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MONETARY ECONOMICS
A REVIEW ESSAY

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ABSTRACT

In this essay I define money to be whatever objects serve as generally acceptable media of exchange and I define monetary economics to be the study of the causes and economic consequences of the monetization of exchange -- that is, of the use of media of exchange. These definitions lead me to specify the distinctive objectives of monetary economics to be to understand (1) the monetization of exchange and its relation to the technologies of production and of exchange, (2) the form that money takes and, especially, the viability of fiat money, (3) the determination and significance of the real value of units of money, and (4) the relation between the nominal quantity of money and aggregate economic activity. The essay tries to acquaint the reader with the contents of the recently published *Handbook of Monetary Economics* as they relate to these objectives of monetary economics and offer some critical thoughts on selected unsettled issues in monetary economics that my reading of the *Handbook* suggested.

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MONETARY ECONOMICS
A Review Essay*

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What is monetary economics about? What are the distinct questions that monetary economics addresses and that differentiate monetary economics as a field of inquiry? If I had been editing a handbook of monetary economics, I would have begun by following the neoclassical economists, especially William Stanley Jevons (1875) and Karl Menger (1892), in defining money precisely and unambiguously to be whatever objects serve as generally acceptable media of exchange and in defining monetary economics to be the study of the causes and economic consequences of the monetization of exchange -- that is, of the use of media of exchange. After some reflection on the great range of difficult questions that economists might address, these definitions would have led me to specify the distinctive objectives of monetary economics to be to understand (1) the monetization of exchange and its relation to the technologies of production and of exchange, (2) the form that money takes and, especially, the viability of fiat money, (3) the determination and significance of the real value of units of money, and (4) the relation between the nominal quantity of money and aggregate economic activity.

My main criticism of the recently published *Handbook of Monetary Economics* is that, although parts of the two volumes, 23 essays, and more than 1300 pages are relevant to these central issues of monetary economics, the *Handbook* does not bring monetary economics into clear focus. It is noteworthy that the editors of the *Handbook*, Benjamin Friedman and Frank Hahn, do not provide an explicit definition of either money or monetary economics. Their introduction, however, refers to the property that "money is a means of exchange between agents differently situated" and recognizes, at least implicitly, that this property differentiates the research program and research methodology of monetary economics. But, the *Handbook* neither gives priority to the study

of the causes or consequences of the monetization of exchange nor uses it, as I would have done, as an organizing principle.

Friedman and Hahn claim that "an important development in recent years, which is still ongoing, is the erosion of any recognizable barrier between financial economics and monetary economics" (Page xv). Friedman and Hahn also refer to "formal theory describing an economy with money, and perhaps other financial assets as well" (Page xi). In light of these statements, it is not surprising that the *Handbook* blurs the distinctions between monetary issues and financial issues and between monetary theory and capital theory. In so doing the *Handbook* obscures the answers to the central questions of monetary economics.

In referring to money as a financial asset, Friedman and Hahn presumably have in mind the standard definition of a financial asset: a written evidence of a legally enforceable, possibly state contingent, contract that entitles its owner either to receive specified future payments of legal tender or to have the future use of specific real resources. Given this definition, neither logic nor experience support the suggestion that money is necessarily a financial asset. In fact, in history and anthropology, media of exchange usually are commodity monies, typically coined from precious metals. The use of financial assets as money has been associated with the development of sophisticated legal systems and has become common only in modern times. Moreover, as the analysis by Peter Garber and Steven Weisbrod (1990) brings out, we cannot understand modern monetary arrangements without recognizing that only a small subset of financial assets serves as money and we cannot understand financial markets and institutions without taking account of the monetization of financial transactions.

Not even one essay in the *Handbook* says much about, let alone focuses on the technology and institutions of monetized exchange, on monetary standards, or on monetary history. The *Handbook* does not consider the questions of what things are or can be money, much less offer any insight into either the transition from commodity

monies to the use of a small subset of financial assets as money or the nature of these financial assets that serve as money.

The difference in orientation and coverage between the *Handbook* and the recent monograph on monetary economics by Bennett McCallum (1989) is striking. According to McCallum, "monetary economics is concerned with the effects of monetary institutions and policy actions ..." (page 3). And, although McCallum takes the monetization of exchange for granted and does not explore its causes, his book discusses monetary standards and deals at length with monetary history. Moreover, McCallum distinguishes between "the monetary and real sectors of the economy," points out "that the financial sector is a real sector," and stresses "that there is no *necessary* connection between financial and monetary issues" (page 30).

Having complained about the focus and coverage of the *Handbook*, let me emphasize that, although the editors have imposed little in the way of order or coordination on the 23 individual essays, many of the essays, including those that deal with issues tangential to monetary economics, are highly instructive. For example, the *Handbook* contains a section on the pricing of nonmonetary assets that includes excellent contributions by Robert Merton, by Kenneth Singleton, and by Robert Shiller and Huston McCulloch. The *Handbook* also includes valuable essays by Andrew Abel on consumption and investment, by Dwight Jaffee and Joseph Stiglitz on credit rationing, and by Michael Haliassos and James Tobin on government finance. More importantly, the *Handbook* provides insightful and suggestive discussions of many issues that bear on what I take to be the distinctive objectives of monetary economics. In what follows, I try to acquaint the reader with the contents of the *Handbook* as they relate to monetary economics and I offer some critical thoughts on selected unsettled issues in monetary economics that my reading of the *Handbook* suggested.

