RIVAL NOTIONS OF MONEY

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Introduction

The rise of Milton Friedman's version of monetarism in the 1960s and early 1970s provoked an antimonetarist backlash culminating in the late Nicholas Kaldor's *The Scourge of Monetarism* (1982). Friedman stressed the ideas of exogenous (i.e., central bank determined) money, money-to-price causality, inflation as a monetary phenomenon, and controllability of money through the high-powered monetary base. He traced a chain of causation running from open market operations to bank reserves to the nominal stock of money and thence to aggregate spending, nominal income, and prices.

By contrast, Kaldor postulated the opposite notions of endogenous (i.e., demand-determined) money, reverse causality, and inflation as a cost-push or supply-shock phenomenon. He denied the possibility of base control given the central bank's responsibility to guarantee bank liquidity and the financial sector's ability to engineer changes in the turnover velocity of money via the manufacture of money substitutes. Kaldor's transmission mechanism runs from wages (and other factor costs) to prices to money and thence to bank reserves. Wages determine prices, prices influence loan demands, and loan demands via their accommodation in the form of new checking deposits created by commercial banks determine the money stock, with central banks passively supplying the necessary reserves.

Kaldor claimed his attack on monetarism was in the tradition of Keynes's *General Theory*. So much so that he labeled it "a Keynesian perspective on money." In so doing, he contributed to the standard textbook tendency to treat the monetarist-antimonetarist debate as a post-Keynesian development. This article shows that the debate long predates Keynes, that it is rooted in classical monetary tradition, and that it traces back at least to the bullionist-antibullionist and currency school-banking school disputes in England in the nineteenth century. More precisely, the following paragraphs demonstrate that the arguments of Friedman and Kaldor were fully anticipated by their classical predecessors.

Bullionist Controversy (1797-1821)

Monetarism did not begin with Friedman nor did antimonetarism originate with Kaldor or Keynes's *General Theory*. Those doctrines clashed as early as the Bank Restriction period of the Napoleonic wars when the Bank of England suspended the convertibility of its notes into gold at a fixed price on demand. The suspension of specie payments and the resulting move to inconvertible paper was followed by a rise in the paper pound price of commodities, gold bullion, and foreign currencies. A debate between strict bullionists, moderate bullionists, and antibullionists then arose over the question: Was there inflation in England and if so what was its cause?

Strict Bullionists: the classical monetarists

Led by David Ricardo, the strict bullionists argued that inflation did exist, that overissue of banknotes by the Bank of England was the cause, and that the premium on gold (the difference between the market and official mint price of gold in terms of paper money) together with the pound's depreciation on the foreign exchange constituted the proof. Price index numbers not then being in general use, the bullionists used the gold premium and depreciated exchange rate to measure inflation.

The bullionists arrived at their conclusions via the following route: The Bank of England determines the quantity of inconvertible paper money. The quantity of money via its impact on aggregate spending determines domestic prices. Domestic prices, given foreign prices, determine the exchange rate so as to equalize worldwide the common-currency price of goods. Finally, the exchange rate between inconvertible paper and gold standard currencies determines the paper premium on specie so as to equalize everywhere the gold price of goods. In short, causality runs unidirectionally from money to prices to the exchange rate and the gold premium. It followed that the depreciation of the exchange rate below gold parity (i.e., below the ratio of the respective mint prices of gold in each country) together with the premium on specie constituted evidence that prices were higher and the quantity of money greater in

England than would have been the case had convertibility reigned. Here is a straightforward application of the monetarist ideas of exogenous money, money-to-price causality, inflation as a monetary phenomenon, and purchasing power parity. On these grounds the strict bullionists attributed depreciation of the internal and external value of the pound solely to the redundancy of money and reproached the Bank for having taken advantage of the suspension of convertibility to overissue the currency.

The strict bullionists also enunciated the monetarist notion of control of the money stock through the high-powered monetary base. With respect to base control, they argued that the Bank of England could, through its own note issue, regulate the note issue of the country (non-London) banks as well as other privately issued means of payment (bills of exchange and checking deposits). Two circumstances, they said, worked to ensure base controllability. First, country banks tended to hold in reserve Bank of England notes (or balances with London agents transferable into such notes) equal to a relatively fixed fraction of their own note liabilities. This established a constant relationship between the Bank note base and the country note component of the money stock. Second, a fixed-exchange-rate regional balance of payments or specie-flow mechanism kept country bank notes in line with the Bank's own issues. Country bank notes were fully convertible into Bank of England notes but did not circulate in London. Should country banks overissue, the resulting rise in local prices over London prices would lead to a demand to convert local currency into Bank of England notes to make cheaper purchases in London. The ensuing drain on reserves would force country banks to contract their note issue, thus eliminating the excess. For these reasons, the quantity of country notes was tied by a rigid link to the volume of Bank notes and could only expand and contract with the latter. The implication was clear: Bank of England notes drove the entire money stock. Country banks were exonerated as a source of inflation.

The strict bullionists displayed another monetarist trait in prescribing rules rather than discretion in the conduct of monetary policy. Their rule called for the Bank of England to contract its note issue upon the first sign of exchange depreciation or rise in the price of gold. This rule derived from the famous *Ricardian definition of excess* according to which if the exchange was depreciated and gold was commanding a premium the currency was by definition excessive and should be contracted.

Moderate Bullionists

Moderate bullionists, led by Henry Thornton, Thomas Malthus, and William Blake, modified the strict bullionists' analysis in one respect: they argued that it applied to the long run but not necessarily to the short. They held that in the short run real as well as monetary shocks could affect the exchange rate such that temporary depreciation did not necessarily signify monetary overissue. In the long run, however, real shocks were self-correcting and only monetary disturbances remained. Their position is best exemplified by Blake's distinction between the *real* and *nominal* exchanges. The real exchange or barter terms of trade, he said, registers the impact of nonmonetary disturbances—crop failures, unilateral transfers, trade embargoes and the like—to the balance of payments. By contrast, the nominal exchange reflects the relative purchasing powers of foreign and domestic currencies as determined by their relative supplies. Both components contribute to exchange rate movements in the short run. In the long run, however, the real exchange is self-correcting (i.e., returns to its natural equilibrium level) and only the nominal exchange can remain permanently depressed. Therefore, persistent exchange depreciation is a sure sign of monetary overissue. On this point the moderate bullionists agreed with their strict bullionist colleagues.

Antibullionists: the classical nonmonetarists

Opposed to the bullionists were the antibullionist defenders of the Bank of England. They denied that the Bank had overissued or that domestic monetary policy had anything to do with the depreciating exchange rate and rising price of gold. Such inflationary symptoms they attributed to real rather than monetary causes. In so doing, they contributed two key ideas that today appear in Kaldor's work.

First was their supply-shock or cost-push theory of inflation. They argued that crop failures and wartime disturbances to foreign trade had raised the price of wheat and other staple foodstuffs that constituted the main component of workers' budgets. These price increases then passed through into money wages and thus raised the price of all goods produced by labor. Ricardo, however, convincingly replied that this explanation confused relative with absolute prices. For without excessive money growth, a rise in the relative price of wheat that required workers to spend more on that commodity would leave them with less to spend on other goods whose prices would accordingly fall. In that case the rise in wheat's price would be offset by compensating falls in other relative prices leaving general prices unchanged.

Second, the antibullionists enunciated the notion of an endogenous, demand-determined money stock. This came in the form of their *real bills doctrine*, which they employed to assert the impossibility of an excess supply of money ever developing to spill over into the commodity market to put upward pressure on prices. The real bills doctrine states that money can never be excessive if issued upon the discount of sound, short-term commercial bills drawn to finance real goods in the process of production and distribution. It purports to match money creation with real output so that no inflation occurs.

The antibullionists used this idea to defend the Bank of England against the charge that it had caused inflation through overissue. The Bank, they said, was blameless since it had restricted its issues to real bills of exchange and so had merely responded to the real needs of trade. In other words, the Bank, by limiting its advances to commercial paper representing actual output, had merely responded to a loan demand for money already in existence and had done nothing inflationary to create that demand.

The real bills doctrine was an early version of Kaldor's notion that a passive, demand-determined money stock cannot be overissued and so cannot cause inflation. Antibullionists also anticipated Kaldor in arguing that since no one would borrow at interest money not needed, the Bank could not force an excess issue on the market. Such excess, they said, would be speedily extinguished as borrowers returned it to the Bank to pay off costly loans. In short, the antibullionists held that the Bank could not cause inflation since it merely supplied money passively in response to a loan demand for it. Thus there could be no excess issue to spill over into the commodity market in the form of an excess demand for goods to bid up prices.

Critique of the Real Bills Doctrine

Monetarists today criticize Kaldor's notion of a transmission mechanism running unidirectionally from wages to prices to money for ignoring the feedback effect of money on prices. Adding this feedback loop produces a two-way interaction in which prices and money can chase each other upward ad infinitum in a self-reinforcing inflationary spiral. Monetarists argue that such a spiral is sure to result if banks, in passively creating new money in response to loan demands for it, set the loan rate of interest below the expected rate of profit on the use of the borrowed funds. In this case loan demands will be insatiable and the resulting rise in money and prices will be without limit.

Bullionists, especially Henry Thornton, advanced exactly this same argument against the antibullionists' real bills doctrine. That doctrine, they said, suffers from two basic flaws. First, it links the nominal money stock with the nominal volume of bills, a variable that moves in step with prices and thus the money stock itself. In so doing it renders both variables indeterminate. It thus ensures that any inadvertant jump in money and prices will, by raising the nominal value of goods in the process of production and hence the nominal quantity of bills eligible for discount, lead to further increases in money and prices ad infinitum in a self-justifying inflationary spiral. Second, it overlooks that the demand for loans and volume of bills offered for discount depend not so much on real output to be financed as on the perceived profitability of borrowing as indicated by the differential between the loan rate of interest and the expected rate of profit on the use of the borrowed funds. In particular, it fails to see that when the profit rate exceeds the loan rate the demand for loans becomes insatiable and the real bills criterion fails to limit the quantity of money in existence.

This last flaw, bullionists argued, rendered the real bills doctrine an especially dangerous policy guide under inconvertibility. To be sure, even under specie convertibility a central bank that set its loan rate too low relative to the expected profit rate would find itself inundated with a potentially unlimited supply of eligible bills clamoring for discount. But the resulting rise in money and prices would, by making home goods dearer than foreign ones, lead to a trade deficit and a matching gold drain that would force the bank to protect its metallic reserves by raising its loan rate thereby ending the inflation. No such result was assured under paper currency regimes, however. For without the crucial check of convertibility, the profit rate-loan rate differential could persist indefinitely and with it the self-reinforcing rise in money, prices, and commercial bills. This point was particularly telling during the suspension period when usury ceilings constrained the Bank of England's lending rate to 5 percent at a time when the expected profit rate, buoyed by the boom conditions of the Napoleonic wars, was well in excess of that level.

Currency School-Banking School Debate (1821-1845)

Monetarist and antimonetarist doctrines clashed again in the three decades following the Bank of England's restoration of the gold convertibility of its notes in 1821. This time the debate focused on how to protect the currency from overissue so as to secure the gold reserve and ensure the maintenance of convertibility. The protagonists in this dispute were known collectively as the currency school and the banking school, but they were the intellectual heirs of the bullionists and antibullionists. Leaders of the currency school included such names as Samuel Jones Loyd (Lord Overstone), George Warde Norman, and Robert Torrens. Similarly, Thomas Tooke, John Fullarton, James Wilson, and J.B. Gilbart led the banking school.

