Autoregressions, Expectations, and Advice

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Macroeconomists have long spent most of their time observing and interpreting aggregative economic time-series. Recent progress has involved formalizing and standardizing this activity into one of estimating and interpreting vector autoregressions. Vector autoregressions provide a convenient way of summarizing the second moments of time-series data, and conform naturally with the recursive decision theory that is associated with stochastic dynamic rational expectations models. In interpreting vector autoregressions, fundamental differences exist between users of rational expectations econometrics and users of "atheoretical" or "uninterpreted" vector autoregressions in the style of Christopher Sims (1980, 1982) and Robert Litterman (1980, 1981).[1] This paper describes these differences, and uses dynamic rational expectations theory to describe strong points of each approach. That theory can be used as forcefully to support Sims' style of more or less uninterpreted vector autoregressive empirical work as it can be to justify the "fully interpreted" or structural vector autoregressive empirical work practiced by rational expectations econometricians.

My purpose is to allude to specific formal models that exist in the literature on rational expectations models, and that can be used to support Sims' actual econometric practices and many of his remarks. To date, Sims' arguments on the points in this paper have been informal, and have not been made in the context of concrete models. Therefore, in advancing the arguments, I have taken the risk that I might miss what Sims has in mind. In fact, in oral remarks, Sims has told me that my interpretation fails to capture his thoughts, and should be labeled as my own argument. Nevertheless, I continue to attribute to Sims a line of argument which he disowns.[2] I do so because the argument that I attribute to him was gathered during my reading of Sims' work and is not my own creation. Sims has told me that he agrees that the argument in the text has the virtue of disposing of often-encountered arguments to the effect that users of vector autoregressions in the style of Sims and Litterman must be regarded as ignoring dynamic economic theory.

I. Vector Autoregressions and Dynamic Macroeconomics

Robert Lucas' (1976) critique of econometric policy evaluation procedures concerned proper ways of interpreting and manipulating vector autoregressions. Lucas observed that it violated dynamic economic theory with purposeful agents, as standard procedures then did, to change one equation representing government policy actions in a

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[1]The philosophy of rational expectations econometrics is described in the introductory essay of Robert Lucas and myself (1981) and by my 1981 article. The approach of Sims and Litterman is described in Sims (1980), Litterman (1980, 1981), and Thomas Doan et al. (1983).

[2]In constructing my unauthorized interpretation of Sims, I have selected and emphasized some themes in his writings, and have deemphasized and deleted others. My intention in doing so has been explicitly to use dynamic rational expectations theory to present a defense of Sims' actual econometric practices. Among Sims' words with which my interpretation might be inconsistent are such statements as those found in his 1982 article: lines 7–13, p. 108; lines 27–29, p. 123; and lines 3–13, p. 151. Whether my interpretation is consistent with Sims' words hinges on the meaning of the terms "policy analysis" and "useful." If they refer to giving advice in choosing government policy actions, my interpretation does not apply. It does apply if the terms refer to making probability statements about the consequences of alternative realizations of policy actions on the basis of the historically estimated probability structure.

vector autoregression while holding fixed the remaining equations, many of which describe private agents' decisions. Of the procedures that Lucas criticized, the most sophisticated explicitly posed an optimal control problem for the government as the way of finding the best equation for government policy variables, holding fixed the remaining equations in an estimated vector autoregression. In such a control problem, the object of choice is a rule or regime for the government, and the predicted outcome of that choice is a new and improved probability structure for the economy. Lucas observed that dynamic economic theory implies that in general all of the equations in the vector autoregression can be expected to change with such a change in regime, not just the equations describing the government policy.