1. The Monetization of Exchange

In the early 1970's, Joseph Ostroy and Ross Starr published a trio of important papers that formalized and expanded on the classic discussions of the monetization of exchange by Jevons and by Menger. See Starr (1972), Ostroy (1973), and Ostroy and Starr (1974). As Robert Jones (1984) puts it in his excellent unpublished critique, "this literature seeks to make precise the notion that money facilitates trade." More specifically, the models developed by Ostroy and by Starr demonstrate rigorously how money allows an economy to achieve an efficient (market-clearing) consumption allocation through bilateral exchange, even if its pattern of initial endowments does not exhibit double coincidence of wants. These models also contrast the use of money with the use of alternative devices for facilitating the transformation of an initial endowment into an efficient consumption allocation in the absence of a double coincidence of wants, such as centralized coordination of trading, multilateral trading (or, equivalently, multiple bilateral trading rounds), trading posts with middlemen, and trade or bank credit.

In the opening essay of the *Handbook*, after discussing sequence-economy models (about which more below), Ostroy and Starr review the analysis in Ostroy and Starr (1974) and also briefly summarize subsequent related contributions to the theory of monetization by Jones (1976) and by Seonghwan Oh (1989). This essay by Ostroy and Starr and the essay in the *Handbook* by Martin Shubik both emphasize the relation between money and bank credit in facilitating exchange. But, as with most issues that the *Handbook* raises, neither Friedman and Hahn nor the individual authors effectively relate the discussions of this issue in the different essays. In addition, the *Handbook* does not discuss some important recent work on the theory of monetization, of which papers by Nobuhiro Kiyotaki and Randall Wright (1989, 1991) seem to promise especially fruitful insights.

The models developed by Jones and by Oh emphasize the relative commonness in exchange of different goods in a framework with a

large number of goods and a large number of traders. These models show how, whether or not a complete double coincidence of wants exists, a commodity money can emerge endogenously from the interactions of individual traders who follow strategies designed to minimize the sequence of bilateral trades necessary to obtain their market-clearing consumption allocations. In contrast to Jones, Oh considers conditional trading strategies and derives a realistic monetary equilibrium in which, although a generally acceptable medium of exchange exists, some barter trading occurs. But, because commonness in exchange is a self-confirming property -- that is, traders accept money if they expect other traders to accept it -- Oh's analysis cannot determine which commodity becomes money. Specifically, although money is most common in exchange, it need not be the most common commodity in either endowments or consumption allocations.

In their 1989 paper, Kiyotaki and Wright develop a complementary analysis that focuses on the relative costs of exchanging and storing different commodities and on the implications of particular patterns of endowments and consumption allocations that do not exhibit a complete double coincidence of wants. Unfortunately, each of the examples that Kiyotaki and Wright consider, because they involve exactly three traders and three goods, blurs the distinction between middlemen, who will accept anything in exchange, and money, which everybody will accept in exchange. Nevertheless, Kiyotaki and Wright show how a commodity money can emerge endogenously from the interactions of individual traders who follow strategies designed to obtain their market-clearing consumption allocations with minimum exchange and storage costs. In addition, Kiyotaki and Wright show how these strategies determine which commodity becomes money.

Interestingly, Kiyotaki and Wright find that, depending on the pattern of endowments and consumption allocations, money may or may not be the cheapest commodity to exchange and to store. In other words, their model allows money to suffer from "rate of return dominance." This result seems analogous to the finding by Oh that

money need not be the most common good in either endowments or consumption allocations. Also, like Oh, Kiyotaki and Wright stress the equilibrium property that some barter trading coexists with a generally acceptable medium of exchange.

In their 1991 paper, Kiyotaki and Wright generalize the analysis to allow goods to be substitutable in consumption. In this model, the equilibrium consumption allocation and the associated frequency of double coincidence of wants are endogenous. Kiyotaki and Wright are able to show that the monetization of exchange can both reduce exchange and storage costs and, importantly, improve the equilibrium consumption allocation.

These recent advances in modelling the monetization of exchange have not yet progressed to the point of generating quantifiable behavioral hypotheses about the using and holding of money. The essays in the *Handbook* by Hahn and by Stephen Goldfeld and Daniel Sichel evidence the gap that remains to be bridged between the theory of monetization and the usual exercise of modelling the demand for money balances. Hahn assumes that assets differ in the transactions costs that are incurred when they are bought or sold, which he denotes as their liquidity, and he identifies money as an asset that involves zero transactions cost and, accordingly, is most liquid. He then shows how desired portfolios, including their monetary component, depend on the given vector of transactions costs as well as on preferences and probability distributions of asset returns.

Hahn recognizes that this theory lacks the foundation of an underlying model of the technology of exchange that generates the assumed vector of transactions costs. Similarly, Goldfeld and Sichel, in their careful and thorough survey of econometric studies of the demand for money, note the lack of clear theoretical guidance that results from "the unfortunate absence of a general portfolio/transactions model" (Page 312). Hahn suggests that the existing theoretical gap might be closed by integrating search theoretic ideas into the theory of the demand for money. Such an integration is what Oh and Kiyotaki and Wright have been pursuing,

a fact that underscores my unhappiness that the *Handbook* does not contain a discussion of their work.

2. The Viability of Fiat Money

According to Friedman and Hahn, a central purpose of the opening essay in the *Handbook* by Ostroy and Starr is to "study the transition from an Arrow-Debreu economy to one in which an intrinsically worthless means of exchange has value" (Page xii). But, as already noted, media of exchange generally have not been fiat monies or even financial assets. Fiat money in particular seems to be the logical and historical culmination of the monetization of exchange. Accordingly, it seems odd to treat fiat money as the starting point for monetary economics.