The currency school's bullionist predecessors had assumed that a convertible currency needed no protection. If the currency were convertible, they reasoned, any excess issue of notes which raised British prices relative to foreign prices would be converted into gold to make cheaper purchases abroad. The resulting loss of specie reserves would force the Bank immediately to contract its note issue thus quickly arresting the drain and restoring the money stock and prices to their preexisting equilibrium levels. Given smooth and rapid adjustment (monetary self-correction) convertibility was its own safeguard.

A series of monetary crises in the 1820s and 1830s, however, convinced the currency school that adjustment was far from smooth and that convertibility per se was not a guaranteed safeguard to overissue. It was an inadequate safeguard because it allowed banks—commercial and central—too much discretion in the management of their note issue. Banks could and did continue to issue notes even as gold was flowing out, delaying contraction until the last possible minute, and then contracting with a violence that sent shock waves throughout the economy.

Currency School's Prescription

What was needed, the currency school thought, was a law removing the note issue from the discretion of bankers and placing it under strict regulation. To be effective, this law should require the banking system to contract its note issue one-for-one with outflows of gold so as to put a gradual and early stop to specie drains. Such a law would embody the currency school's *principle of metallic fluctuation* according to which a mixed currency of paper and coin should be made to behave exactly as if it were wholly metallic, automatically expanding and contracting to match inflows and outflows of gold. Departure from this rule, the currency school argued, would permit persistent overissue of paper, forcing an efflux of specie through the balance of payments, which in turn would endanger the gold reserve, threaten gold convertibility, compel the need for sharp contraction, and thereby precipitate financial panics. Such panics would be exacerbated if internal gold drains coincided with external ones as moneyholders, alarmed by the possibility of suspension, sought to convert paper currency into gold. No such consequences would ensue, however, if the currency conformed to the metallic principle. Forced to behave like gold (regarded by the currency school as the stablest of monetary standards) the currency would be spared those sharp procyclical fluctuations in quantity that constitute a prime source of economic disturbance.

The currency school scored a triumph when its ideas were enacted into law. The Bank Charter Act of 1844 embodied its prescription that, except for a small fixed fiduciary issue, Bank notes were to be backed by an identical amount of gold while the country bank note issue was frozen at its 1842 level. In modern terminology, the Act effectively established a marginal gold reserve requirement of 100 percent behind note issues. With notes tied to gold in this fashion, their volume would start to shrink as soon as specie drains signaled the earliest appearance of overissue. Monetary overexpansion would be corrected automatically before it could do much damage.

Banking School

The rival banking school flatly rejected the currency school's prescription of mandatory 100 percent gold cover for notes. Indeed, the banking school denied the need for statutory note control of any kind, arguing that a convertible note issue was automatically regulated by the needs of trade and required no further limitation. This conclusion stemmed directly from the real bills doctrine and *law of reflux*, which the banking school took from the antibullionists and applied to convertible currency regimes.

The school's real bills doctrine stated that money could never be excessive if issued on loans made to finance real transactions in goods and services. Similarly the law of reflux asserted that overissue was impossible because any excess notes would be returned instantaneously to the banks for conversion into coin or for repayment of loans. Both doctrines embodied the notions of a passive, demand-determined money supply and of reverse causality running from economic activity and prices to money rather than vice versa as in the currency school's view. According to the reverse causality hypothesis, changes in the level of prices and production induce corresponding shifts in the demand for bank loans which the banks accommodate via variations in the note issue. In this way prices help determine the note component of the money stock, the expansion of which is the result, not the cause, of price inflation. As for the price level itself, the banking school attributed its determination to factor incomes or costs (wages, interest, rents, etc.) thus establishing the essentials of a cost-push theory of inflation. The importance of the cost-push idea to the banking school cannot be overestimated: it even led Thomas Tooke to argue that high-interest-rate tight-money policies were inflationary since they raised the interest component of business costs.

Antimonetarist Ideas

The concepts of cost inflation, reverse causality and passive money are the hallmarks of an extreme antimonetarist view of the monetary transmission mechanism to which the banking school adhered. Its list of antimonetarist ideas also included the propositions (1) that international gold movements are absorbed by and released from idle hoards and have no effect on the volume of money in circulation, (2) that an efflux of specie stems from real shocks to the balance of payments and not from domestic price inflation, (3) that changes in the stock of money tend to be offset by compensating changes in the stock of money substitutes leaving the total circulation unchanged, and (4) that discretion is superior to rules in the conduct of monetary policy.

In its critique of the monetarist doctrines of the currency school, which contended that note overissue is the root cause of domestic inflation and specie drains, the banking school argued as follows: Overissue is impossible since the stock of notes is determined by the needs of trade and cannot exceed demand. Therefore, no excess supply of money exists to spill over into the goods market to bid up prices. In any case, causality runs from real activity and prices to money rather than vice versa. Finally, specie drains stem from real rather than monetary disturbances and occur independently of domestic price level movements.

These arguments severed all but one of the links in the currency school's monetary transmission mechanism running from money to prices to the trade balance, thence to specie flows and their impact on the high-powered monetary base and finally back again to money. The final link was broken when the banking school asserted that gold flows come from idle hoards (i.e., buffer stocks of specie reserves) and could not affect the volume of money in circulation. Falling solely on the hoards, gold drains would find their monetary effects neutralized (sterilized) by the implied fall in reserve-note and reserve-deposit ratios. To ensure that these hoards would be sufficient to accommodate gold drains, the banking school recommended that the Bank of England hold larger metallic reserves. With regard to the currency school's prescription that discretionary policy be replaced by a fixed rule, the banking school rejected it on the grounds that rigid rules would prevent the banking system from responding to the needs of trade and would hamper the central bank's power to deal with financial crises. Finally, the banking school asserted the impossibility of controlling the entire stock of money and money substitutes through the bank note component alone since limitation of notes would simply induce the public to use money substitutes (deposits and bills of exchange) instead. In other words, the total circulation is like a balloon; when squeezed at one end, it expands at the other. More generally, the banking school questioned the efficacy of base control in a financial system that could generate an endless supply of money substitutes.

The currency school, however, rejected this criticism on the grounds that the volume of deposits and bills was rigidly constrained by the volume of notes and therefore could be controlled through notes alone. In short, the total circulation was like an inverted pyramid resting on a bank note base, with variations in the base inducing equiproportional variations in the superstructure of money substitutes. In counting deposits as part of the superstructure, the currency school excluded them from its concept of money. It did so on the grounds that deposits, unlike notes and coin, were not generally acceptable in final payments during financial crises.

Subsequent Developments

In retrospect, the currency school erred in failing to define deposits as money to be regulated like notes. This failure enabled the Bank of England to exercise discretionary control over a large and growing part of the money stock, contrary to the intentions of the school. The school also erred in not recognizing the need for a lender of last resort to avert liquidity panics and domestic specie drains. With respect to specie drains, the currency school refused to distinguish between domestic (internal) and foreign (external) ones. As far as policy was concerned, both drains were to be handled the same way, namely by monetary contraction. By the time Walter Bagehot wrote his celebrated *Lombard Street* in 1873, however, it was widely recognized that the two drains required different treatment and that the surest way to arrest an internal drain was through a policy of liberal lending. Such drains were caused by panic-induced demands for high-powered money (gold and Bank notes) and could be terminated by the central bank's announced readiness to satiate those demands. The currency school nevertheless remained opposed to such a policy, fearing it would place too much discretionary power in the hands of the central bank. These shortcomings in no way invalidated the currency school's contention that convertibility is an inadequate safeguard to overissue and therefore must be reinforced by positive regulation. Nor did they undermine its monetary theory of inflation, which was superior to any explantion its critics had to offer.

As for the banking school, it rightly stressed the importance of checking deposits in the payments mechanism. But it was wrong in insisting that the real bills doctrine, which tied note issues to loans made for productive purposes, would prevent inflationary money growth. The currency school triumphantly exposed this flaw by pointing out that rising prices would require an ever-growing volume of loans just to finance the same level of real transactions. In this way inflation would justify the monetary expansion necessary to sustain it and the real bills criterion would fail to limit the quantity of money in existence. Also, by the 1890s Knut Wicksell had rigorously demonstrated the same point made by Henry Thornton in 1802, namely that an insatiable demand for loans results when the loan rate of interest is below the expected rate of profit on capital. In such cases the real bills criterion provides no bar to overissue.

Despite this criticism the real bills doctrine survived in banking tradition to be incorporated as a key concept in the Federal Reserve Act of 1913. And during the German hyperinflation of 1922-23 the doctrine formed the basis of the Reichsbank's policy of issuing astronomical sums of money to satisfy the needs of trade at ever-rising prices. Oblivious to the Thornton-Wicksell demonstration that the real bills test provides no check to overissue when lenders peg loan rates below the going profit rate, the Reichsbank insisted on pegging its discount rate at 12 percent (later raised to 90 percent) at a time when the going market rate of interest was well in excess of 7000 percent per annum. This huge differential of course made it extremely profitable for commercial banks to rediscount bills with the Reichsbank and to loan out the proceeds, thereby producing additional inflationary expansion of the money supply and further upward pressure on interest rates. The authorities failed to perceive this inflationary sequence and did nothing to stop it. On the contrary, they saw their duty as passively supplying on demand the growing sums of money required to mediate real transactions at skyrocketing prices. They simply refused to believe that issuing money on loan against genuine commercial bills could have an inflationary effect.

After the hyperinflation debacle of the 1920s, banking school doctrines reappeared in renovated form as part of the Keynesian revolution. Keynes in his *General Theory* (1936) stressed the banking school's notion of money entering idle hoards (liquidity traps) rather than active circulation. He also stressed the school's ideas (1) of variable velocity absorbing the impact of money-stock changes leaving spending and prices unaffected, (2) of real rather than monetary causes of cyclical depressions, and (3) of prices determined by autonomous factor costs. And in the immediate postwar period, Keynesians developed the notion of cost-push inflation emanating from growing union bargaining strength, business monopoly power, supply shortages, and other institutional forces that produce autonomous increases in labor and other factor costs. Only the banking school ideas of unlimited money substitutes and the futility of base control were missing. And these were provided in the famous report of the British Radcliffe Committee (1959). Representing the apogee of post-Keynesian skepticism of the relevancy of the quantity theory, the Radcliffe Report concluded that attempts to control inflation by limiting the stock of a narrowly defined monetary aggregate would merely induce spenders to turn to money substitutes instead. Velocity would rise to offset monetary restriction.

The Debate Goes On

Today currency school doctrines survive in Friedman's work just as banking school doctrines appear in Kaldor's writings. When Friedman argues that rules are preferable to discretion, that inflation is largely or solely the result of excessive monetary growth, that monetary shocks are a primary cause of cyclical swings, and that the entire stock of money and money substitutes can be governed by control of the high-powered monetary base, he echoes currency school opinion.

Likewise, Kaldor echoes the doctrines of the banking school. The school's cost-push theory informs his view of inflation. Inflation, he argues, stems mainly from increasing militancy of trade unions and the resulting rise in unit labor costs caused by money wages advancing faster than labor-hour productivity. The banking school's notion of passive money appears in his statement that money is a demand-determined variable that comes into existence as banks accommodate loan demands and central banks acting as lenders of last resort permissively supply the necessary reserves. The school's law of reflux surfaces in his declaration that because money is demand-determined its supply can never exceed demand; any oversupply is extinguished automatically as borrowers return it to the banks to pay off costly loans. Finally, the banking school notion of a potentially unlimited supply of money substitutes underlies his belief in the futility of base control. Like the banking school, he argues that restriction of the monetary base induces offsetting rises in the stock of money substitutes thereby thwarting base control.

In short, Kaldor emerges as the intellectual heir of the banking school and the antibullionists just as Friedman is the heir of the currency school and the bullionists. It follows that the debate between the monetarists and antimonetarists is not of post-Keynesian origin. Rather it has its roots in policy controversies going back to the era of classical monetary thought.