One constructive response to Lucas' observation has been an ambitious research program to build workable dynamic rational expectations models and methods of estimation that can be used to predict how all of the other equations of a vector autoregression will change when one equation describing a government policy variable is hypothetically altered.[3] The goal of this rational expectations econometric program remains ultimately to search for rules for government policy variables that are predicted to imply the most desirable vector autoregression for the economy. The intention is thereby to obtain good practical quantitative advice for formulating new strategies for government actions in the years beyond the sample period.[4]

The most telling criticism of rational expectations econometrics has come from Sims (1980, 1982) in a sequence of remarks about appropriate ways of estimating and utilizing vector autoregressions. While accepting the theoretical observation underlying Lucas' critique, Sims challenges rational expectations econometrics, and does so by appealing to the very same general body of dynamic economic theory that Lucas used. Sims' vision and rational expectations econometrics are based on different models of the economy. To begin, it is necessary to clarify what is meant by a model economy.

A model economy consists of a collection of agents arranged in a particular way over time and space; a description of agents' endowments of and preferences for goods; a technology for converting goods into one another, possibly at different points in time and space; and a mechanism for arranging agents into coalitions or institutions, and for coordinating decisions both within and across coalitions. This conception of an economy is so broad that it leaves open whether the coordination mechanism is a Walrasian one, or an alternative one that, when compared with a Walrasian mechanism, seems to constitute a "disequilibrium."[5]

With a given mechanism, the economy can be viewed as the solution of a dynamic game.

[3] Contributions that share this goal, while differing in some technical details, are represented by John Taylor (1979, 1980, 1982) and Lars Peter Hansen and myself (1980), by Finn Kydland and Edward Prescott (1982), and by Hansen and Kenneth Singleton (1982).

[4] In the brand of rational expectations econometrics that I am describing, the historical time-series are supposed to have been generated as the solution of a dynamic game whose outcome can be improved upon. This can occur in a variety of rational expectations equilibria in which suboptimal government behavior in conjunction with nonneutralities prevent rational expectations equilibria from being Pareto optimal. Some useful examples are studied by Zvi Eckstein and Martin Eichenbaum (1984a, b). In such contexts, the computationally convenient equivalence between a rational expectations equilibrium and the solution of the social planning problem, which Lucas and Prescott (1971) have fruitfully exploited, fails to occur. Such nonoptimal rational expectations equilibria must be computed by methods other than those used by Lucas and Prescott (see Kydland and Prescott, 1977; Dennis Epple et al., 1984; Paul Romer, 1982; and Charles Whiteman (1983)). Notice that Willem Buiter's (1980) characterization of some rational expectations work in macroeconomics as being "the economics of Dr. Pangloss" does not apply to the line of work that I am summarizing under the category of rational expectations econometrics. Rather, it is Sims' criticism of rational expectations econometrics that comes closer to resting on the view that "we live in the best of all possible stochastic processes."

[5] Robert Townsend (1983a) describes a model economy with purposeful price-setting agents. For a particular game that he sets out, a Walrasian equilibrium is a solution. Presumably, settings exist in which games specified in terms of the same primitive objects as Townsend's have non-Walrasian solutions.

In a dynamic game, the strategy of each agent depends on the strategies chosen by "nature" and the other agents in the system. Such strategic interdependence is the reason that when an equation in a vector autoregression describing one agent's strategy is hypothetically altered, other equations should also be expected to change. The "rational expectations revolution" in macroeconomics consists of a broad collection of research united mainly by an aim to respect the principle of strategic interdependence.

This principle is respected and heavily exploited both in rational expectations econometrics and in Sims' criticism of that program. The difference between Sims and rational expectations econometrics involves both the specification of the dynamic game that was imagined to have been played during the historical sample period, and also the dynamic game that is imagined to occur after the sample period, when the analyst is contemplating an intervention.