Nevertheless, explaining the viability of fiat money is an interesting problem. Ostroy and Starr begin their essay by arguing that one solution to this problem is the "intertemporal allocative function" that fiat money allegedly performs in "sequence-economy" models. These models, early examples of which include Hahn (1973) and Mordecai Kurz (1974), emphasize that an economic agent typically wants to implement a time pattern of consumption that differs stochastically from the time pattern of his endowment, but they assume that achieving this objective either through trade in futures markets or by holding real assets involves significant "transaction and storage costs." More recent contributions, such as Robert King and Charles Plosser (1986) and Robert Townsend (1989), model the unfeasibility of futures markets explicitly by assuming that the information necessary to implement contingent claims is private. In this framework, as Ostroy and Starr explain, "Introduction of fiat money -- assumed to be transaction costless -- results in a move to a Pareto superior allocation ... Money restores allocative efficiency by allowing both fulfillment of the sequential budget constraints and the use of only spot goods transactions, without distortion of the lifetime consumption plan" (Page 16).

Whereas Ostroy and Starr base their discussion of

intertemporal exchange only on sequence-economy models, W. A. Brock, in his wide ranging *Handbook* essay, discusses the alternative overlapping-generations framework. In overlapping-generations models, the incompleteness of futures markets reflects an intrinsic and natural structural property, the impossibility of trading with generations that are as yet unborn. Another attraction of overlapping-generations models is that they yield the interesting result that holding real assets in order to reallocate consumption intertemporally can result in inefficient overaccumulation of capital even if the productivity of capital exceeds storage costs.

Ostroy and Starr point out that in their modelling of the "intertemporal allocation function" of "money," as in their formalization of the social value of media of exchange, "money is a device to record and make public one's trading history" (Page 57). But, as McCallum stresses in his *Handbook* essay, and as both Ostroy and Starr and Brock recognize, the medium-of-exchange property, which I take to be the defining characteristic of money, plays no intrinsic role in either sequence-economy or overlapping-generations models. As Ostroy and Starr note, "it takes an economy of at least three goods and at least three agents to generate a need for a medium of exchange" (Page 27). What the sequence-economy and overlapping-generations frameworks show is that an arrangement to economize on "transaction and storage costs" in intertemporal exchange or to avoid overaccumulation of capital can be socially valuable. But, this conclusion relates to fiat money only through the assumption, which neither Ostroy and Starr nor Brock try to justify, that fiat money is the only or best such arrangement.

As alternatives to fiat money, nonmonetary financial assets like government bonds and state-contingent tax and transfer schemes provide in both theory and practice means by which government policy facilitates efficient risk sharing and intertemporal consumption allocations. In addition, recent contributions to the overlapping-generations literature -- see, for example, McCallum

(1987) -- have begun to address the subtle issue of the extent to which changes over time in the value of existing real assets in terms of consumption goods can support an efficient temporal allocation of consumption without the need for governmental intervention. In addition, extensions of the overlapping-generations literature -- see, for example, Laurence Kotlikoff and Avia Spivak (1981) and Douglas Bernheim, Andrei Shleifer, and Lawrence Summers (1985) -- have directed attention to the family as an arrangement for sharing risk and allocating consumption intertemporally.

In any event, whatever conclusions we reach about the social value of fiat money, attributing social value to fiat money is not the same thing as explaining why fiat money is viable. Both Ostroy and Starr and Brock recognize that for a fiat money to have positive value currently it is necessary and sufficient that people expect it to have positive value at all future dates, including the terminal date if one exists. But neither Ostroy and Starr nor Brock have much to say about the critical issue of how the expected future value of fiat money is determined.

Darrell Duffie's *Handbook* essay attempts to address this issue. After briefly mentioning suggested solutions in the existing literature, Duffie proposes a model with a finite deterministic horizon in which fiat money has value because, by assumption, some agents are willing to sell their endowment of bads for fiat money in the terminal period. This trick amounts to essentially the same thing as putting fiat money directly into the utility function. In their papers, Kiyotaki and Wright also show how fiat money can replace commodity money if "everyone believes that others will accept fiat money." They use an infinite-horizon setup in which this belief can be viable because, and only because, it is self-confirming.

These theoretical results contrast with my quick reading of history, which suggests that in practice credible sovereign power -- specifically, the ability to enforce the legal tender status of fiat money -- is necessary to create the expectations that support

a viable fiat money. (Recall that the defeat of the Confederacy rendered Confederate fiat money worthless.) More generally, experience suggests that, in order to be money, a financial asset, whether in the form of a piece of paper or a bookkeeping entry, must be either redeemable in precious metals on demand, or enforceable legal tender by fiat, or redeemable in legal tender on demand. The *Handbook* does not consider hypotheses such as these about the monetization of financial assets, which would seem to be the appropriate starting point for analyzing the viability of fiat money, much less explore the ability of such hypotheses to withstand careful theoretical end empirical scrutiny. The reconciliation of theory with the "facts" about fiat money remains a central problem in monetary economics.

3. The Value of Money

Several of the essays in the *Handbook* discuss issues relating to the average level of money prices and its inverse, the real value of units of money. These essays reflect a current concensus, stemming from the seminal work of Don Patinkin (1956), that regards the value of money to be, except for transitory deviations, an element of the general-equilibrium solution to a system of supply and demand equalities in which the price level adjusts to equate the real value of the nominal quantity of money to the demand for real money balances or, equivalently, to equate the marginal return and the marginal cost associated with holding money balances. But, these essays also illustrate the current lack of concensus about the answers to important questions relating to the value of money that the basic framework suggested by Patinkin does not address.

One such question is whether the parametric specification of tastes, technology, and endowments, together with the nominal quantity of money, uniquely determines the price level that would be consistent with general market clearing. In other words, can the equilibrium price level also depend on extraneous factors as in models of sunspot equilibria and rational bubbles?