THE FORECAST PERFORMANCE OF ALTERNATIVE MODELS OF INFLATION

Yash P. Mehra[*]

I INTRODUCTION

What determines inflation? Several theoretical models of the inflation process have been advanced in the literature, and these models typically yield different predictions about the role of certain variables in determining prices. To illustrate, consider, for example, the expectations-augmented Phillips curve model. This model generally assumes prices are set as a markup over labor costs, the latter being determined by expected inflation and the degree of demand pressure. It is assumed further that expected inflation is a function of past price history, and demand pressure can be measured by the excess of real growth over potential (termed the output gap). Thus, in the reduced-form price equation associated with the Phillips curve model, past prices and the output gap (or another demand pressure variable) play a key role in determining the price level. This model thus implies that by monitoring the behavior of these two variables one could assess the outlook for inflation. Another example is provided by the price equation associated with the traditional monetarist model. In this equation, lagged money growth is the predominant force in price determination. Thus, depending upon the nature of the price structure chosen different determinants of inflation have been suggested in the literature.

The most controversial question raised by these competing inflation models is, however, the following: which one of the theoretical models (equivalently, the key variables implied by the associated reduced form price equations) can most accurately describe the actual behavior of prices in recent years? Interest in this question has revived as a result of some recent evidence that the relationship that had existed in the past between money and prices has been severed in recent years. For example, in an important contribution, Stockton and Glassman (1987) select four inflation models (three structural and one nonstructural), estimate the associated reduced form price equations, and evaluate their comparative forecast performance over a common period 1977-84. In two of the structural models (termed by them as the traditional monetarist model and the rational expectations model with instantaneous market clearing), actual or expected money (M1) plays a key role in determining the price level. The third structural model examined is the expectations-augmented Phillips curve, in which past prices and the output gap are the prominent variables. They report that over the period 1977-84 the Phillips curve model rarely performs worse and in the period 1981-84 performs substantially better than the other two structural models. They also show that in many cases a simple nonstructural time series model of inflation provides quite respectable forecasts relative to the theoretically based price equations. They conclude that, at least in the 1980s, there is no support for the monetarist view of the inflation process.

The main objective of this article is to present additional evidence on the forecast performance of alternative inflation models. It is now widely known that the recent financial deregulation and disinflation have altered the character of M1 demand. However, such developments have not affected as much the character of M2 demand.[1] Hence, the relative poor forecast performance of the inflation models in which money growth as gauged by the behavior of M1 plays a key role might be due to shifts in M1 demand. This paper, therefore, reexamines the evidence using the broader monetary aggregate M2. This article also considers Fama's (1982, 1983) alternative structural model of the inflation process, in which inflation is explained by money growth in excess of growth in real money demand. The Fama model implies that in assessing implications of higher money growth for future inflation it is necessary to control for changes in the demand for money.[2]

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[1] Simpson and Porter (1984), Mehra (1986), Judd and Trehan (1987), Rasche (1987), Hetzel and Mehra (1988), and Moore, Porter and Small (1988).

[2] Hetzel (1984) implements this approach in the context of the M1 demand function. Fama's model is monetarist in the sense that excessive monetary growth leads to higher prices in the long run.

This article compares over the period 1977 to 1987 the relative forecast performance of the four inflation models including the one due to Fama. The evidence reported here is very favorable to Fama's model. Consistent with Stockton and Glassman's results, the Phillips curve model outperforms the monetary models in predicting the rate of inflation when money is defined as M1, but that is not always the case when money is defined as M2. The evidence shows that over the period 1977 to 1987 the Fama model based on M2 demand outperforms the Phillips curve model in predicting the rate of inflation. In the subperiod 1981 to 1987, however, its performance is second to that of the Phillips curve model. Both the Fama money demand and the Phillips curve models outperform the simple time series model. This evidence thus implies that it is inappropriate to ignore the role of money in explaining the generation and perpetuation of inflation.[3] In particular, the results imply that a sustained increase in M2 growth in excess of growth in real money demand will be associated with a higher inflation rate.

Section II describes briefly the specification and estimation of the inflation models used. Section III reports the empirical results. Concluding remarks are in the final section.

II
SPECIFICATION AND ESTIMATION ISSUES

2.1 Specification of Inflation Models

This section describes briefly the price equations that underlie this study. I have chosen three structural models of the inflation process: the traditional monetarist model, the expectations-augmented Phillips curve, and the Fama money demand model.[4] The specification of price equations used for the first two inflation models is similar to those described in Glassman and Stockton (1983) and Stockton and Glassman (1987). The price equation that underlies the money demand model is similar to those given in Fama (1982) and Hetzel and Mehra (1988).

The Traditional Monetarist Model The traditional monetarist price equation considered here expresses inflation as a function of current and past values of the monetary variable (measured commonly by M1) and the fiscal policy variable (measured commonly by high employment government expenditures). As pointed out in Glassman and Stockton (1983), this equation can be shown to be the reduced form equation associated with a structural model that is similar in spirit to the St. Louis structural model discussed in Andersen and Carlson (1970).

To illustrate this, consider the following aggregate supply, aggregate demand, and expected inflation equations.

$$\dot{P}_t = \dot{P}^e_t + d_1 (\dot{y}_t - \dot{y}_{pt}) + d_2 SH_t \tag{1.1}$$

$$\dot{P}_t + \dot{y}_t = f_0 + \sum_{s=0}^{n1} f_{1s} \dot{M}_{t-s} + \sum_{s=0}^{n2} f_{2s} \dot{G}_{t-s} \tag{1.2}$$

$$\dot{P}^e_t = g_0 + \sum_{s=0}^{n1} g_{1s} \dot{M}_{t-s} \tag{1.3}$$

Equation (1.1) shows the aggregate supply curve which includes expected inflation ($\dot{P}^e$), excess demand as measured by the rate of change of real output ($\dot{y}$) over potential output ($\dot{y}_p$), and the supply shocks (SH). Equation (1.2) shows the aggregate demand curve which includes current and past values of money growth ($\dot{M}$) and government expenditures ($\dot{G}$). Equation (1.3) describes the formation of ex pected inflation, which is modeled as a function of current and past values of money growth. Solving equation (1.2) for the growth of real output and then substituting it and equation (1.3) into equation (1.1) enables one to express inflation in general form as

$$\dot{P}_t = a + \sum_{s=0}^{n1} b_s \dot{M}_{t-s} + \sum_{s=0}^{n2} c_s \dot{G}_{t-s} + d\, SH_t. \tag{1.4}$$

Thus, in equation (1.4) inflation is determined by current and past values of the growth rates in money and government expenditure variables. In the empirical work reported below, supply shocks (SH_t) are captured by relative food and energy prices, and the government expenditure variable by high employ-

[3] In Stockton and Glassman (1987) the forecast performance of alternative models is evaluated conditional on actual as well as projected values of the right-hand side exogenous variables in the price equations. In this paper the forecast performance is conditional only on actual values of the right-hand side exogenous variables. This means that the evidence reported in this paper does not necessarily imply that the inflation model based on M2 demand can be used as a forecasting tool.

[4] I have not considered the rational expectations model in this paper. It is quite difficult in practice to measure rational expectations accurately and thus test this model. See Stockton and Glassman (1987) and Stockton and Struckmeyer (1988) for an attempt in this direction.

ment government expenditures.[5] Hence, the inflation equation (hereafter called Monetarist) estimated here is of the following form

$$\dot{P}_t = a + \sum_{s=0}^{n1} b_s \dot{M}_{t-s} + \sum_{s=0}^{n2} c_s \dot{E}_{t-s} + \sum_{s=0}^{n3} d_s R\dot{E}P_{t-s} + \sum_{s=0}^{n4} e_s R\dot{F}P_{t-s} \quad (1.5)$$

where $\dot{E}$ is the growth rate of high employment government expenditures; $R\dot{E}P$, change in the relative price of energy; $R\dot{F}P$, change in the relative price of food; and other variables are defined as before. Each n_i is the number of lagged values of the relevant variable included in the equation.

The Phillips Curve Model The expectations-augmented Phillips curve model expresses inflation as a function of its own lagged values (capturing expectations), the output gap (a demand pressure variable), and changes in the relative prices of food and energy. As shown in Glassman and Stockton (1983), this inflation equation can be derived from separate wage and price equations. To see this, consider the following price and wage equations

$$\dot{P}_t = h_1 \, GAP_t + h_2 (\dot{W}_t - \dot{q}_n) + h_3 \, SH_{pt} \quad (2.1)$$

$$\dot{W}_t = k_0 + k_1 \, GAP_t + k_2 \dot{P}^e_t + k_3 \, SH_{wt} \quad (2.2)$$

$$\dot{P}^e_t = \sum_{j=1}^{n} \lambda_j \dot{P}_{t-j} \quad (2.3)$$

where $\dot{W}$ is wage growth; $\dot{q}_n$, trend growth rate of labor productivity; SH_{pt}, supply shocks affecting the price equation; SH_{wt}, supply shocks affecting the wage equation; GAP, the GNP gap variable defined as the difference between actual real output and potential real output; and $\dot{P}^e_t$, the expected rate of inflation. Equation (2.1) describes price markup behavior. Prices are marked up over productivity-adjusted labor costs $(\dot{W} - \dot{q}_n)$ and are influenced by cyclical demand (measured by the GAP variable) and the exogenous relative price shocks (SH_p). Wage inflation (2.2) is assumed to be a function of cyclical demand and expected price inflation ($\dot{P}^e$), the latter modeled as a lag on past inflation as in equation (2.3).

Combining (2.1), (2.2), and (2.3) yields the Phillips curve equation (2.4) below

$$\dot{P}_t = f_0 + \sum_{s=0}^{n} f_{1s} \dot{P}_{t-s} + f_2 \, GAP_t + f_3 \, SH_{pt} + f_4 \, SH_{wt} \quad (2.4)$$

where f_i's are the parameters and where other variables are as defined before.

The empirical work below estimates an alternative version of equation (2.4). Noting that the GAP variable can be expressed as

$$GAP_t = y_t - y_{pt} = Y_t - P_t - y_{pt} \quad (2.5)$$

where Y_t is the log of nominal GNP; y_t, the log of real GNP; and y_p, the log of potential GNP. Taking first difference of (2.5) results in expressing GAP as

$$GAP_t = y_t - y_{pt} = (y_{t-1} - y_{pt-1}) + (\dot{Y}_t - \dot{y}_{pt}) - \dot{P}_t. \quad (2.6)$$

If we substitute (2.6) into (2.4), the Phillips curve inflation equation can be expressed as

$$\dot{P}_t = f_0 + \sum_{s=0}^{n} f_{1s} \dot{P}_{t-s} + f_2 (y_{t-1} - y_{pt-1}) + f_2 (\dot{Y}_t - \dot{y}_{pt}) + f_3 \, SH_{pt} + f_4 \, SH_{wt}. \quad (2.7)$$

This specification of the Phillips curve equation allows explicitly the influence of nominal aggregate demand (via the term $\dot{Y}_t - \dot{y}_{pt}$) on inflation. SH_p and SH_w terms in (2.7) are captured in the empirical work by changes in relative food and energy prices. Hence, the Phillips curve equation estimated is of the form (2.8).

$$\dot{P}_t = g_0 + g_1 (y_{t-1} - y_{pt-1}) + g_2 (\dot{Y}_t - \dot{y}_{pt}) + \sum_{s=0}^{n1} g_{3s} \dot{P}_{t-s} + \sum_{s=0}^{n2} g_{4s} R\dot{E}P_{t-s} + \sum_{s=0}^{n3} g_{5s} R\dot{F}P_{t-s} \quad (2.8)$$

[5] An alternative specification used in Stockton and Glassman (1987) has inflation determined primarily by current and past values of money growth. This specification reflects the empirical assumption, consistent with the monetarist view, that fiscal policy actions have no long-run effect on nominal aggregate demand. However, I have kept the specification used here somewhat more general by letting government expenditures stay in the inflation equation. The main conclusions of this paper are unaffected if one excludes government expenditures when estimating the inflation equation.