II. Rational Expectations and Fully Interpreted Vector Autoregressions

Rational expectations econometrics proceeds on the supposition that the dynamic game that was being played during the estimation period is different than the one to be analyzed, and whose playing is to be recommended in the future. Rational expectations econometrics typically assumes that during the historical sample period, private agents' decisions solved constrained stochastic intertemporal optimization problems. Among private agents' constraints are laws of motion for government policy variables. Usually, these government policy variables are posited to follow arbitrary, more or less general, stochastic processes. The econometrician specifies parametric forms for preferences, for technologies, and for stochastic processes for government policy variables and other exogenous variables. The econometrician next imposes the hypotheses that private agents have rational expectations and behave purposefully, and that there is a given mechanism assuring consistency among various individuals' decision strategies and their perceptions (a rational expectations competitive equilibrium is one tractable and commonly used such mechanism). It is then possible to define a mapping from the free parameters of agents' preferences and constraints to the implied theoretical probability distribution of all of the variables in the model. The second moments of this probability distribution can be completely summarized as a theoretical vector autoregression. Given this mapping, estimation can proceed using the philosophy of maximum likelihood or generalized method of moments, each of which selects free parameters of the model so that the theoretical probability distribution (or vector autoregression) matches the empirical one as closely as possible.

Once estimates of the free parameters of agents' objectives and constraints have been obtained, the aim is to use them to analyze how the economy would behave under hypothetical strategies for setting government policy variables that are different from the one evident in the sample period. A systematic search is to be conducted for the government strategy that optimizes the performance of the economy as a stochastic process in the following particular sense. An intertemporal objective function is posited for the government, in some cases the utility functional of the representative private agent in the model. A dynamic game is formulated in which the government is dominant and is imagined to choose a strategy to maximize its criterion, taking into account the reaction of optimizing private agents' strategies to the government's choice of strategy. A solution to this dynamic game will in general be a stochastic process for the economy that differs from the one in place during the sample period.[6]

The piece of this stochastic process that describes the government's policy decisions is what the rational expectations econometrician is prepared to recommend for policy; the entire vector stochastic process is his prediction about how the economy would behave were his policy recommendations to

[6]An exception to this statement occurs when the government policy rule was optimal during the sample period.

be adopted. This hypothetical stochastic process will have a vector autoregressive representation, which will generally differ from the one in the sample period.

This setup envisions that government behavior may have been guided by different principles during the sample period than are hypothesized to guide it during the future. During the sample period, there is permitted to be an asymmetry between the principle guiding the government's strategy, which is arbitrarily (if generally) specified, and that guiding private agents, which is purposeful. However, for computing the optimal government policy strategy for the future, this possible asymmetry of behavior is removed, and both private agents and the government are supposed to be purposeful. (*Some* such difference in government behavior between the sample period and the hypothetical future *must* be posited by anyone recommending a change in the government's strategy.)

III. Sims' Challenge

I interpret Sims as objecting to the assumed asymmetry between private agents' behavior and government behavior during the estimation period. Sims' view is that the asymmetry should be eliminated by assuming that government agents as well as private agents have behaved as rational expectations intertemporal optimizers during the sample period.[7]

This view has definite consequences for how the time-series are to be interpreted in terms of deep parameters of preferences and constraints during the estimation period, and would require modifications of most existing methods of rational expectations econometrics.[8] Further, if the very same dominant player dynamic game is imagined to be played during and after the estimation period, the presumption is that the same stochastic process will hold both during and after the estimation period. It is then of no interest to analyze a change in the government strategy or "regime" because government behavior is posited to be determined by the same purposes and constraints after the estimation period as before it.[9]

On the one hand, this view implies that, while it could be extended to include parameters for government agents, the rational expectations econometrics pursuit of the deep parameters of agents' preferences and constraints is in itself of little value.[10] Interventions in the form of changes in government strategies are supposed not to occur; but the ability to analyze such interventions is a major motive of rational expectations econometrics. On the other hand, this view implies that for forecasting, it is useful to estimate vector autoregressions that are left uninterpreted in terms of parameters of agents' preferences and constraints. Such vector autoregressions can be used to produce linear least squares forecasts of the future vector of variables given past values. They can also be used to predict the future of some variables, conditioned on particular assumed paths over part of the future for some government policy variables.[11]

[7]"...it is not clear that the existing pattern of policy in most countries, in which there is weight given to stabilization of inflation, employment, and income distribution, is very far from an optimal policy" (Sims, 1980, p. 14).

