possible scenarios on the basis of a purely forward-looking criterion. But such an approach may lead to time-inconsistent choices, and even when it does not, it will almost inevitably lead to policy that is insufficiently inertial.¹⁸ An optimal outcome can in fact often be achieved through a procedure focused on ensuring that projections satisfy an appropriate target criterion at all times, but the criterion should be history-dependent. The acceptable transition path along which the inflation rate and output gap should be projected to return to their medium-term target levels will depend on recent past conditions.¹⁹

Purely forward-looking policy can be especially harmful when the zero lower bound on short-term nominal interest rates is reached, as in Japan for the past several years, and as some feared could occur in the United States in 2003. When the zero bound is reached, further monetary stimulus is possible *only* by shifting expectations about future policy. But if policy is expected to be conducted in a purely forward-looking way in the future, then there will be no reason for the public to expect looser policy in the future simply because the zero bound currently prevents interest rates from being cut as sharply as would be needed to create demand in line with the economy's productive capacity. Gauti Eggertsson and I have shown that this can result in a protracted and severe deflationary contraction, even when the same real fundamentals would be consistent with a much more benign outcome in the case of alternative policy expectations. A desirable outcome requires advance commitment to a history-dependent policy, under which rates will be kept unusually low for a period of time even after fundamentals have recovered, even though higher rates would be called for under the latter conditions if one were determined to avoid generating inflationary pressures.²⁰ It is arguable that the Bank of Japan's emphasis (prior to 2001) on its determination to end loose monetary policy as quickly as possible prolonged the Japanese deflation unnecessarily.²¹ When the possi-

bility of a similar situation arose in the United States, the Fed undertook a bold experiment with policy signaling, committing to maintain a low federal funds rate “for a considerable period” as a substitute for further interest-rate cuts. This seems to have dissipated the market anxiety about premature tightening that had threatened to derail the U.S. recovery.²²

A possible objection to advice of this kind is that theoretical analyses of optimal policy that assume a rational expectations equilibrium consistent with whatever kind of systematic policy is adopted exaggerate the degree of precision with which a central bank can expect to control the expectations of market participants simply by disciplining its own procedures. In recent work, I have sought to relax this assumption by assuming instead only that the central bank should expect that private-sector expectations about the future evolution of the economy will not be *too far* from model-consistency, as measured by a relative-entropy criterion (which ensures that the public will not believe in patterns that they should be able to reject on the basis of even short time series). One can then characterize the optimal policy decision of the central bank if it wishes to choose a *robust* policy—one that is not too bad even under the worst of the outcomes that can occur under “near-rational expectations.” My analysis shows that the qualitative conclusions of the rational-expectations analysis of optimal policy continue to apply. For example, policy commitment continues to be important—indeed, the losses resulting from discretionary policy are *even greater* in the case of allowance for near-rational expectations; and optimal policy continues to be history-dependent—in fact, even *more* history-dependent than if the central bank could count on the public's having precisely model-consistent expectations.²³

Optimal Target Criteria for Policy

One way of specifying a rule for the conduct of policy that has both practical and normative relevance is in terms of a

“target criterion” that the central bank is committed to ensure is satisfied (or at least, projected to be satisfied) each time its instrument setting is reviewed.²⁴ The criteria used by inflation-forecast targeting central banks, such as the Bank of England (which seeks to ensure that CPI inflation is always projected to reach its target level of 2 percent per year at a horizon two to three years in the future), are an example of commitments of this kind. They represent the closest approximation to the ideal of rule-based policymaking yet observed. At the same time, target criteria often provide an especially convenient way of characterizing optimal policy. For example, it may be possible to specify optimal policy in this way independently of the parameters governing the statistical properties of the economic disturbances affecting the economy; the target criterion is then a particularly robust characterization of optimal policy.