Money Demand Model The price equation based on money demand views inflation as being caused by money growth in excess of growth in real money demand. In order to derive the inflation equation used here, consider the following relationship

$$\ln P_t = \ln M_t^s - \ln md_t \qquad (3.1)$$

where md_t is the public's demand for real money; M_t, actual level of money balances; P_t, the price level; and ln is the natural logarithm. Equation (3.1) says that the price level is determined by the actual level of money balances in excess of real money demand. It is assumed that actual level of money balances are exogenously given by the monetary authority. The price level then adjusts so as to equate the public's demand for real money balances to the nominal money balances. Thus in (3.1) an increase in nominal money stock given real money demand causes the price level to rise, and a rise in the public's real money demand given the fixed money stock causes the price level to fall.

The empirical work reported below assumes that the public's demand for real money balances depends positively on real income y (which measures the real value of transactions financed by money) and inversely on the opportunity cost variable defined as the difference between the market rate of interest (R) and the own rate on money (RM).[6] This is expressed as

$$\ln md_t = a + b \ln y_t - c\,(R-RM)_t. \qquad (3.2)$$

Substituting (3.2) into (3.1) yields (3.3)

$$\ln P_t = -a + \ln M_t - b \ln y_t + c\,(R-RM)_t. \qquad (3.3)$$

In equation (3.3) the price level depends upon levels of the actual money stock (M), real income (y), and the nominal interest rate (R – RM). An increase in real income raises the public's demand for real money balances. Given the exogenous money stock, the price level would have to fall to equate the rise in real money demand to the real money supply. Thus, an increase in real income depresses the price level. Similarly, a rise in the opportunity cost of holding money would reduce the public's demand for real money balances, and the price level would have to rise to equate the reduced demand for real money balances to the predetermined stock of money. Thus, a rise in the opportunity cost of holding money raises the price level.

Since, in the short run, there are lags in the adjustment of the price level to changes in its determinants identified in (3.3), the inflation equation consistent with this approach could be expressed as

$$\dot{P}_t = k_0 + \sum_{s=0}^{n1} k_{1s}\,\dot{M}_{t-s} - \sum_{s=0}^{n2} k_{2s}\,\dot{y}_{t-s} + \sum_{s=0}^{n3} k_{3s}\,(R-\dot{RM})_{t-s} \qquad (3.4)$$

where k_i's are the parameters and where other variables are as defined before.

It should, however, be pointed out that the aggregate labeled M in the price equation (3.1) is presumed to possess some well-defined properties. In particular, it should fulfill two conditions as discussed in Patinkin (1961) and Fama (1983). The first is that the aggregate has a well-defined real demand. The second is that the interest rate on this aggregate is fixed at below its free-market value. If these two conditions are fulfilled, then one could view the price level as being causally determined by the supply of this monetary asset in excess of its real demand.

Fama (1982) has argued that the relevant aggregate in the U.S. inflation process is the monetary base. Before 1981 the monetary base and perhaps M1 fulfilled the above noted two conditions. That has not been the case during the period since then. As noted before, there is considerable evidence consistent with the view that the character of M1 and base demands has changed during the 1980s, and M1 since 1981 includes assets that pay explicit market interest rates. In case of M2,only one of the above conditions appears to hold. M2 demand has been relatively stable during the 1980s. But some components of M2 do pay market-determined interest rates.

Time Series Model As an alternative to the theoretically based models of the inflation process, the study included a simple autoregressive model of inflation

$$\dot{P}_t = a + \sum_{s=1}^{n} a_{1s}\,\dot{P}_{t-s}. \qquad (4)$$

If the theories are of any value they should at least outperform this simple time series model.

[6] Hetzel and Mehra (1987) and Moore, Porter and Small (1988). See Reichenstein and Elliott (1987) for a different specification of the money demand function.

2.2 Estimation, Data, and Forecast Evaluation Strategy

The inflation equations (1.5), (2.8), (3.4), and (4) were estimated using quarterly data that span the period 1959-87. The price index used as the dependent variable in these equations is the fixed-weight GNP deflator. In equation (1) the monetary variable used is either M1 or M2 and the fiscal policy variable used is high employment government expenditures. Relative food and energy prices were calculated as the prices of food and energy in the fixed-weight personal consumption expenditure deflator relative to the fixed weight consumption expenditure deflator excluding food and energy. In the Phillips curve equation (2.8) potential output was an extended Council of Economic Advisers series. Since 1984 potential output is assumed to grow at a 2.5 percent annual rate.[7] In the money demand equation (3.4) the scale variable used is real GNP and the opportunity cost variable is the 4-6 month commercial paper rate minus the own rate of return on the monetary aggregate used. Thus, in case of M2 the own rate is the weighted average of the explicit deposit rates paid on the various components of M2, with weights given by relative component shares. In case of M1, the own rate is the weighted average of the rates paid on NOW and Super NOW accounts.

The price equations associated with inflation models were estimated either by ordinary least squares (equations (2.8) and (4)) or by generalized least squares to correct for the presence of first order serial correlation (equations (1.5) and (3.4)).[8] Another issue in the estimation of these equations was the choice of lag lengths on various monetary and fiscal policy variables. Since economic theory provides no guidance on this issue, one approach commonly used has been to select either 8- or 16-quarter lags on the key variables and estimate lag shapes using polynomial lag structures. This study follows a similar procedure with two differences. The first is that the lag shape is not restricted a priori. All lags are estimated freely. The second is that F-tests were performed to choose between 8- and 16-quarter lags. This procedure indicated 8-quarter lags for most of the key variables used, except those on M2 in Fama's model and past prices in the Phillips curve model. On these two variables 16-quarter lags were used.[9]

The focus of this study is on the relative forecast performance of the above four inflation models over a relatively longer-term forecast horizon. With this goal in mind, the 8-quarter ahead inflation forecasts from these models were generated and evaluated over a ten-year period in the following manner. Each model's coefficients were estimated using quarterly data from 1963Q2 to 1976Q4. Out-of-sample dynamic forecasts conditional on actual values of the exogenous variables were constructed for the 8-quarter period from 1977Q1 to 1978Q4. These quarterly forecasts were then assembled to calculate the expected 8-quarter inflation rate

$$\hat{\dot{\Pi}}_t = \prod_{s=1}^{8} (1 + \hat{\dot{P}}_{t+s}) - 1$$

where $\hat{\dot{\Pi}}_t$ is the 8-quarter inflation rate expected at time t and where $\hat{\dot{P}}_{t+s}$'s are the model's quarterly forecasts for eight quarters. The error was calculated as the subsequent actual 8-quarter inflation rate minus the rate predicted. In order to generate another observation on the prediction error, each model's coefficients were reestimated using data from 1963Q2 to 1977Q1, and out-of-sample forecast constructed from 1977Q2 to 1979Q1. That procedure was repeated until the model was reestimated and forecasts prepared based on data ending in each quarter through 1985Q4. Thus, the last estimation period was 1963Q2 to 1985Q4, and the last out-of-sample forecast interval, 1986Q1 to 1987Q4. This procedure generated for each model 37 observations on the error in predicting the subsequent 8-quarter inflation rate spanning the period 1977-87. These forecast errors were then compared across models for their relative performance.[10]

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[7] Estimates of growth in potential output range from 2 to 3 percent. I have used the midpoint of this suggested range in this paper.

[8] It should, however, be pointed out that some of the right-hand side explanatory variables included in these price equations could be correlated with the error term and hence not strictly exogenous in a statistical sense. Therefore, estimation by ordinary (or generalized) least squares could have produced biased coefficient estimates. In order to examine the effect of this potential bias, the price equations were reestimated using only lagged values of the key right-hand side explanatory variables and the forecasting exercise was repeated. This had no effect on major conclusions of the paper (see footnote 10 for the resulting ranking of inflation models).

[9] The sample period over which the lag lengths were searched is 1963Q2-1987Q4. This amounts to assuming that lag lengths had been invariant over the period. Alternatively, the choice between 8- and 16-quarter lags within each model group could be made on the basis of the out-of-sample forecast performance. This procedure was also employed and yielded lag lengths similar to those based on F-tests.

[10] Reichenstein and Elliott (1987) adopt a similar approach.

III
EMPIRICAL RESULTS

Table I reports the estimated coefficients in the four inflation models for the whole sample period, 1963Q2 to 1987Q4. As can be seen, these estimated coefficients have the theoretically predicted signs and in most cases are significant at the conventional 5 percent level. The parameter estimates for the Phillips curve and M2 demand equations are statistically significant and pass the Chow test of structural stability over the sample period (see Fs in the last column of Table I). However, the parameters that appear on the monetary aggregate used in the Monetarist and M1 demand equations are generally not significant. Furthermore, the parameter estimates of the Monetarist equations are not stable over time (see Fs in the last column of Table I).

Table II reports the results of the forecast experiment described in the previous section. Column 1 ranks the inflation equations (which are summarized in Table I) by the root mean squared error (RMSE) calculated using errors over 37 overlapping forecast intervals spanning 1977Q1 to 1987Q4. The mean error (ME) and the mean absolute error (MAE) are also presented. Charts 1 through 3 display for some models period-by-period expected and subsequent actual 8-quarter inflation rates.

If one ranks inflation models by the RMSE criterion, then the M2 demand model outperforms the Phillips curve in predicting inflation over the 1977 to 1987 period. The Phillips curve model, in turn, performs much better than M1 demand, the time series, and Monetarist models by a substantial margin (see Table I).[11]

[11] As explained in footnote 7, the forecasting exercise was repeated using price equations that were estimated omitting contemporaneous values of the right-hand side key explanatory variables. Thus, in the reestimated Monetarist and money demand equations, only past values of money, government expenditures, real income, and opportunity cost appear. In the Phillips curve equation, the past value of output gap appears. Other remaining variables appear in the form shown in equations reported in Table I. For the estimating periods ending in 1976Q4 to 1985Q4, the six inflation models ranked by the RMSE criterion are: Money Demand (M2), 1.94; Phillips Curve, 2.86; Monetarist (M2) 3.69; Monetarist (M1), 3.89; Time Series, 3.93; and Money Demand (M1), 3.99. Money demand (M2) and Phillips curve models continue to be the best two performing models, doing much better than the time series model. The worst performing model is the M1 demand model.

Table I

Estimates of Inflation Equations, 1963Q2-1987Q4

Monetarist

Monetary Aggregate	Constant	ΔM	ΔE	ΔREP	ΔRFP	SER	DW	F
M2	.0008 (.2)	.07 (.35;8)	.20 (1.7;8)	.04 (2.8;0)	.11 (2.9;0)	.00289	2.40	1.66**
M1	-.008 (.2)	.26 (1.4;8)	.28 (2.6;8)	.04 (2.9;0)	.10 (3.0;0)	.00276	2.42	2.6 *

Phillips Curve

Constant	Δp	$(y_{t-1} - y_{pt-1})$	$(\Delta Y_t - \Delta y_{pt})$	ΔREP	ΔRFP	SER	DW	
.0002 (.3)	.97 (14.7;16)	.0005 (3.9;0)	.082 (3.1;0)	.03 (2.9;0)	.09 (3.3;0)	.00229	1.92	1.11

Money Demand

Monetary Aggregate	Constant	ΔM	Δy	Δ(R – RM)	SER	DW	
M2	-.001 (2.1)	1.2 (6.27;16)	-.70 (4.8;8)	.02 (5.2;8)	.00329	2.06	.91
M1	.011 (2.4)	.17 (2.72;8)	-.33 (1.2;8)	.01 (2.7;8)	.00338	2.54	1.11

Time Series

Constant	Δp	SER	DW	
.0016 (2.2)	.87 (15.0;8)	.00319	1.99	.63

Notes: All variables are in first differences of logs except the interest rate variables which are in first differences of the levels. M is M1 or M2; E, high employment government expenditures; REP, the relative price of energy; RFP, the relative price of food; y, the log of real GNP; Y_p, the log of the potential GNP; Y, the log of nominal GNP; R, 4-6 *month commercial paper rate*; RM, the own rate on money, and p, the log of the price level. Coefficients reported are sums of lagged coefficients, with t values and lag lengths reported in parentheses. A zero lag length implies that only the contemporaneous value is included. SER is the standard error of the regression, and DW is the Durbin-Watson statistic. F tests the hypothesis that the estimated coefficients are constant over time.