[8]Many of these modifications are described in Epple et al. Note that a rational expectations econometrician imposing one of their games E or F during an estimation period would automatically be led to a position close to Sims' when it comes to giving advice for an improved regime outside the sample.

[9]"Accurate projections can be made from reduced form models fit to history because it is not proposed to change the policy rule, only to implement effectively the existing rule" Sims (1980, p. 13).

[10]If the overidentifying restrictions imposed on a vector autoregression by a rational expectations dynamic game are approximately true, imposing them could be defended on the same instrumental grounds that Doan et al. and Litterman (1980) give for imposing restrictions not based on explicit economic theories.

[11]Sims states (1982): "...effects of policy actions that affect expectation-formation mechanisms can be correctly evaluated with models that are reduced form in the sense that they do not explicitly display parameters of the expectation formation mechanism" (pp. 115–16); "They [the procedures] take account of policy endogeneity by generating true conditional projections, given specified paths for policy variables" (p. 150); "...a valid reduced form will make relatively precise conditional projections for the effects of policy actions or sequences of actions that are close in form to what has been observed historically" (p. 118).

Both of these kinds of forecasts are to be made in a way that respects the assumption that the same stochastic process governs the vector of variables during and after the estimation period. In particular, both kinds of forecasting exercises are formulated mathematically as projections of unknown variables on known variables, using the estimation-period vector autoregression as the probability model. These are the only kinds of forecasting exercises that are of practical interest, given Sims' conception of the game. These forecasting exercises respect the principle of strategic interdependence underlying Lucas's critique, because they never involve hypothesizing an altered strategy for the government outside of the sample period.

Closely related to his challenge of the estimation period-policy prescription period asymmetry in rational expectations econometrics, Sims has disputed the appropriateness of the commonly formulated dominant player dynamic game as one in which the government is imagined to search for a regime or strategy to be used into the indefinite future. In such a formulation, the government is an infinitely lived agent that is imagined to attain beneficial outcomes now by binding itself to state-contingent future actions. These beneficial effects come through "expectations effects," or, more precisely, through the workings of the principle of strategic interdependence.

Sims doubts the applicability of a setup in which an infinitely lived government is imagined to choose among infinitely lived "regimes."[12] Instead, he can be interpreted as urging that the government be thought of as consisting of an intertemporal sequence of finitely lived agents. There is a sequence of administrations, each of which cannot commit its successor even though current options are influenced by the public's speculation about what successor "governments" will do. Typically, it is posited that each administration is followed by successors with similar objective functions.[13]

In such a formulation, government agents are imagined to be dominant vis-à-vis private agents, and to take into account the effects of their current actions on future actions of private agents. However, because they cannot commit their successors, in optimizing they disregard the effects on private agents of those future government actions that are beyond the control of the current administration. This sequential setup is designed to reflect a reality in which government policy emerges from a succession of personalities within a succession of administrations, each lacking power to commit its successors.[14] In such games, there is no sense in which a policy regime is chosen once and for all. Instead, the stochastic process for government policy is determined by the purposeful behavior of a temporal hierarchy of agents, each of whom influences or controls only a few periods of actions.

IV. Contradictions

Neither of the two above approaches is free of philosophical difficulties. The rational expectations econometrics position is exposed to the following internal contradiction. Suppose that the free parameters of private agents' preferences and constraints have been estimated during an estimation period, and then are used to calculate a new and im-

[12]Sims (1982): "Yet in practice macroeconomic policymaking does not seem to be this sort of once-for-all analysis and decision. Policymakers ordinarily consider what actions to take in the next few quarters or years, reconsider their plans every few months, and repeatedly use econometric models to project the likely effects of alternative actions" (p. 109); "But permanent shifts in policy regime are by definition rare events. If they occurred often they would not be permanent" (p. 118).