Marc Giannoni and I have shown that in the case of a very general class of linear-quadratic policy problems, it is possible to derive a target criterion that is robustly optimal in the sense just described: a credible commitment to ensure that the criterion holds at all times will implement an optimal equilibrium, regardless of the statistical properties of the various types of exogenous disturbances, as long as they are all additive, mean-zero disturbances.²⁵ The precise form of the optimal target criterion depends, however, on the non-stochastic part of the structural equations of one’s model of the transmission mechanism. In the case of a canonical “New Keynesian” model, with an aggregate-supply relation of the kind implied by flexible wages and Calvo-style staggered pricing, the optimal target criterion is a “flexible inflation target,” under which short-run departures of the inflation rate from a constant long-run target level should vary inversely with the projected growth in the output gap. Such a criterion would allow inflation to increase temporarily in response to a positive cost-push shock, for example, given the expected decline in the output gap, although the

amount that inflation should be allowed to increase will be strictly limited by the required proportionality between the inflation projection and the projected output-gap change. After the real effects of the disturbance dissipate, the rate at which the output gap should be returned to zero will be determined by the necessity of programming lower-than-average inflation during a period of output-gap growth. Anticipation of this kind of history-dependent policy should restrain price increases during the period of high costs, mitigating the temporary effect of the shock on the available inflation/output tradeoff at the cost of a slower recovery.²⁶ And, because the projected medium-term growth rate of the output gap will always be zero, a credible commitment to such a criterion would never allow ambiguity about the medium-term outlook for inflation, despite the existence of transitory variations in the inflation rate in response to shocks.

More complex (and realistic) economic models imply that a more complex target criterion would be needed to implement a fully optimal policy. For example, if the likelihood of a price revision increases with the time since the last revision, then the optimal target criterion allows the short-run inflation projection to be an increasing function of recent past inflation. Thus temporary increases in inflation should not be immediately reversed. (Other sources of intrinsic inflation inertia, such as the kind of indexation commonly assumed in current-vintage empirical DSGE models, lead to a similar conclusion.) If wages and prices are sticky, then the optimal target criterion involves projected nominal wage growth as well as projected goods price inflation.

Moreover, if a binding lower bound on interest rates sometimes forces targets to be missed, then the target criterion in subsequent periods should be adjusted in proportion to the size of the targeting errors. This would create the kind of anticipations of history-dependent policy that mitigate the distortions created by the lower-bound constraint.²⁷

Given the dependence of the opti-

mal target criterion on model structure, research of this kind cannot hope to derive a single rule that would represent a universally optimal policy prescription. And in any event, even a minimally realistic degree of complexity in one’s model implies that a fully optimal criterion will be more complex than any principle for guiding policy deliberations that one can imagine actually being adopted at a central bank.²⁸ Nonetheless, I believe that the study of optimal target criteria for fairly simple environments that capture important features of more realistic models can suggest qualitative features of desirable target criteria. For example, one important conclusion from my study of this topic is that an optimal target criterion almost surely will not be focused so exclusively on projected outcomes two or more years in the future, as are the criteria that currently are used at the leading inflation-targeting central banks, at least according to their official rhetoric. In a realistic model, a commitment of this form is unlikely even to suffice to determine an appropriate short-term policy stance, in the absence of auxiliary assumptions such as a constant interest rate over the projection horizon, while the forecast-targeting exercise is likely to be time-inconsistent with the addition of such an assumption.²⁹ An approach that is both coherent and transparent would instead require central banks to commit themselves in advance to clear criteria for judging the acceptability of the transition paths along which an economy is expected to return to its normal state following a disturbance.

¹ *These developments are described in more detail in* Interest and Prices: Foundations of a Theory of Monetary Policy, Princeton University Press, 2003.

² *This approach was first illustrated in* J. J. Rotemberg and M. Woodford, “An Optimization-Based Framework for the Evaluation of Monetary Policy,” NBER Macroeconomics Annual 12: pp. 297–346 (1997). *The general method is discussed in* “Inflation Stabilization and Welfare,” NBER Working Paper No. 8071, January 2001, and Contributions to

Macroeconomics 2(1), article 1 (2002). The results of the latter paper are generalized in P. Benigno and M. Woodford, "Inflation Stabilization and Welfare: The Case of a Distorted Steady State," NBER Working Paper No. 10838, October 2004, and *Journal of the European Economic Association* 3: pp. 1185–236 (2005).

³ The results summarized here are discussed further in *Interest and Prices* [cited footnote 1], chapter 6.

⁴ G. A. Calvo, "Staggered Prices in a Utility-Maximizing Framework," *Journal of Monetary Economics* 12: pp. 383–98 (1983).