* Significant at .05 level
** Significant at .10 level

Table II

Summary Statistics for Errors in Predicting the Eight-Quarter Inflation Rate from Alternative Inflation Models

Estimation Periods End 1976Q4 to 1985Q4[a]

Rank	Model	RMSE	ME	MAE
1	Money Demand (M2)	1.62	.0003	1.3
2	Phillips Curve	2.65	1.54	2.1
3	Monetarist (M2)	3.66	.013	2.9
4	Money Demand (M1)	3.79	−.020	2.8
5	Time Series	3.93	−.002	3.2
6	Monetarist (M1)	3.97	−.008	2.9

Subperiod Results

Estimation Periods End[b] 1974Q4 to 1980Q3

Rank	Model	RMSE	ME	MAE
1	Money Demand (M2)	1.35	1.0	1.11
2	Money Demand (M1)	1.36	.78	1.02
3	Monetarist (M1)	3.56	3.33	3.33
4	Phillips Curve	3.75	3.53	3.53
5	Time Series	4.10	3.25	3.57
6	Monetarist (M2)	5.1	4.87	4.87

Estimation Periods End[c] 1980Q4 to 1985Q4

Rank	Model	RMSE	ME	MAE
1	Phillips Curve	1.28	.03	1.10
2	Money Demand (M2)	1.79	−.71	1.45
3	Monetarist (M2)	2.05	−1.41	1.50
4	Time Series	3.8	−2.76	2.89
5	Monetarist (M1)	4.3	−3.91	3.91
6	Money Demand (M1)	4.9	−4.17	4.29

Notes: The inflation equations that underlie these models are reported in Table I. See the text for the procedure used to generate forecast errors. RMSE is the root mean squared error; ME, the mean error; and MAE, the mean absolute error.

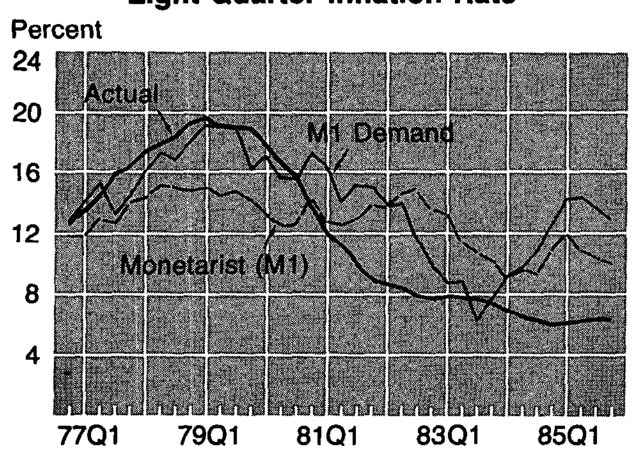
a. The forecast period is 1977Q1 to 1987Q4
b. The forecast period is 1977Q1 to 1982Q3
c. The forecast period is 1981Q1 to 1987Q4

The inflation model that performs poorly, in some cases even worse than the time series model, is the Monetarist model in which money growth is measured by M1. This can be seen in Chart 1 which graphs predictions from the Monetarist model; the inflation rate is consistently overpredicted during the 1980s. With the acceleration of M1 growth first in 1982-83 and then in 1985-86, this inflation model predicts an acceleration of inflation that did not occur. This breakdown reflects the random shifts that have occurred in M1 demand during this period due to factors such as financial deregulation and disinflation. This point is further illustrated by predictions of the M1 demand model, also graphed in Chart 1, which does control for the systematic shifts in money demand due to changes in real income and the nominal interest rate. Early in the period it performs better than the Monetarist model; its performance, however, also deteriorates over time as M1 demand has changed during the 1980s.

Another point suggested by the results in Table I is that the M2 demand model performs much

Chart 1

Expected and the Subsequent Actual Eight-Quarter Inflation Rate



Note: X axis measures the end of the sample period over which the model is estimated. Y axis measures the inflation rate over the out-of-sample eight-quarter prediction interval.

better than the Monetarist model based on M2 measure of money. This result suggests that it is not M2 growth per se but M2 growth in excess of growth in real M2 demand that determines inflation. This point is illustrated further in Chart 2 which graphs predictions from these two inflation models.

The Phillips curve model is the second best performing model. The predictions from this model are displayed in Chart 3. In contrast with the Monetarist equations, the Phillips curve model predicts reasonably well the sharp deceleration in the rate of inflation which occurred in the early 1980s. The recession in 1982 generated a great deal of slack in labor and product markets and widened the gap between actual and potential GNP. The Phillips curve model views the widening gap as a source of decelerating prices. But, as can be seen, it does not predict the sharp acceleration in inflation that occurred in the 1977-79 period.

The predictions from the time series model are also graphed in Chart 3. As is clear, this model lags in predicting turning points in the rate of inflation.

Turning to the subperiods, no clearcut ranking of models emerges (see Table II). During the estimating periods ending in 1976Q4 to 1980Q3, a period of rapidly accelerating prices, money demand models based on M1 or M2 substantially outperform the Phillips curve model. The root mean squared error value from the M2 demand model is 1.35,[12] which is substantially lower than the value 3.77 from the Phillips curve model. However, during the estimating periods ending in 1980Q4 to 1985Q4, a period of decelerating prices, the Phillips curve model turns in a somewhat better performance than the M2 demand model, as measured by their relative root mean squared error values (1.28 vs 1.79). This point is also clear if we compare Charts 2 and 3 over these two subperiods.

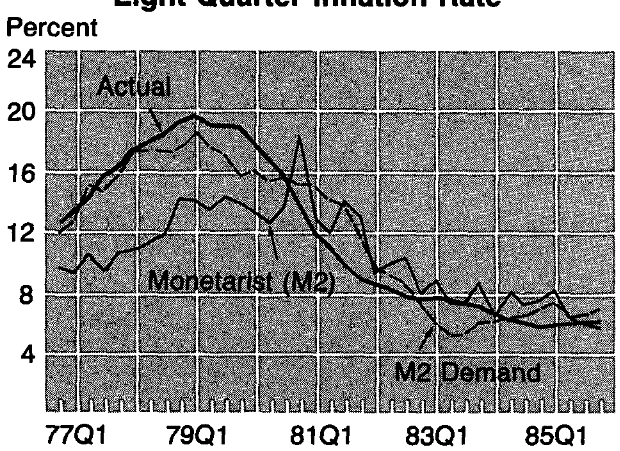
As noted before, Fama (1982) has argued that the relevant monetary variable in the U.S. inflation process is the monetary base (MB). In order to evaluate the role of the monetary base, the forecast performance of the inflation equation (3.4) using MB was also evaluated.[13] For the estimation periods ending in 1976Q4 to 1985Q4 the root mean squared error

[12] It should be noted that over the early subperiod there is no difference in the RMSE values of the M1 and M2 demand models, suggesting that the non-M1 components of M2 did not matter. However, that is not the case for the latter subperiod.

[13] Fama's MB demand model was estimated using the measure of base collected by the Federal Reserve Bank of St. Louis. Four lagged values of the monetary base, real income, and the nominal interest rate were used in the inflation equation. The monetary base equation did not pass the Chow test for structural stability. Estimation was by generalized least squares to correct for the presence of first order serial correlation. The base equation was also estimated using only past values of the right-hand side explanatory variables. It did not have any major effect on the relative rankings of the inflation models.

Chart 2

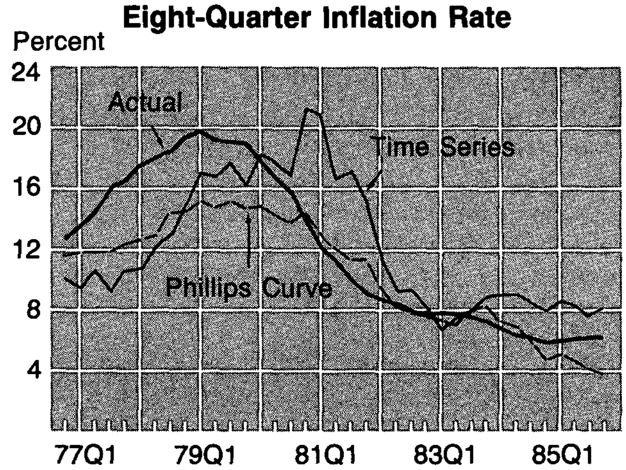
Expected and the Subsequent Actual Eight-Quarter Inflation Rate



Note: X axis measures the end of the sample period over which the model is estimated. Y axis measures the inflation rate over the out-of-sample eight-quarter prediction interval.

Chart 3

Expected and the Subsequent Actual Eight-Quarter Inflation Rate



Note: X axis measures the end of the sample period over which the model is estimated. Y axis measures the inflation rate over the out-of-sample eight-quarter prediction interval.

in predicting the 8-quarter inflation rate is 3.07, which makes it the third best performing model after M2 demand and the Phillips curve models (compare with the RMSE values reported in Table II). For the estimating subperiods ending in 1976Q4 to 1980Q3 and 1980Q4 to 1985Q4, the RMSE values for the MB demand model are 2.59 and 3.39, respectively. Thus, even over the subperiods the inflation model based on M2 demand outperforms its counterpart using MB.

IV
CONCLUDING OBSERVATIONS

The empirical results presented here lead to two observations. First, the relatively poor forecast performance of inflation models in which M1 growth appears suggests that the character of M1 demand has changed. In contrast, the M2 demand model, in which inflation is related to M2 growth in excess of growth in real money demand, performs reasonably well, suggesting that M2 demand has been relatively stable over time. This result implies that a sustained increase in M2 growth in excess of growth in its real demand has been associated with higher inflation. Second, two structural models of the inflation process, the Phillips curve and the M2 demand model, outperform a simple time series model by a substantial margin.

A 1987 study by Reichenstein and Elliott reaches a similar conclusion about M2. These authors compare forecasts of the long-term inflation rate from several nonstructural inflation models (drawn from time series and interest rate relationships) to forecasts generated by Fama's M2 demand model. They find that over the period 1975 to 1982 Fama's structural model is best in predicting the long-term inflation rate.[14]

The relative superior forecast performance of M2 in Fama-type inflation equations raises an interesting question about the nature of the monetary aggregate that is causal in determining the price level. Fama (1982, 1983) has suggested that in theory the price level can be determined by the supply of a nominal asset that has a well-defined real demand and pays a fixed below-market rate of interest. He has argued that the relevant monetary asset is the monetary base. The empirical evidence reported in this paper, however, favors M2 as the relevant aggregate, even though it violates one of the conditions laid down by Fama. While this might suggest some caution, the results overall do imply that it might be inappropriate to ignore the role of money in explaining the generation and evolution of inflation over time.