Another question concerns the welfare significance of the time path of the price level. In particular, what is the basis for popular antipathy to increases in the price level? A related positive question concerns attempts to expand the basic general-equilibrium model to endogenize governmental decisions, including monetary policy, and thereby to explain the evolution of the variables such as the price level that seem to be proximate targets of policymaking.

Finally, another central question concerns the importance of transitory deviations of the actual price level from the hypothetical price level that would be consistent with general market clearing. This question is closely related to the issue of the relation between money and aggregate economic activity, which I discuss in the next section.

Determination of the Price Level

The *Handbook* devotes little attention to the question of whether or not the fundamental factors of tastes, technology, and endowments uniquely determine the real quantity of money. The essays by McCallum and Michael Woodford include brief discussions of this issue, but the *Handbook* does not provide a synthesis, or even an overview, of the theoretical and empirical literature that relates to the possible dependence of the price level and the real quantity of money on extraneous factors and to the possible existence of such phenomena as sunspot equilibria and rational bubbles. The neglect of this central problem in monetary economics is especially unfortunate because the existing literature suffers from both conceptual and semantic confusion.

Fundamentals can fail to determine uniquely the price level and real quantity of money for two distinct reasons. One reason reflects the general property that a system of supply and demand equalities can have multiple steady-state or stationary solutions for equilibrium prices and quantities. Following the terminology used by David Cass and Karl Shell (1983) and by Eric Maskin and Jean Tirole (1987), I refer to this type of nonuniqueness as the

phenomenon of a (stationary) sunspot equilibrium. [Other authors, including Woodford (1988), use "sunspot equilibria" as a generic term for any failure of fundamentals to determine the price level uniquely.]

Models of the demand for real money balances typically imply a market-clearing condition in the form of an expectational difference equation that relates the current price level to the expected future price level as well as to the nominal quantity of money and the vector of tastes, technology, and endowments. In this setup, a sunspot equilibrium, on my definition, involves nonuniqueness of the particular solution to this expectational difference equation that is obtained by setting the associated homogeneous equation equal to zero. In particular, a sunspot equilibrium is a type of nonuniqueness that can occur even if the economy has a known finite terminal date and an associated terminal value or terminal probability distribution for the real quantity of money. The simplest form of sunspot equilibrium would be a randomization over multiple stationary equilibria, with the set of possible equilibria being independent of the stochastic sunspot process that chooses among them, but it is also possible, as in nonmonetary examples suggested by Cass and Shell (1983) and by Maskin and Tirole (1987), to imagine that the set of possible equilibria itself depends on the sunspot process.

The literature contains theoretical examples of sunspot equilibria for the price level -- see, in particular, Costas Azariadis and Roger Guesnerie (1986) and Woodford (1988). There seems, however, to be no systematic analysis of the empirical relevance of this type of nonuniqueness. Does the real quantity of money ever jump from one steady-state value, or from one stationary distribution, to another in response to events that do not involve changes in tastes, technology, or endowments?

Two observations lead me to the tentative view that we cannot rule out an affirmative answer to this question. First, there are models of sunspot equilibria for other economic phenomena that have the ring of truth. An intriguing example is the theory of

statistical discrimination developed by Kenneth Arrow (1973) and by David Starrett (1976) -- see also Herschel Grossman and Warren Trepeta (1981). Second, we observe, since major monetary authorities dropped the practice of pegging exchange rates between their currencies, sharp movements in real and nominal exchange rates that are not readily explicable in terms of changes in fundamentals. Maybe this phenomenon reflects our poor understanding of fundamentals, but then again maybe it implies that multiple vectors of relative currency values are consistent with equilibrium.

The other reason that fundamentals can fail to determine uniquely the price level and the real quantity of money is that, without a known finite terminal date and associated terminal value or terminal probability distribution for the real quantity of money, the homogeneous equation associated with the expectational difference equation that governs the price level can have solutions other than zero. In that event, the general solution to the expectational difference equation does not restrict the price level to a unique time path. Following the terminology used by Robert Flood and Peter Garber (1980), I refer to this type of nonuniqueness as the phenomenon of rational bubbles. Rational bubbles can occur even if fundamentals imply a unique steady-state or stationary equilibrium for the price level.

Rational bubbles in the price level can be either deterministic, as in analysis of Flood and Garber, or stochastic, as in the analysis of Behzad Diba and Herschel Grossman (1988). In the case of a deterministic rational bubble, the price level follows a self-confirming dynamic path that depends on the initial price level in addition to fundamentals. In the case of a stochastic rational bubble, this self-confirming path depends also on the history of innovations in any nonfundamental random variables that agents expect to influence the price level. Mathematically, rational bubbles can involve either convergence towards a steady-state or stationary solution or divergence away from a steady-state or stationary solution. An economically

meaningful (i.e., forward looking) steady-state or stationary equilibrium, however, typically requires that the eigenvalue of the relevant expectational difference exceed unity, in which case rational bubbles have explosive conditional means. Specifically, the expected value of a rational bubble in the price level either would increase or would decrease geometrically into the infinite future.

Given this explosive property of rational bubbles in the price level, various authors have advanced theoretical arguments for precluding their existence. For example, William Brock (1982), shows that a necessary condition for intertemporal optimization by agents with infinite planning horizons is a "transversality condition" that requires the discounted value of each agent's wealth to tend to zero. This transversality condition implies, as explained, for example, by JoAnna Gray (1984), that rational *deflationary* bubbles cannot exist in an economy with a representative agent who has an infinite planning horizon. This transversality condition, however, as Jean Tirole (1985) and Stephen O'Connell and Stephen Zeldes (1988) show, does not rule out rational *deflationary* bubbles in an economy with a growing number of potential holders of money balances, with either infinite or finite planning horizons, if the growth rate of the economy is not smaller than the rate of return that money holders require.