[13]Sims (1982): "Policy is not made by a single maximizing policymaker, but through the political interaction of a number of institutions and individuals. The people involved in the process, the nature of the institutions, and the views and values of the public shift over time in imperfectly predictable ways" (p. 110); "...disputes about the optimal rule are no more important in principle than disputes about how to implement the existing 'rule' as it emerges from existing institutions and interests" (p. 139).

[14]Such games have been analyzed by Abderrahmane Alj and Haurie Alain (1983) and Epple et al. For a general reference on dynamic games, see Tamer Basar and Geert Olsder (1982). Epple et al.'s "game F" comes close to embodying the conception that Sims seems to have in mind.

proved strategy for government policy in the future. On the one hand, if this procedure were in fact likely to be persuasive in having the policy recommendation actually adopted soon, it would mean that the original econometric model with its arbitrarily specified rules for government policy had been misspecified. A rational expectations model during the estimation period ought to reflect the procedure by which policy is thought later to be influenced, for agents are posited to be speculating about government decisions into the indefinite future. On the other hand, if this procedure is not thought likely to be a source of persuasive policy recommendations, most of its appeal vanishes.[15]

Sims' vision is subject to the observation that, smacking of determinism as it does, it lends limited interest not only to the estimation of "structural" or "fully interpreted" vector autoregressions, but to any vector autoregression whatsoever.[16] In dynamic decision and game theory, the relevant choices are among different stochastic processes. In these terms, an analysis that maintains the assumption of a fixed probabilistic structure permits no policy advice to be given or choices to be delineated. Vector autoregressions become tools for passive, intervention-free forecasting of various types.

V. Positive and Normative Economics

The view that I have attributed to Sims subverts normative economics, and does so by embracing a normative or optimizing theory of government behavior as a positive theory of how the government has actually behaved. This method of understanding past government policy leaves no room for improving government policy in the future. In economics and other social sciences, there are many examples that exhibit the tension between having a theory that, on the one hand, can fully explain existing institutions and events in terms of purposeful behavior, and on the other hand, can be used to give advice for improving things. For example, this tension exists between the theory of the firm and operations research.[17] The recent work on vector autoregressions and dynamic rational expectations theory manifests this tension in a new and dramatic context, but the tension itself is an old one.

Sims has ample company among recent macroeconomists in using the hypothesis of optimizing government agents to explain observations on government behavior. Two examples will illustrate this. First, there is Lucas and Nancy Stokey's model (1983) of the optimal time structure of government deficits, and of the term structure of government debt. Their model gives the prediction that in response to temporary large current account government expenditures, such as those associated with wars, the government should run temporary deficits, issuing state-contingent interest-bearing securities to finance the deficit. The motive for running deficits is to minimize the distortions from taxes by smoothing their occurrence over time. The Lucas-Stokey normative results can be regarded as a positive theory of government finance that seems to work well for the advanced countries over much of the last 200 years. Under the gold standard, wars were typically accompanied by temporary suspensions of convertibility into specie of government notes, with the probability of subsequent resumption at par depending directly on the prospects for military victory. This suspension pattern governs European and U.S. data from 1789 to 1928, and can be regarded as a mechanism designed to ap-

[15]In formal work, this contradiction is evaded by regarding analyses of policy interventions as descriptions of different economies, defined on different probability spaces. The mental comparison is among economies identical with respect to private agents' preferences and technologies, but differing in government policy regime. The contradiction mentioned in the text surfaces when attempts are made to put these formal results to practical use by speaking of regime changes that are imagined to occur suddenly in real time. My article with Neil Wallace (1976) described a version of this contradiction.

[16]The issue here also concerns Gabriel Garcia Marquez (1971, 1983) and D. M. Thomas (1982), who describe settings in which individuals have access to more or less imperfect foresight, but exercise few effective choices.