[14] The results presented in Stockton and Struckmeyer (1988) also suggest that the monetarist models contain information about aggregate inflation that is not incorporated in an expectations-augmented version of the Phillips curve.

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THE MONETARY RESPONSIBILITIES OF A CENTRAL BANK

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I. INTRODUCTION

In today's world of paper money, money consists of currency created by the printing press and bank deposits created by the bookkeeping operations of bankers. What limits the ability of the printing presses and the pens of bankers to create money? The currency component of money is central bank money (dollar bills). The bank deposits component of money is backed by central bank money (bookkeeping entries at the central bank). It is the central bank's monopoly of its own money that allows it to limit creation of the public's money. In turn, limitation of central bank money and the public's money limits the price level. The essence of central banking lies in the responsibility to limit the money stock in order to tie down the price level.

In practice, central banks typically do not decide explicitly how much of their money to create. Instead, they create and extinguish their money in response to the current behavior of financial markets. The particular nature of this process of central bank money creation determines how the money stock and the price level are actually limited. The nature of this process depends in turn upon the macroeconomic goals of the central bank. How then does the way the central bank selects macroeconomic goals and weights their relative importance determine the behavior of the price level?

In order to answer these questions, it is necessary to have a model that captures the connection between the goals of the central bank and nominal (dollar) variables: the monetary base (central bank money), the money stock and the price level. The purpose of this article is to lay out such a model. The model is general in that it applies to any central bank that operates in a regime of paper money, although occasional specific references are made to the Federal Reserve System.

Section II presents an intuitive discussion of the model. The actual model is presented in the Appendix.[1] Section III elucidates the working of the model by showing how the central bank smooths interest rate fluctuations. Section IV uses the model to discuss money stock and price level determination. This section states the two major responsibilities of the modern central bank. First, the central bank gives the price level an equilibrium value. Specifically, the central bank gives the price level a well-defined or particular value such that market forces operate to eliminate departures of the actual price level from this value. Second, the central bank determines how the equilibrium value of the price level changes over time. The article concludes with suggestions for clarifying the responsibility of the central bank for the behavior of the price level.

II. THE MODEL

The Structure of the Economy and the Interest Rate

The model gives substance to the natural rate hypothesis. This hypothesis summarizes the inherent limitations on the central bank's ability to influence real variables. These limitations derive from the fact that paper money creation, or monetary base creation, does not alter the real resources available to the economy. The public cares only about real variables, while the central bank only determines the behavior of a nominal variable, the monetary base.

In the literature that follows the work of Lucas (1972), the natural rate hypothesis is given content by allowing only changes in money and the price level not expected by the public to affect real variables. Furthermore, the public is assumed to form its expectations "rationally," that is, in a way that is consistent with assumptions made about the structure

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[1] This model has been worked on especially by economists associated with the Federal Reserve Bank of Richmond. [See Dotsey and King (1983), McCallum (1981 and 1986), and Goodfriend (1987)].

of the economy and the behavior of the central bank. The natural rate hypothesis then implies that the central bank cannot systematically affect the level of real variables. For example, the central bank cannot systematically lower the level of the real (inflation-adjusted) rate of interest [Sargent (1973)]. Through the policy process it chooses for determining the monetary base, however, it can influence the way random macroeconomic disturbances affect fluctuations in real variables.

Equation (1) summarizes the determinants of the market rate (r_t).[2]

$$(1)\quad r_t = \left(\frac{E_tP_{t+1}}{P_t} - 1\right) + F_{rr}[c, (P_t - E_{t-1}P_t)] \cdot Q_t$$

This equation is derived from two more fundamental relationships. One, the IS function, summarizes the conditions under which the goods market clears. For different values of real output, it shows the values of the expected real rate of interest that cause investment and saving to be equal. The other function makes the supply of real output depend upon the contemporaneous price level error ($P_t - E_{t-1}P_t$). The IS function and the aggregate supply function are equated, and output is eliminated from the resulting expression. (The goods market must clear at a level compatible with the aggregate supply of output.) The resulting partially reduced form, when solved for the market rate, is equation (1).

The first right-hand term of (1) equals the rate of inflation the public expects. In the second right-hand term, the function F_{rr} is the expected real rate of interest. The real rate depends upon a constant (c) and the contemporaneous price level error ($P_t - E_{t-1}P_t$). This functional form derives from the particular form of the natural rate hypothesis, which makes fluctuations in output respond to discrepancies between the contemporaneous price level and the public's prior expectation of the contemporaneous price level. When the price level is higher than the public had expected in the prior period, that is, when P_t exceeds $E_{t-1}P_t$, real output and saving rise, and the real rate of interest falls, and conversely. (These real effects of inaccurate forecasts of the price level can be thought of as deriving from the existence of one-period contracts fixed in dollar terms.) Finally, the expected real rate is affected by real sector disturbances (Q_t).

[2] E indicates an expectation formed by the public and the subscript t indicates the time period when the public formed that expectation. The subscript t is the contemporaneous time period, while t − 1 and t + 1 are the prior period and the following period, respectively.

The Demand and Supply of Money

Equation (2) is a money demand function.

$$(2)\quad M_t^d = P_t \cdot F_{md}[r_t, (P_t - E_{t-1}P_t)] \cdot V_t$$

Nominal money demand (M_t^d) equals the product of the price level (P_t), real money demand (given by the function F_{md}), and a random disturbance term (V_t). Real money demand varies inversely with the market rate of interest (r_t) and positively with real output. The function F_{md}, instead of showing real output as a variable, shows the variable ($P_t - E_{t-1}P_t$) because real output varies positively with this variable, the contemporaneous price level error.

The money supply function has the form of a money-multiplier formula.

$$(3)\quad M_t^s = B_t \cdot F_{mm}[r_t] \cdot X_t$$

The money supply (M_t^s) equals the product of the monetary base (B_t) and the multiplier, which is given by the function F_{mm}. This function depends upon the market rate (r_t). There is a positive relationship between the market rate and the multiplier because of the effect of the market rate on the reserves-deposit ratio desired by banks and the currency-deposit ratio desired by the nonbank public. The multiplier is also affected by a random term (X_t).

The Monetary Policy Process

The monetary policy process is summarized by the procedure the central bank puts into place for creating and extinguishing the monetary base (B_t). This procedure is shown in equation (4).

$$(4)\quad B_t = B_{t-1}(1 + \theta_{trend}) + \theta_{smooth}(r_t - E_{t-1}r_t) - \theta_{drift}(B_{t-1} - E_{t-2}B_{t-1})$$

The three θ parameters of (4) determine the time-series behavior of the monetary base.[3] They summarize the information the public needs about monetary policy to form an expectation of the future price level.

[3] Equation (4) summarizes the policy process through the time-series behavior of the monetary base, as determined by the θ parameters. Equation (4) could, alternatively, be solved in a way that makes the market rate (r_t) the left-hand variable. With this formulation, the policy process would be summarized by the time-series behavior of the market rate. The model is unaffected by the choice of whether to summarize the policy process in terms of the behavior of the base or the market rate. Although monetary policy can be summarized by the behavior of the interest rate, the effect of monetary policy on the economy is transmitted solely through the process that generates the monetary base [Goodfriend and King (1988)].

The first parameter, θ_{trend}, specifies the trend rate of growth of the monetary base. With the simplifying assumption that real output does not grow over time, this rate of growth is also the trend rate of inflation. The second parameter, θ_{smooth}, is the rate smoothing parameter. θ_{smooth} specifies the change in the monetary base the central bank makes in response to deviations in the market rate from a reference rate $E_{t-1}r_t$. It follows from the natural rate hypothesis that the central bank must set this reference rate equal to the model's expected real rate plus the trend rate of inflation ($c + \theta_{trend}$).

Each period, random disturbances impact the economy and move the market rate away from the reference rate. When the market rate exceeds the reference rate, the central bank increases the monetary base by an amount that depends upon the value of θ_{smooth}, and conversely. The result is that each period there is a change in the monetary base that could not have been predicted in the previous period. The base drift parameter, θ_{drift}, specifies how much of the prior period's unpredictable change in the monetary base the central bank offsets in the subsequent period. There are two general cases. In the case of either no offset or only a partial offset (θ_{drift} not equal to one), the level of the monetary base will be affected permanently each period by some random amount. Because there is then no path to which the base tends to return, the monetary base follows a random walk (superimposed on the persistent movement given by the value of the growth rate parameter θ_{trend}). In the case of a complete offset, the base fluctuates over time around a well-defined path. These two cases are also said to produce, respectively, nonstationary and stationary behavior of the monetary base.

Central Bank Objectives

Assume now that the central bank possesses two macroeconomic objectives: an economic stabilization objective and a monetary stabilization objective. These objectives can be expressed by the loss function (5).

$$(5)\quad C = \beta \operatorname{var}[P_t - E_{t-1}P_t] + \gamma \operatorname{var}\left[\frac{E_tP_{t+1}}{P_t} - 1\right]$$

The first right-hand term in (5) measures the variability of contemporaneous price level errors. The central bank considers the fluctuations in output caused by these errors to be undesirable. It therefore attempts to limit the variability of these errors. The second right-hand term measures the variability in the rate of inflation the public expects. The central bank also attempts to minimize this variability. The coefficients on the two right-hand terms reflect the relative importance of the economic stabilization and inflation stability objectives. The central bank chooses the values of the θ parameters in (4) in order to minimize the value of C in (5).[4]

The Complete Model

The equations of the model are listed below.

$$(1)\quad r_t = \left(\frac{E_tP_{t+1}}{P_t} - 1\right) + F_{rr}[c, (P_t - E_{t-1}P_t)] \cdot Q_t$$

$$(2)\quad M_t^d = P_t \cdot F_{md}[r_t, (P_t - E_{t-1}P_t)] \cdot V_t$$

$$(3)\quad M_t^s = B_t \cdot F_{mm}[r_t] \cdot X_t$$

$$(4)\quad B_t = B_{t-1}(1 + \theta_{trend}) + \theta_{smooth}(r_t - E_{t-1}r_t) - \theta_{drift}(B_{t-1} - E_{t-2}B_{t-1})$$

$$(5)\quad C = \beta \operatorname{var}[P_t - E_{t-1}P_t] + \gamma \operatorname{var}\left[\frac{E_tP_{t+1}}{P_t} - 1\right]$$

With the constraints imposed by rational expectations and the assumption that money demand equals money supply, equations (1)-(4) can be solved for r_t, P_t, M_t, B_t, $E_{t-1}P_t$ and E_tP_{t+1}. The resulting values for $[P_t - E_{t-1}P_t]$ and $[E_tP_{t+1}/P_t - 1]$ are substituted into the central bank's loss function (5). The loss function is now expressed in terms of the structural parameters of the model, the disturbances, and the θ parameters. Finally, the central bank sets the θ values in order to minimize this expression for the loss function.

[4] The model is intended for policy analysis. Policy analysis involves the conceptual exercise of assuming different objective functions for the central bank as a way of discussing how the central bank affects the behavior of the economy. In contrast to this kind of analysis, the model could be used to forecast, say, inflation. In this case, it would be necessary to use the actual objective function of the central bank and to be explicit about the way this function changes over time. This kind of exercise is more difficult because of the need to understand how in the real world the policy process affects the way the public forms its expectations. In a world in which monetary policy evolves in unexpected ways, it will be inherently difficult to model realistically the way in which the expectations formation of the public is shaped by the policy process. In order to form expectations, the public must evaluate how the central bank's objective function will change and how such changes will alter the time series behavior of the monetary base.