Maurice Obstfeld and Kenneth Rogoff (1983) show that rational *inflationary* bubbles can exist only in the value of a pure fiat money -- that is, money with a zero probability of having a positive real redemption value. Moreover, Diba and Grossman (1988) show that, if rational *deflationary* bubbles are ruled out but a rational *inflationary* bubble exists, then the rational *inflationary* bubble must have started on the date of initial issuance of the fiat money and that, if it ever bursts, then it cannot restart.

Empirical analysis of the existence of rational bubbles faces the basic difficulty, pointed out by Flood and Garber (1980) and emphasized by James Hamilton and Charles Whiteman (1985), that a researcher cannot distinguish a rational bubble in the price level

from the effect on the price level of elements of fundamentals that he does not observe. Hamilton (1986) presents theoretical examples in which a researcher who is unable to observe warranted changes in the expectations of asset holders about future fundamentals might conclude falsely that a rational bubble exists, and Alessandra Casella (1989) reports an empirical example in which misspecification of the process generating the quantity of nominal money balances leads to the false conclusion that the German hyperinflation involved a rational bubble. Because potential misspecification of fundamentals makes it impossible in principle to reject the hypothesis that a rational bubble does not exist, the appropriate focus of empirical analysis has to be on tests of the converse hypothesis that rational bubbles in the price level exist. As McCallum points out in his *Handbook* essay, this hypothesis seems inconsistent with available evidence that, as, for example, Hamilton and Whiteman (1985) show, indicates that even in hyperinflations differencing the inflation rate yields a stationary time series.

The Welfare Significance of Inflation

In their *Handbook* essay, John Driffill, Grayam Mizon, and Alistair Ulph correctly emphasize "that inflation per se does not cause welfare losses, but is itself the result of government economic policy ... and external 'shocks'" (Page 1060). In particular, the hypothetical experiment of changing the inflation rate while holding other effects on economic welfare unchanged is neither practically nor theoretically feasible. Moreover, Driffill, Mizon, and Ulph point out that "aggregate inflation, its variability over time, its unpredictability, and the variability in prices across the economy, are all endogenous variables within some general equilibrium model. The associations which emerge between them depend on the nature of the exogenous driving forces of the model. There is no general or necessary connection between, say, the average inflation rate and the variability of prices across firms" (Page 1046).

In accord with these observations, Driffill, Mizon, and Ulph, as well as Athanasios Orphanides and Robert Solow, McCallum, and Woodford in their *Handbook* essays, focus their welfare analysis of inflation on the particular policy of using the seigniorage revenue from a steady anticipated increase in the quantity of fiat money either to replace other revenues or to finance transfer payments. A complete specification of this experiment includes, of course, the other revenue sources for which the inflation tax associated with seigniorage revenue is a substitute and the transfer payments that seigniorage finances. Even after focusing the analysis this way, the discussions presented by Driffill, Mizon, and Ulph, Orphanides and Solow, McCallum, and Woodford illustrate that, as Driffill, Mizon, and Ulph put it, "assessing the welfare implications of different inflation tax rates turns out to be impossible at any level of generality" (Page 1025). A further complication is that, if the size of the inflation tax is not known for certain in advance, then its realized effect also can depend on whether or not other existing taxes and transfer payments are effectively indexed for inflation.

Nevertheless, these essays, and especially Woodford's thorough review of an extensive literature, suggest that we are safe in believing that the normative proposition popularized by Milton Friedman (1969), "according to which an optimal monetary policy would involve a steady contraction of the money supply [relative to the growth of the economy] at a rate sufficient to bring the nominal interest rate down to zero" (Page 1068), is at least approximately true. At the same time, we are left with the impression that the welfare implications of deviating from Friedman's prescription by substituting somewhat less deflation, or a small positive inflation, for other distortionary taxes are not likely to be large.

On reaching this conclusion, economists often express puzzlement at the apparently strong popular antipathy to inflation. As Driffill, Mizon, and Ulph put it, "It appears to remain the case that the man-in-the-street notions of the costs of inflation have

not been formalized in rigorous theoretical models" (Page 1046). My conjecture is that the problem here is simply semantic confusion.

Popular discussions of inflation surely do not have in mind the hypothetical experiment of a change in the rate of money growth with technology, resource availability, government expenditures, and the distribution of income and wealth all unchanged and with other taxes adjusted accordingly. In fact, I have found it easy to get laymen to agree that they would be indifferent to such an experiment. Actual popular antipathy to inflation seems to recognize that, in contrast to this experiment, increases in the price level historically are associated with negative innovations in real disposable incomes. In other words, popular discussion seems to use inflation, whether transitory or persistent, as a signifier for what experience has shown to be its main causes -- namely, negative aggregate supply shocks and/or increases in the inflation tax without offsetting decreases in other taxes.

Positive Analysis of Monetary Policy

Most of the existing literature on monetary policy is concerned with analysis, both descriptive and prescriptive, of the techniques of monetary control. The essential question that this ongoing research program asks is how should the monetary authority conduct policy in order to achieve its given objectives. The *Handbook* essays by Karl Brunner and Allan Meltzer, by Lucas Papademos and Franco Modigliani, and by Benjamin Friedman provide thorough, albeit partially overlapping, discussions of the issues and problems about monetary control that arise in the American institutional framework. The *Handbook* essay by Rudiger Dornbusch and Alberto Giovannini extends the discussion of monetary control to the broader issues that arise in an open economy.