⁵ A. Wolman, "Sticky Prices, Marginal Cost, and the Behavior of Inflation," *Federal Reserve Bank of Richmond Economic Quarterly* 85: pp. 29–48 (1999); R. Mash, "Optimizing Microfoundations for Inflation Persistence," *Oxford University Department of Economics discussion paper no. 183*, January 2004; K. D. Sheedy, "Structural Inflation Persistence," working paper, Cambridge University, November 2005.

⁶ K. D. Sheedy, "Resistance to Persistence: Optimal Monetary Policy Commitment," working paper, Cambridge University, November 2005.

⁷ This is not the conclusion that Sheedy draws from his loss-function derivation in the paper cited in footnote 6. For my own analysis of the consequences of intrinsic inflation inertia, see *Interest and Prices* [cited footnote 1], section 7.1; and M. P. Giannoni and M. Woodford, "Optimal Inflation Targeting Rules," NBER Working Paper No. 9939, September 2003, and in B. S. Bernanke and M. Woodford, eds., *The Inflation Targeting Debate*, University of Chicago Press for NBER, 2005.

⁸ L. J. Christiano, M. Eichenbaum, and C. Evans, "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," NBER Working Paper No. 8403, July 2001, and *Journal of Political Economy* 113: pp. 1–45 (2005).

⁹ J. Gali and M. Gertler, "Inflation Dynamics: A Structural Econometric Analysis," *Journal of Monetary Economics* 44: pp. 195–222 (1999). A welfare-theoretic loss function is derived for this model

in J. Steinsson, "Optimal Monetary Policy in an Economy with Inflation Persistence," *Journal of Monetary Economics* 50: pp. 1425–56 (2003).

¹⁰ K. Aoki, "Optimal Monetary Policy Responses to Relative Price Changes," *Journal of Monetary Economics* 48: pp. 55–80 (2001). Aoki's analysis is generalized in *Interest and Prices* [cited footnote 1], section 4.3.

¹¹ P. Benigno, "Optimal Monetary Policy in a Currency Area," *International Economic Review* 44: pp. 195–222 (1999).

¹² C. J. Erceg, D. W. Henderson, and A. T. Levin, "Optimal Monetary Policy with Staggered Wage and Price Contracts," *Journal of Monetary Economics* 46: pp. 281–313 (2000). This derivation is generalized in P. Benigno and M. Woodford, "Optimal Stabilization Policy when Wages and Prices are Sticky: The Case of a Distorted Steady State," NBER Working Paper No. 10839, October 2004, and in J. Faust, A. Orphanides, and D. Riefischneider, eds., *Models and Monetary Policy*, Federal Reserve Board, 2005.

¹³ For further discussion of the general problem and a demonstration of the pitfalls of "naïve" LQ approximation, see *Interest and Prices* [cited footnote 1], section 6.1, and P. Benigno and M. Woodford, "Optimal Taxation in an RBC Model: A Linear-Quadratic Approach," NBER Working Paper No. 11029, January 2005.

¹⁴ Our method was first introduced in P. Benigno and M. Woodford, "Optimal Monetary and Fiscal Policy: A Linear-Quadratic Approach," NBER Working Paper No. 9905, August 2003, and *NBER Macroeconomics Annual* 18: pp. 271–333 (2003). It is also illustrated in the Benigno and Woodford papers cited in footnotes 2, 12, and 13 above. A general algorithm for the application of this method to the derivation of LQ approximations to policy problems is discussed and illustrated in F. Altissimo, V. Curdia, and D. Rodriguez Palenzuela, "Linear-Quadratic Approximation to Optimal Policy: An Algorithm and Two Applications," working paper, European Central Bank, September 2005.

¹⁵ Benigno and Woodford, "Inflation Stabilization" [cited footnote 2].

¹⁶ "Pitfalls of Forward-Looking Monetary Policy," *American Economic Review* 90(2): pp. 100–4 (2000); and *Interest and Prices* [cited footnote 1], chapter 7.

¹⁷ "Optimal Monetary Policy Inertia," NBER Working Paper No. 7261, July 1999; parts of this paper appear in revised form in "Optimal Interest-Rate Smoothing," *Review of Economic Studies* 70: pp. 861–86 (2003). The desirability of policy inertia is also analyzed in more complex models in J. J. Rotemberg and M. Woodford, "Interest-Rate Rules in an Estimated Sticky-Price Model," NBER Working Paper No. 6618, June 1998, and in J. B. Taylor, ed., *Monetary Policy Rules*, University of Chicago Press for NBER, 1999; and in M. P. Giannoni and M. Woodford, "How Forward-Looking is Optimal Monetary Policy?" *Journal of Money, Credit and Banking* 35(6–2): pp. 1425–69 (2003).