Policy Analysis

The nature of the model imposes a discipline on policy analysis. The model is dynamic, that is, it is concerned with how the monetary aggregates and the price level change over time. Furthermore, the public's expectations of the future values of these variables are shaped by the *process* the central bank uses to generate changes in the monetary base. (That is, the public's expectations depend upon the θ parameters the central bank chooses to govern monetary base creation.) It follows that one can use the model to ask what happens when the central bank takes a particular *policy action* only if the *policy process* that generated the particular action is also specified. That is, one must know the θ values of (4). For example, the model cannot be used to predict the effect on the money stock and the price level of a change in the monetary base of a given amount, if that change is all that is specified. The reason is that the effect of a particular policy action depends upon the public's expectation of subsequent policy actions, and this expectation depends upon the nature of the policy process.[5]

III. RATE SMOOTHING

Insight into the way the model works can be gained by using it to understand how the central bank smooths interest rates. The central bank can smooth fluctuations in the market rate in two ways. Assume that the policy process that governs the behavior of the monetary base makes θ_{smooth} positive. Assume also that θ_{drift} is greater than zero. (There is at least some subsequent offset of random variations in the monetary base.) Consider an unanticipated, positive real sector disturbance (Q_t), for example, a technological innovation that increases investment. This disturbance increases the market rate and the central bank responds by increasing the monetary base. The money stock and the price level rise. The price level will now exceed the value the public had predicted last period, so real output rises. Because of the rational expectations assumption, both the error in predicting the price level and the associated rise in output will be transitory. Because the rise in output is transitory, the public saves a relatively high proportion of it. This increased saving offsets to some extent the initial rise in the real rate of interest and in the market rate.

The market rate is also smoothed as a consequence of the interaction between the rate smoothing and base drift parameters. As noted above, with a positive θ_{smooth} parameter, the positive real sector disturbance increases the money stock and raises the price level. Because the central bank is assumed not to allow complete base drift, the public will expect that the central bank will offset next period at least some of the current period's increase in money. The public will then expect that, after adjusting for trend growth, the money stock and the price level will be higher in the present period than in the next period. The expected future one-period inflation rate will fall below trend. A fall in the premium in the market rate for expected inflation will mitigate the rise in the market rate caused by the real disturbance.

IV. MONEY STOCK AND PRICE LEVEL DETERMINATION

Graphical Analysis and Determinacy of the Price Level

The determination of the money stock and the price level is shown graphically in Figure 1. The inverse of the price level (the goods price of money) is shown on the vertical axis. The nominal amounts of money demanded and supplied are shown on the horizontal axis. The nominal money demand and supply schedules are derived by substituting (1) into (2) and (3), respectively. The money demand (supply) schedule then expresses the relationship between the price level and nominal money demand (supply) given a partially-reduced form that assumes fixed values for price level expectations ($E_{t-1}P_t$ and E_tP_{t+1}) and the monetary base, but allows the interest rate and output to vary.

Before discussing these schedules, it is useful to note that, given the public's prior expectation of the contemporaneous price level ($E_{t-1}P_t$), a rise in the contemporaneous price level (P_t) produces a positive price level forecast error, that is, $[P_t - E_{t-1}P_t]$ becomes positive. As a result, there is a transitory increase in output. Also, under the assumption that both $E_{t-1}P_t$ and E_tP_{t+1} are fixed, a rise in the price level lowers the market rate of interest in two ways.

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[5] In the model, for example, the effect of a change in the monetary base can only be predicted with an understanding of how the market rate is affected. The public, however, in order to set the market rate, must form an expectation of the future price level. (It needs this expectation to estimate the inflation premium to put into the market rate.) In order to form an expectation of the future price level, it must know the value of the base drift parameter. The reason is that the base drift parameter determines the extent to which the change in the monetary base will be incorporated permanently into the future level of prices.

First, the transitory increase in output just described increases saving, which lowers the real rate of interest. Second, an increase in the price level reduces the expected one-period rate of inflation, that is, $(E_tP_{t+1} - P_t)$ declines. The market rate then declines from a reduction in the inflation premium.

With this discussion in mind, now consider the ways in which money demand is increased by a rise in the price level (a fall in the inverse of the price level). First, a rise in the price level produces a direct proportional increase in the demand for money. Second, money demand is increased by the increase in output produced by a positive price level prediction error. Third, the fall in the market rate of interest produced by the price rise increases money demand.

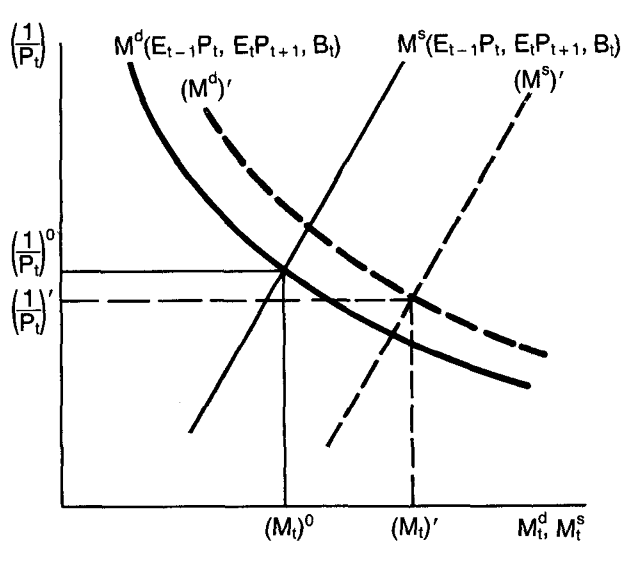
Consider next the effect of a price rise on nominal money supply. A rise in the price level causes the market rate to decline for the reasons mentioned above. This decline in the market rate decreases the money supply by lowering the value of the money multiplier function, F_{mm}, for a given value of the monetary base.

The money stock and the price level are endogenously determined through the intersection of the money demand and supply schedules. These variables possess well-defined equilibrium values because of the existence of these schedules. If the price level falls below its equilibrium level, the nominal amount of money supplied exceeds the nominal amount of money demanded, and the price level returns to its equilibrium value, and conversely. The nominal money demand and supply schedules exist because the central bank's policy process (4) permits the public to form an expectation of the future price level (E_tP_{t+1}).

This policy process specifies the θ parameters upon which E_tP_{t+1} depends.[6] These parameters derive from the objectives of the central bank as summarized in (5). One can, therefore, ask the question, "How are nominal variables made well defined?" by asking "What characteristics must the central bank's objective (loss) function possess in order to permit the public to form an expectation of the future price level?" With the loss function (5), the central bank cares about the contemporaneous price level (through the first right-hand term) and the change in the price level (through the second right-hand term). This loss function, therefore, constrains the behavior of nominal variables sufficiently for the public to be able to form an expectation of the future price level. In short, it is the central bank that gives nominal variables (the price level and money stock) equilibrium values.

Figure 1

NOMINAL MONEY DEMAND AND SUPPLY SCHEDULES



Note: The variables in parentheses $(E_{t-1}P_t, E_tP_{t+1}, B_t)$ are held constant while P_t and M_t change. The dashed lines show the effect of a positive real sector disturbance.

The Effect of Macroeconomic Disturbances on the Money Stock

Consider first the way in which an unexpected, positive real sector disturbance (Q_t) influences the money stock and the price level with rate smoothing (θ_{smooth} greater than zero) and base drift (θ_{drift} less than one). As the market rate begins to rise, the central bank supplies reserves and the money supply schedule shifts rightward. In Figure 1, M^s shifts to $(M^s)'$. Two opposing forces shift the position of the nominal money demand schedule. On the one hand, an increase in the market rate shifts it leftward. On the other, the unexpected increase in the monetary base and the money stock requires a higher price level than the public had expected, so real output rises. The increase in output shifts the money demand schedule rightward. In Figure 1, the net result is assumed to yield a rightward shift from M^d to $(M^d)'$.

[6] The solution for E_tP_{t+1} yielded by (1)–(4) includes values of the θ parameters in all its terms. These terms are a) a constant; b) the value of the monetary base in the prior period multiplied by the two-period growth rate $(1 + \theta_{trend})^2$; c) a negative term, θ_{drift}, multiplied by the prior period's unexpected change in the monetary base; d) a term, $\theta_{smooth}(1 - \theta_{drift})$, multiplied by a linear combination of the monetary and real disturbances.

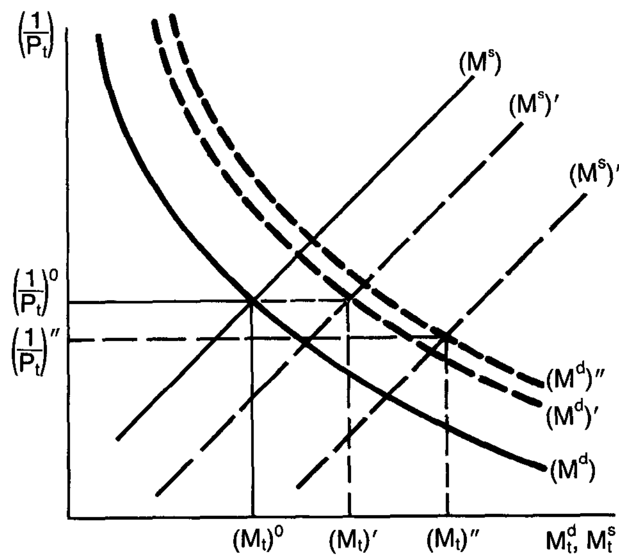
The rightward shift in the money supply schedule dominates the rightward shift in the money demand schedule, and the price level rises.[7,8]

Consider next the effect of a positive money demand disturbance (V_t) with significant rate smoothing (θ_{smooth} large) and significant base drift (θ_{drift} near zero). Because the model is dynamic and accounts for the way the policy process affects the expectations of the public, it yields strikingly different results than the standard static models of money stock determination. The following example illustrates that, when there is base drift, rate smoothing does not insulate the price level and the real sector from money demand shocks. The positive disturbance to money demand causes an incipient increase in the market rate. For a large value of θ_{smooth}, the central bank increases the monetary base by enough to make the money supply schedule shift rightward in line with the money demand schedule. In Figure 2, (M^d) and (M^s) shift rightward by the same amount to $(M^d)'$ and $(M^s)'$, with no effect on the price level. In the absence of base drift, there are no further effects. The price level and real variables are unaffected.

If the central bank allows base drift, however, the money demand disturbance will increase permanently the level of the monetary base and the money stock. Because the model assumes that the increase in money demand due to the monetary disturbance is transitory, the public will expect a higher price level next period. The expected one-period inflation rate will rise, and the market rate will start to rise further due to an increase in the inflation premium. In response, the central bank will then increase the monetary base again, and the money supply schedule will shift rightward again. In Figure 2, $(M^s)'$ shifts rightward to $(M^s)''$. As in the case of the real sector disturbance, the price level rises and real output is stimulated. It then follows that $(M^d)'$ shifts to $(M^d)''$.[9] Rate smoothing does not insulate the real sector from monetary disturbances.[10]

Figure 2

NOMINAL MONEY DEMAND AND SUPPLY SCHEDULES



Note: The dashed lines show the effect of a positive disturbance to money demand. The dashed lines marked by a double prime show that part of the effect due to base drift.

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[7] These shifts in the money demand and supply schedules are the primary shifts due to a θ_{smooth} greater than zero. There are secondary shifts (not shown in Figure 1) due to the interaction between θ_{smooth} and θ_{drift}. The real sector disturbance produces a higher money stock in the contemporaneous period. The increase in the price level required by the higher money stock, however, is mitigated by the rise in the demand for real money produced by the higher level of output. The rise in real output is transitory. The existence of base drift in the monetary aggregates implies that, in contrast, at least some of the increase in the money stock is permanent. Consequently, the public will expect (adjusting for trend growth) a price level in the future that is higher than the contemporaneous price level. The inflation premium in the market rate will rise. The consequent rise in the market rate will cause the central bank to increase further the monetary base. The shifts in the money demand and supply schedules shown in Figure 1 are then amplified. The initial change in the money stock is proportional to θ_{smooth}. The additional change is proportional to the product $\theta_{smooth}(1 - \theta_{drift})$. With no base drift ($\theta_{drift}$ equal to one), there are no secondary effects.