Recent years also have seen remarkable developments in the positive analysis of economic policy, including monetary policy. This research program abstracts from the details of monetary control. Its objective is to analyze how the objectives of the

monetary authority are transformed into an equilibrium monetary policy through the strategic interactions of the monetary authority and the public. The analysis focuses on the problem of time consistency.

The *Handbook* essays by McCallum and by Stanley Fischer both emphasize the seminal contributions in this research program -- namely, the derivations of time-consistent equilibria in positive models of monetary policy by Finn Kydland and Edward Prescott (1977) and by Robert Barro and David Gordon (1983). In a time-consistent equilibrium, the public expects the policymaker to enact the equilibrium policy and the policymaker cannot do anything better from his perspective than to validate this expectation. Kydland and Prescott assumed that the monetary authority follows a myopic strategy and they showed for this case that, if the monetary authority would prefer positive unexpected inflation, then a time-consistent, and, hence, credible, monetary policy exhibits inflationary bias -- that is, a higher inflation rate than would obtain if the monetary authority could commit itself not to try to create unexpected inflation.

As both McCallum and Fischer point out, this inflationary bias does not depend on the nature of the underlying policy objectives that cause the monetary authority to prefer positive unexpected inflation. For example, it does not depend on whether this preference reflects a desire to stimulate aggregate economic activity, or to reduce the cost of servicing nominally denominated debts, or to obtain more seigniorage revenue or on the use to which the government would put any additional resources over which unexpected inflation would give it control. In a related paper, Guillermo Calvo (1978) showed that, if the monetary authority is not averse to high inflation per se, an assumption that would seem consistent with underlying policy objectives that involve only real economic outcomes, then with a preference for positive unexpected inflation and with the monetary authority following a myopic strategy a unique time-consistent equilibrium exists at the maximum feasible inflation rate.

Kydland and Prescott also suggested that the promulgation of monetary "rules" could alleviate this inflationary bias, but they did not address the deeper issue that inability to commit to follow a rule is an intrinsic property of economic policymaking. The problem is that, in order to establish a monetary standard, whether it be a commodity standard or a fiat standard, and to control the value of money, as well as to undertake other essential functions, the government must have the sovereign power to act as the ultimate enforcer of contractual commitments. But, this sovereign power precludes the existence of a higher authority capable of enforcing commitments about future policy choices. Consequently, any policy "rule," even one that allows for state-contingent flexibility, can be viable only as long as it is expedient for the policy authority to follow it. The history of the gold standard, as Fischer recognizes, is an excellent example that illustrates this point.

Accordingly, Fischer emphasizes that a theoretically complete and empirically relevant model of time-consistent policy equilibria requires a theory of the viability of policy rules. Barro and Gordon developed such a theory. Most importantly, they showed how the introduction of "reputational" considerations leads to nonmyopic strategies that can yield time-consistent equilibria with less inflationary bias than in the Kydland and Prescott model. In fact, as Fischer shows, for some specifications of the preferences of the monetary authority, which include the authority's time-discount factor, the time-consistent reputational equilibrium even can be the same as the hypothetical equilibrium that would obtain if the monetary authority could commit itself not to try to create unexpected inflation. In this fortunate case, the time-consistency constraint does not bind and reputation serves as a perfect substitute for policy commitments. In Herschel Grossman and John Van Huyck (1986) and Grossman (1990a), we showed that this result can obtain even if, as seems plausible, the monetary authority, although it prefers low expected inflation and positive unexpected inflation, has no distinct aversion to high inflation per se.

Although they recognize that the consideration of reputation introduces an essential element of reality into the positive analysis of monetary policy, both McCallum and Fischer endorse the criticism that the concept of reputation does not lead naturally to a fully specified model of the behavior of the policymaker and the public and that closure of a reputational model requires arbitrary extraneous assumptions. This allegation that reputational equilibria are not unique involves two separable questions: First, does a particular reputational model imply a unique set of time-consistent policies? Second, given a set of time-consistent policies, does a particular model imply the selection of a unique equilibrium policy from this set?

To address these questions, it is useful to be clear about the generic properties of a reputational model. I interpret the idea that a policymaker has a reputation for behaving in a certain way to mean that the public has formed a rational inference about properties of the policymaker's decision making that the public does not observe directly. With the concept of reputation defined in this way, the core of any reputational model must be a specification of the signalling and inference problems that the policymaker and the public, respectively, face. Given this analytical perspective, the allegation of nonuniqueness, it seems to me, largely reflects the failure of particular modelling exercises to articulate these problems fully.

For example, in the paper by Barro and Gordon the set of time-consistent equilibria seemed to be nonunique and to depend on an arbitrary assumption about the persistence of the response of the expected inflation rate to the actual inflation rate. But this problem arose only because Barro and Gordon did not specify explicitly the public's inference problem, but tried instead to model the formation of expectations by treating the public as a strategic player. In fact, as long as the relevant private agents are atomistic, ideas about strategic behavior are not relevant for modelling their response to monetary policy. Moreover, as subsequent contributions have shown, an explicit and complete

specification of the public's inference problem and the policymaker's associated signalling problem can yield a unique response of the expected inflation rate to the actual inflation rate and a unique set of time-consistent policies.

In Grossman (1990a), for example, I assume that the public knows the policymaker's preferences for expected and unexpected inflation, but that it must infer whether the policymaker's behavior is rational or opportunistic. In this model, a rational policymaker is able to resist the temptation to act opportunistically whenever the short-term gains from opportunistic behavior are not larger than its long-term costs. In contrast, an opportunistic policymaker behaves as a rational policymaker would behave if its discount factor were zero -- that is, as if he is concerned only with the current realization of his preference function.