[17]This example was suggested to me by Robert E. Lucas, Jr.

proximate a Lucas-Stokey optimal fiscal policy.[18]

A second example is John Bryant and Wallace's thesis (1984) that the observed denomination structure of government debt (interest-bearing securities are typically issued only in large denominations, while non-interest-bearing ones are available in small and large denominations) is to be understood as the result of the government's effort to price discriminate between different classes of portfolio holders, so as to raise seignorage and finance expenditures in an efficient way.[19,20]

VI. Concluding Remarks

I find persuasive the preceding defense of empirical work in the style of Sims and Litterman. While that work is "atheoretical" in terms of restrictions that it actually imposes on estimated vector autoregressions, it has foundations in terms of a deep and consistent application of rational expectations dynamic theory.

Nevertheless, my own response to the tensions highlighted by Sims' arguments is to continue along the path of using rational expectations theory and econometrics.[21] This response is based partly on the opinion that existing patterns of decentralization and policy rules can be improved upon. This opinion comes from the perception that unfinished and imperfect theories have been believed and acted upon in designing and operating institutions. Dynamic rational expectations models provide the main tools that we have for studying the operating characteristics of alternative schemes for decentralizing decisions across institutions and across time. I believe that economists will learn interesting and useful things by using these tools.

[18]A closely related example is Robert Barro's work (1979) using a theory of dynamic optimal taxation to generate restrictions on time-series observations on government finance.

[19]It is noteworthy that during 1922–23, when the Soviets were intent on extracting seignorage, two government currencies circulated simultaneously, the large denomination, stable valued chervonetz, and the small denomination, rapidly depreciating Soviet ruble (zovzhnak). Keynes remarked about the ingenuity of the Soviets in devising clever ways of extracting seignorage.

[20]Another example is Townsend's (1983b) theory of economic development and financial intermediation.

[21]I am unaware of an alternative approach to Sims or to rational expectations econometrics that avoids these contradictions and tensions. Even informal descriptions and analyses of historical and contemporary economic events inevitably involve somehow tentatively resolving these tensions, whether explicitly or implicitly. The nature of this tentative resolution, which cannot be totally satisfactory on philosophical grounds because of the contradictions mentioned above, often governs ones interpretations in an important way. For example, in my informal studies of inflation (1983a, b), interpretations spring from the stand taken on the issues raised in the present paper.

REFERENCES

Alj, Abderrahmane and Alain, Haurie, "Dynamic Equilibrium of Multigeneration Stochastic Games," *IEEE Transactions on Automatic Control*, February 1983, *A6-28*, 193–203.

Barro, Robert J., "On the Determination of the Public Debt," *Journal of Political Economy*, October 1979, *87*, 940–71.

Basar, Tamer and Olsder, Geert J., *Dynamic Noncooperative Game Theory*, New York: Academic Press, 1982.

Bryant, John and Wallace, Neil, "A Price Discrimination Analysis of Monetary Policy," *Review of Economic Studies*, forthcoming, 1984.

Buiter, Willem H., "The Macroeconomics of Dr. Pangloss: A Critical Survey of the New Classical Macroeconomics," *Economic Journal*, March 1980, *90*, 34–50.

Doan, Thomas, Litterman, Robert and Sims, Christopher, "Forecasting and Conditional Projection Using Realistic Prior Distributions," manuscript, Federal Reserve Bank of Minneapolis, 1983.

Eckstein, Zvi and Eichenbaum, Martin, (1984a) "Inventories and Quantity Constrained Equilibria in Regulated Markets: The U.S. Petroleum Industry, 1947–1972," in T. Sargent, ed., *Energy, Foresight and Strategy*, Resources for the Future, forthcoming 1984.

_____ **and** _____, (1984b) "Oil Supply Disruptions and the Optimal Tariff in a Dynamic Stochastic Equilibrium Model," in T. Sargent, ed., *Energy, Foresight and Strategy*, forthcoming 1984.

Epple, Dennis, Hansen, Lars Peter and Roberts,

Will, "Linear Quadratic Games of Resource Depletion," in T. Sargent, ed., *Energy, Foresight and Strategy*, forthcoming 1984.

Garcia Marquez, Gabriel, *One Hundred Years of Solitude*, New York: Avon Books, 1971.