¹⁸ "Commentary: How Should Monetary Policy be Conducted in an Era of Price Stability?" in *Federal Reserve Bank of Kansas City, New Challenges for Monetary Policy*, 1999.

¹⁹ L. E. O. Svensson and M. Woodford, "Implementing Optimal Policy through Inflation-Forecast Targeting," NBER Working Paper No. 9747, June 2003, and in B. S. Bernanke and M. Woodford, eds., *The Inflation Targeting Debate*, University of Chicago Press for NBER, 2005.

²⁰ G. B. Eggertsson and M. Woodford, "The Zero Bound on Interest Rates and Optimal Monetary Policy," *Brookings Papers on Economic Activity* 2003–1: pp. 139–211.

²¹ More recently, the BOJ has consciously sought to signal an intention not to tighten prematurely, at least partially along the lines argued for by Eggertsson and myself; see, for example, K. Ueda, "The Bank of Japan's Struggle with the Zero Lower Bound on Nominal Interest Rates: Exercises in Expectations Management," CIRJE discussion paper, University of Tokyo, September 2005.

²² For discussions of this episode, see my "Central-Bank Communication and

Policy Effectiveness,” NBER Working Paper No. 11898, December 2005; and B. S. Bernanke, V. R. Reinhart, and B. P. Sack, “Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment,” Brookings Papers on Economic Activity 2004-1: pp. 1-78.

²³ “Robustly Optimal Monetary Policy under Near-Rational Expectations,” NBER Working Paper No. 11896, December 2005.

²⁴ An important early discussion is by L. E. O. Svensson, “Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets,” *European Economic Review* 41:pp. 1111-46 (1997).

²⁵ M. P. Giannoni and M. Woodford, “Optimal Interest-Rate Rules: I. General Theory,” NBER Working Paper No. 9419, January 2003.

²⁶ Both this paragraph and the following one are based on Giannoni and Woodford

[cited footnote 7].

²⁷ Eggertsson and Woodford [cited footnote 20].

²⁸ See, for example, the optimal target criterion derived for a small empirical model in Giannoni and Woodford [cited footnote 7].

²⁹ “Inflation Targeting and Optimal Monetary Policy,” Federal Reserve Bank of St. Louis Economic Review, July/August 2004, pp. 15-41.

NBER Profile: Christopher Carroll



Christopher Carroll is an NBER Research Associate in the Programs on Monetary Economics and Economic Fluctuations and Growth and Professor of Economics at the Johns Hopkins University in Baltimore. Originally from Knoxville, Tennessee, he received his A.B. in Economics from Harvard University in 1986 and his Ph.D. from the MIT in 1990.

After graduating from MIT, he worked at the Federal Reserve Board in Washington, where his responsibilities included preparation of the forecast for consumer expenditure. He moved to the Johns Hopkins University in 1995, but spent 1997-8 working at the President's Council of Economic Advisers in Washington; there, his responsibilities included analysis of Social Security reform proposals, tax and pension policy, and bankruptcy reform.

Carroll's research has focused primarily on consumption and saving behavior, with an emphasis on reconciling the empirical evidence from both microeconomic and macroeconomic sources with theoretical models.

In addition to articles in economics journals, he has written *Encyclopedia Britannica* articles on consumption-related topics. He was also the recipient of an Alfred P. Sloan Foundation early career fellowship and of the TIAA-CREF/Samuelson Certificate of Excellence for his work on precautionary saving behavior over the life cycle.

Carroll's recent research has focused on models of the dynamics of expectations formation, particularly on how expectations reflect households' learning from each other and from experts. This focus flows from a career-long interest in consumer sentiment and its determinants. He is also an associate editor at the *Review of Economics and Statistics* and the *Journal of Business and Economic Statistics*.

Carroll lives in Columbia, Maryland with his wife, Jennifer Manning. His interest in economics dates from early in his life: his father recently retired from a career as Professor of Economics at the University of Tennessee, where he taught Industrial Organization for many years.