My analysis focuses on the behavior of a rational policymaker with a positive discount factor, who always wants to set the inflation rate low enough to signal that he is in fact rational, in order to avoid being mistakenly thought to have become compulsively opportunistic. The set of time-consistent inflation rates implied by this strategy is uniquely related to the policymaker's preferences. In addition, it seems natural to presume that, by announcing his intentions, the policymaker can cause the public to expect the best time-consistent inflation rate, which is either the inflation rate that would obtain if the policymaker could commit himself not to try to create unexpected inflation, if that inflation rate is in this set of time-consistent inflation rates, or the lowest inflation rate in this set, otherwise. Such announcements, moreover, need not be explicit, because the public can infer from its knowledge of the policymaker's preferences what a rational policymaker would announce. A complete analysis of the use of announcements to select a unique equilibrium policy from the set of time-consistent policies, however, would have to address possible nontrivial communication problems that could arise if policy intentions involve a complex array of state contingencies.

In this analysis, conditional on the policymaker being rational, the public is able to predict future monetary policy as well as the policymaker himself can. This implication seems to me to approximate reality. In practice, the objectives of monetary policy, although they are admittedly complex, as well as the political environment in which monetary policy is formed seem to be sufficiently stable that it is relatively easy to formulate forecasts of future monetary policy that are conditioned on the realizations of the many exogenous random variables that enter into the constraints on policy choices. The main forecasting problem, which is faced both by the monetary authority and by the public, seems to concern not the intentions of the authority but the evolution of events that are outside of the authority's control but to which it must react.

Nevertheless, other models of reputation -- see, for example, Barro (1986) and Torsten Persson and Guido Tabellini (1990) -- assume that the public knows that all policymakers are forward looking and rational, but that the current policymaker's preferences are private information. Specifically, the public must infer from observed inflation rates whether the policymaker prefers a large or small amount, possibly zero, of unexpected inflation. In this framework, depending on, among other things, his time-discount factor, a policymaker who prefers a large amount of unexpected inflation might choose temporarily to set a low inflation rate in order to create the false impression that he prefers a small amount of unexpected inflation. Moreover, given that a policymaker who prefers a large amount of unexpected inflation might pretend to prefer a small amount of unexpected inflation, a policymaker who actually prefers a small amount of unexpected inflation might choose to set an even lower inflation rate to avoid being mistakenly thought to prefer a large amount of unexpected inflation. The analysis by Persson and Tabellini implies that in this framework the equilibrium inflation rate can be greater than, equal to, or even less than the inflation rate that would obtain if the policymaker could commit himself not to

try to create unexpected inflation. Related work by Jeremy Stein (1989) and by Michelle Garfinkel and Seonghwan Oh (1990) explores the possibility that monetary authority also could make credible, if imprecise, announcements that partially reveal its preferences. In all of these models, the choices between different strategies, the sets of inflation rates that transmit the desired signals, and the inflation rates in these sets that the policymaker would choose all depend uniquely on his preferences and the probability distribution of policymaker preferences.

Fischer's essay raises the objection that in this framework for a range of preference distributions and discount factors a policymaker who prefers a high inflation rate can be indifferent about whether or not to dissemble his preferences. As Fischer puts it, "it is difficult to believe a model of reputation in which a central bank creates inflation because the dice fell one way rather than another" (Page 1178). But, the possibility of indifference seems to arise only if we restrict possible policymaker preferences to discrete amounts of unexpected inflation and also assume that the policymaker's planning horizon has a finite deterministic terminal date that is common knowledge. Analysis by Kenneth Rogoff (1987), to which McCallum's essay refers, suggests that with preferences distributed over a continuum of amounts of unexpected inflation the policymaker's choice as to whether or not to dissemble his preferences depends on whether the difference, which is a continuous variable, between the value of a marginal improvement in his reputation and the cost of dissembling is negative or positive. Alternatively, if we assume that the terminal date is an unbounded random variable that corresponds to the policymaker's prospective survival in power, so that the policymaker in effect plans over an infinite horizon with a discount factor related to his survival probability, then, as Barro shows, the policymaker chooses to dissemble or not to dissemble depending on whether his discount factor, which is a continuous variable, is less than or greater than a critical value.

McCallum suggests that the inflationary bias identified by Kydland and Prescott can help to explain "why the authorities have behaved, over the postwar era, in a manner that has resulted in a many-fold increase in the price level in most industrialized nations" (Page 1007). But, as noted above, time-consistency constraints and associated credibility problems are intrinsic properties of economic policymaking and, hence, presumably were a source of potential inflationary bias before as well as after 1945. The interesting question, then, is why were reputational incentives apparently more effective in mitigating this inflationary bias before 1945 than after 1945.

In Grossman (1990b), I focused on the United Kingdom and the United States and I argued that before World War II the objective of maintaining a trustworthy reputation for honoring war debts required deflationary postwar monetary policies. In contrast, after World War II, because of unforeseeable, but verifiable, changes in economic and political conditions, especially the extension of the voting franchise, the increased economic and political power of organized labor, and, perhaps most significantly, the large postwar demands on national resources with which the servicing of World War II debts had to compete, a partial default on war debts was excusable and, hence, a moderately inflationary policy was consistent with reputational equilibrium.

4. Money and Aggregate Economic Activity

In his *Handbook* essay, Olivier Blanchard emphasizes the difficulty of estimating econometrically the effect of monetary policy on aggregate economic activity and, in particular, of testing the hypothesis that money is neutral. Monetary neutrality means, among other things, that transitory deviations of the price level from its general-equilibrium solution are unimportant and that monetary policy is inconsequential for cyclical fluctuations in economic activity. The biggest econometric problem in testing this hypothesis is the apparent correlation of nominal monetary aggregates with unobserved exogenous nonmonetary variables that

influence economic activity independently of monetary policy. Most of the variation in nominal monetary aggregates in fact probably reflects an endogenous response of monetary policy to these nonmonetary variables. Given this structure, the pertinent questions about the effect of monetary policy are whether and to what extent the form of this response of monetary policy and/or innovations to it affect economic activity.