_____, *Chronicle of a Death Foretold*, New York: Alfred A. Knopf, 1983.

Hansen, Lars Peter and Sargent, Thomas J., "Formulating and Estimating Dynamic Linear Rational Expectations Models," *Journal of Economic Dynamics and Control*, February 1980, *2*, 7–46.

_____ **and Singleton, Kenneth,** "Generalized Instrumental Variables Estimation of Nonlinear Rational Expectations Models," *Econometrica*, September 1982, *50*, 1269–86.

Keynes, John Maynard, *Collected Writings IV: A Tract on Monetary Reform*, Cambridge: MacMillan, (1923) 1971.

Kydland, Finn and Prescott, Edward C., "Rules Rather Than Discretion: The Inconsistency of Optimal Plans," *Journal of Political Economy*, June 1977, *85*, 473–91.

_____ **and** _____, "Time to Build and Aggregate Fluctuations," *Econometrica*, November 1982, *50*, 1345–70.

Litterman, Robert, *Techniques for Forecasting with Vector Autoregressions*, unpublished doctoral dissertation, University of Minnesota, 1980.

_____, "A Bayesian Procedure for Forecasting with Vector Autoregressions," Working Paper, Massachusetts Institute of Technology, 1981.

Lucas, Robert E., "Econometric Policy Evaluation: A Critique," in K. Brunner and A. Meltzer, eds., *The Phillips Curve and Labor Markets*, Vol. 1, Carnegie-Rochester Conferences on Public Policy, *Journal of Monetary Economics*, Suppl. 1976, 19–46.

_____ **and Prescott, Edward C.,** "Investment Under Uncertainty," *Econometrica*, September 1971, *39*, 659–81.

_____ **and Sargent, Thomas J.,** *Rational Expectations and Econometric Practice*, Minneapolis: University of Minnesota Press, 1981.

_____ **and Stokey, Nancy,** "Optimal Fiscal and Monetary Policy in an Economy Without Capital," *Journal of Monetary Economics*, July 1983, *12*, 55–93.

Romer, Paul, "Notes on Existence of Dynamic Competitive Equilibria: Externalities, Increasing Returns and Unbounded Growth," University of Rochester, May 1982.

Sargent, Thomas J., "Interpreting Economic Time Series," *Journal of Political Economy*, April 1981, *89*, 213–48.

_____, (1983a) "The Ends of Four Big Inflations," in R. E. Hall, ed., *Inflation: Causes and Effects*, Chicago: University of Chicago Press, 1983.

_____, (1983b) "Stopping Moderate Inflations: The Methods of Thatcher and Poincare," in R. Dornbusch and M. Simonsen, eds., *Indexation*, Cambridge: MIT Press, 1983.

_____ **and Wallace, Neil,** "Rational Expectations and the Theory of Economic Policy," *Journal of Monetary Economics*, April 1976, *2*, 169–83.

Sims, Christopher A., "Macroeconomics and Reality," *Econometrica*, January 1980, *48*, 1–48.

_____, "Policy Analysis with Econometric Models," *Brookings Papers on Economic Activity*, 1:1982, 107–64.

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

_____, "Output and Price Stability: An International Comparison," *Journal of Economic Dynamics and Control*, February 1980, *2*, 109–32.

_____, "The Swedish Investment Funds System as a Stabilization Policy Rule," *Brookings Papers on Economic Activity*, 1:1982, 57–99.

Thomas, D. M., *The White Hotel*, New York, Pocket Books, 1982.

Townsend, Robert M., (1983a) "Theories of Intermediated Structures," in K. Brunner and A. Meltzer, eds., *Carnegie-Rochester Conference Series on Public Policy: Money, Monetary Policies and Financial Institutions*, 1983, *18*, 221–72.

_____, (1983b) "Financial Structure and Economic Activity," *American Economic Review*, December 1983, *73*, 895–911.

Whiteman, Charles, *Linear Rational Expectations Models: A User's Guide*, Minneapolis, University of Minneapolis Press, 1983.