To answer these questions, it is necessary not only to model the direct effect of monetary policy on economic activity, but also to control for the effects of exogenous nonmonetary variables on economic activity as well as on monetary policy itself. Moreover, it is important not to confuse the issue of the non-neutrality of money with the distinct issue of the relative importance of nonmonetary disturbances and exogenous monetary innovations in explaining fluctuations in aggregate output during specific historical periods. Given that monetary policy is largely endogenous, nonmonetary disturbances must be in the main ultimately responsible for fluctuations in economic activity. But this observation does not bear on the questions of whether and to what extent the response of monetary policy matters for economic activity.

Notwithstanding the difficult problem of determining the effect of monetary policy econometrically, all of the relevant discussion in the *Handbook* accepts, either implicitly or explicitly, that money is not neutral and that the observed correlation between fluctuations in money and in economic activity reflects at least in part the effect of monetary policy on economic activity. These conclusions rest primarily on historical analysis. As Blanchard points out, "The event studies provided by the U.K. and U.S. disinflations of the early 1980's, in addition to those described by Friedman and Schwartz, strongly support the view that monetary policy affects output" (Page 791).

The *Handbook* essays by Blanchard and by McCallum also emphasize the theoretical problem of reconciling monetary non-neutrality with the neoclassical postulate that economic agents

maximize real objectives and its corollary that exchange exhausts perceived gains from trade. As McCallum puts it, "It is inherently difficult to devise a theory to explain the nature of the relationship between real and nominal variables while respecting the axiom, fundamental to neoclassical economic theory, that rational agents are concerned only with real variables" (Page 990). The essay by Blanchard surveys and brings out the problematic nature of the ongoing modern attempts to solve this problem, beginning with Keynes, proceeding through the Phillips Curve, the Natural-Rate Hypothesis, and the Rational-Expectations Hypothesis, and concluding with "new-Keynesian" models of imperfect competition.

New-Keynesian models are "Keynesian" in that in order to generate monetary non-neutrality they rely on the failure of nominal wages and/or nominal prices to adjust promptly to their new market-clearing values in response to changes in nominal monetary aggregates. New-Keynesian models are "new" in that they incoporate the Natural-Rate Hypothesis and the Rational-Expectations Hypothesis and in that they emphasize the role of imperfect competition in determining jointly the behavior of wages and prices and the effects of monetary policy on economic activity. Blanchard's excellent summary of new-Keynesian models stresses that, although stickiness of nominal wages and/or nominal prices in the face of changes in nominal monetary aggregates is the sine qua non of monetary non-neutrality, a quantitatively interesting model of monetary non-neutrality also requires additional structural factors, which Blanchard denotes as "real rigidities," that alone would not cause monetary policy to affect economic activity, but that amplify monetary effects on economic activity.

In combination, stickiness of nominal wages and/or nominal prices together with the Natural-Rate hypothesis and Rational-Expectations Hypothesis focus attention on the non-neutrality of rationally unanticipated monetary developments -- that is, innovations to monetary aggregates -- whether exogenous or endogenous. Blanchard, in common with much of the literature, is

not completely clear on the difference in this respect between new-Keynesian models and models that emphasize incomplete information about monetary aggregates and resulting confusion between monetary and nonmonetary disturbances. These incomplete-information models focus attention on the non-neutrality of unperceived monetary developments. [On this analytical distinction and its empirical implications, see my discussions of money and economic activity in Grossman (1983, 1986).]

In his recent critique, Robert Gordon (1990, p. 1137) notes that "an interesting aspect of recent U.S. new-Keynesian research is the near-total lack of interest in the general equilibrium properties of non-market-clearing models." In the *Handbook*, the essay by Jean-Pascal Benassy on non-Walrasean equilibria provides a masterful survey of the research program that has explored these general equilibrium properties, but Benassy returns the favor by displaying no interest in the new-Keynesian research program that Blanchard surveys. It is indeed striking that the essays by Benassy and by Blanchard, which are the main discussions in the *Handbook* of the effect of money on economic activity and which make more than 100 references each to the existing literature, have only three references in common -- John Maynard Keynes (1936), Paul Samuelson (1947), and Oliver Hart (1982).

Concluding Thought

The reader should be left with the impression that the field of monetary economics is both unsettled and exciting. Monetary economics raises distinctive and intrinsically difficult analytical problems, for which the standard intuition derived from either Marshallian partial-equilibrium analysis or Walrasian general-equilibrium analysis is frequently not helpful. For example, as Friedman and Hahn point out, because monetary economics is fundamentally concerned with exchange, a "tension" arises if monetary theory attempts to use the abstraction of "the representative agent", which is so useful in studying the economics

of production. In other words, although the story of Robinson Crusoe addresses many important economic questions, it is not relevant for the issues of monetary economics. But, of course, every difficult problem represents an opportunity for an impressive solution, and such opportunities abound in the field of monetary economics.

Footnote

Handbook of Monetary Economics. Edited by B. M. Friedman and F. H. Hahn. Handbooks in Economics Series. Amsterdam and New York: North-Holland, 1990. Volume 1, Pp. xxv, 722. $78.50. ISBN 0-444-88025-9. Volume 2, Pp. xxv, 586. $78.50. ISBN 0-444-88026-7.

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