[8] As noted above, the rise in the price level, relative to both the prior period's expectation of the price level and the contemporaneous expectation of next period's price level, affects the public's savings behavior and inflationary expectations in a way that mitigates the rise in the market rate.

[9] The increase in output increases saving. Increased saving lowers the real rate and offsets the increase in the market rate caused by the increase in the inflation premium . The rise in the market rate caused by the money demand disturbance is, therefore, mitigated. These secondary effects from the money demand disturbance are analogous to those described in footnote 7.

[10] The model is constructed with nominal money demand and supply schedules that derive from different behavioral relations. The money demand schedule comes from (2), the real money demand function. The money supply schedule comes from (3), the money-multiplier function. The determinants of real money demand and nominal money supply are different. The model, therefore, makes the quantity-theory assumption that macroeconomic disturbances will produce divergent shifts in the nominal money demand and supply schedules. In the jargon of econometrics, the model assumes that the money demand and supply schedules are identified. Independent shifts in these schedules occur that permit the econometrician to use actual observations on the money stock and the price level to identify separate demand and supply schedules.

The Central Bank and the Behavior of the Price Level

Although with rate smoothing the monetary base is determined endogenously, the procedure the central bank puts into place for altering the monetary base determines how the monetary base, the money stock, and the price level are affected by macroeconomic disturbances. Furthermore, while particular random realizations of the monetary base are produced by macroeconomic disturbances, the timeseries behavior of the monetary base is largely determined by the central bank. The θ parameters, which are set by the central bank, determine the general behavior over time of the monetary base and also the time series behavior of the money stock and the price level.

The rate smoothing parameter (θ_{smooth}) determines the variability of the monetary aggregates and price level. A higher value of θ_{smooth} requires increased variability in the monetary aggregates and, after some point, increased variability in the price level. The trend growth rate parameter (θ_{trend}) determines the trend growth rate of the monetary aggregates and the price level. With a positive value of θ_{trend}, the money supply schedule (M^s) shifts rightward over time down the money demand schedule (M^d) at the rate given by θ_{trend}. The price level rises at the rate given by θ_{trend}. Sustained inflation is always and everywhere a monetary phenomenon [Friedman (1968)].

The base drift parameter θ_{drift} determines how a change in the money stock shifts the initial position of the money supply schedule in the subsequent period. With a value of θ_{drift} different from one, transitory macroeconomic disturbances shift permanently the position of the money supply schedule. In this way, transitory disturbances are incorporated permanently into the price level. An implication of the model is that a random walk in prices is always and everywhere a monetary phenomenon. The model is special in that it does not allow for a permanent component to real sector and money demand disturbances. If these disturbances possessed a significant permanent component, base drift in the price level could still occur even in the absence of base drift in the monetary aggregates. There would, however, still be truth to the statement that a random walk in prices is a monetary phenomenon. The central bank can have any time series behavior of the price level it desires. For example, nonstationary behavior in the price level could never arise if the central bank had price stability as one of its objectives. Such an objective would introduce into the central bank's objective function a term like $k(P_t - \overline{P})$, where k is a constant and $\overline{P}$ is the central bank's stable price level objective.

V. POLICY CHOICES FACED BY THE CENTRAL BANK

The model makes possible a comparison of alternative policies by elucidating the trade-offs made in selecting one policy rather than another. First, the model identifies those policies that do not require the policymaker to make trade-offs among objectives. When it is necessary to make trade-offs, the model clarifies their nature. The policymaker can ask, "In order to gain the benefits from adoption of a particular policy, what benefits must be foregone by rejection of alternative policies?"

When Must the Policymaker Trade Off?

The standard discussion of trade-offs in policymaking is by Tinbergen (1967). Tinbergen points out that the policymaker with multiple objectives need not make compromises when seeking to attain these objectives if he possesses as many policy instruments as he has objectives. Attainment of the objectives of policy is then constrained only by the structure of the economy. If the number of objectives exceeds the number of policy instruments, the policymaker must make a choice about the relative importance of each objective. An increase in the significance attached to one objective necessarily decreases the significance that can be attached to the other objectives. This section reformulates Tinbergen's discussion in terms of the dynamic model used here.

In order to discuss policy choices, it is necessary to posit an objective function. An objective function makes explicit the central bank's objectives and the relative importance it assigns to achievement of its different objectives. In (5), the objective function is expressed as a loss function that the central bank attempts to minimize through the choice of the θ parameters in (4). The parameters β and γ express the relative importance the central bank assigns to achievement of the two objectives of economic stabilization and inflation stabilization.

The central bank has available two degrees of freedom (θ_{smooth} and θ_{drift}) to use in pursuit of its objectives. It can vary these parameters in order to influence the way macroeconomic disturbances affect the relationship between the contemporaneous price level and the prior period's expectation of this variable. Also, it can vary these parameters in order to influence the way macroeconomic disturbances affect the relationship between the contemporaneous price level and the contemporaneous expectations of next period's price level. These variations in the price level and the contemporaneous expectation of next period's price level. These variations in the policy process can only be effected through changes in θ_{smooth} and θ_{drift}. Under the assumption that the public's expectations are formed rationally, the central bank's choice of the trend growth-rate parameter (θ_{trend}) cannot affect the first relationship and affects the second relationship only by the addition of a constant. The choice of a value for θ_{trend} greater than zero does not help the central bank attain any of its macroeconomic objectives.[11]

With the loss function (5), the central bank possesses two objectives and possesses two degrees of freedom for manipulating the behavior of the monetary base. The central bank is not forced to trade off between achievement of its objectives. It can minimize the variability of inaccurate forecasts of the price level without reducing its ability to minimize the variability of expected inflation, and vice versa. Its pursuit of each objective is constrained only by the inherent uncertainty caused by random macroeconomic disturbances. Formally, this result shows up in the central bank's choices of θ_{smooth} and θ_{drift} that minimize (5). The optimal values of the θs do not depend upon the relative magnitudes of β and γ. Even if the central bank were to weight heavily one objective, it would not have to sacrifice achievement of its other objective.

The Optimal Choice of θ_{smooth}

The optimal value of the rate smoothing parameter increases as the variability of money demand disturbances (the variability of the V_t) rises relative to the variability of the real sector disturbances (the variability of the Q_t). Increases in the value of the rate-smoothing parameter up to its optimal value reduce variability in the price level and reduce undesirable fluctuations in output. Further increases raise the variability of the price level and increase fluctuations in output. This result can be understood by considering the allocative role played by the interest rate in the price system.

The real rate of interest is a price (the price of current output in terms of future output) whose variations distribute aggregate demand across time. The interest rate varies in order to cause the goods market to clear at a level of output compatible with aggregate supply. A change in the interest rate due to a disturbance in money demand, however, offers a misleading signal for intertemporal resource allocation. The greater the importance of disturbances from the monetary sector relative to disturbances from the real sector, the more frequently changes in interest rates will be misleading guides to resource allocation and the higher the optimal value of the rate-smoothing parameter. If monetary disturbances are large relative to real disturbances, it is desirable for the central bank to supply the monetary base in a way that smooths fluctuations in the market rate.

The Optimal Choice of θ_{drift}

One striking result derived from minimizing (5) is that it is optimal for the central bank to eliminate completely base drift. This result can be understood intuitively. The optimal value of the rate smoothing parameter puts an amount of interest rate sensitivity into the monetary base that reflects the likelihood that an interest rate fluctuation is due to a money demand disturbance. Because such disturbances are assumed to be transitory, there is no reason to allow fluctuations in the monetary aggregates due to fluctuations in the market rate to affect permanently the money stock.[12] Base drift would increase the variability of expected inflation, the second right-hand term in (5), without reducing the variability of inaccurate forecasts of the price level, the first right-hand term in (5).

Trade-offs in the Choice of Policies

The loss function (5) cannot explain the actual time series behavior of the monetary aggregates and the price level. An obvious problem with (5), given the result noted in the preceding paragraph, is that it cannot explain the significant amount of base drift

[11] A loss function like (5) that contains only macroeconomic objectives cannot rationalize a positive rate of inflation. Barro and Gordon (1983) attempt to explain the existence of positive inflation in a model like the one here in that the central bank understands the structure of the economy. Their explanation turns on the discretionary character of policy (the inability of the central bank to precommit itself to a particular objective function) and a desire by the central bank to lower persistently the value of a real variable like unemployment. Hetzel (1988) explains inflation as a way of generating revenue through an inflation tax.

[12] If there is a permanent component to either money demand disturbances or real output disturbances and if the central bank desires to render the price level stationary, it needs to allow some amount of base drift in the monetary base and the money stock [Walsh (1986)]. Whether shocks to the money demand function exercise a transitory or a permanent effect upon the demand for money is an empirical issue. (In fact, it appears to depend upon the monetary aggregate considered. M1 velocity appears to be a random walk, but M2 velocity is stationary. There may be a permanent element to disturbances in real output, although the time series behavior of output is disputed by economists.) In any event, the nonstationarity in the price level that appeared after countries abandoned the gold standard for a paper money standard can only be explained by the nonstationarity introduced into the monetary base at this time.

in these variables [Broaddus and Goodfriend (1984)]. A loss function [from Goodfriend (1987)] that can explain base drift is shown in (6).

$$(6)\quad C = \alpha\, var[r_t - E_{t-1}r_t] + \beta\, var[P_t - E_{t-1}P_t] + \gamma\, var[\frac{E_tP_{t+1}}{P_t} - 1]$$

With (6), the central bank attempts to minimize the variability of three variables: the market rate of interest, inaccurate price level forcasts, and expected inflation. Minimization of this loss function can generate the kind of base drift that has characterized nominal variables in the post-World War II era.

Now, while the central bank possesses three objectives, it still has only two degrees of freedom for varying its policy process; consequently, it must trade off among achievement of its objectives. Minimization of (6) implies that in general the central bank will allow base drift. It will also set a higher value for the rate smoothing parameter than is optimal for minimizing fluctuations in real output. The central bank trades off achievement of reduced variability in price level forecast errors and expected inflation in order to obtain a reduction in variability in the market rate. With (6), in contrast to (5), the optimal values of the θ parameters depend upon the ratios of the trade-off parameters: α, β and γ.

VI. CLARIFYING THE MONETARY RESPONSIBILITIES OF THE CENTRAL BANK

The Role of Money in the Formulation of Monetary Policy

There is an ongoing debate over the importance to assign to the behavior of money in the formulation of monetary policy. With the financial deregulation of the early 1980s and the resulting uncertainty over the behavior of the public's M1 demand function, this debate has centered on the contention that the role of money should be reduced when money demand is highly variable.[13] For example, Stephen Axilrod (Staff Director of the Office for Monetary and Financial Policy at the Board of Governors until July 1986) uses the increased uncertainty over the behavior of money demand to explain the deemphasis of money in the policy process after 1982:

> . . . money became less useful as a policy instrument because of a combination of market developments and attitudinal shifts that made it more unstable in relation to the economy and its own history. So money was deemphasized after 1982 for pragmatic economic reasons. [Axilrod (1988), p. 59]

[See also Axilrod (1985), p. 17.]

The most important aspect of monetary policy is the central bank's objective function. The objective function determines the policy process (4) through the values set for the θ parameters. This policy process can be formulated with the monetary base as the left-hand variable or the interest rate as the left-hand variable. In the former formulation (the one employed here), it is natural to discuss monetary policy in terms of the behavior of the monetary aggregates. In the latter formulation, it is natural to discuss monetary policy in terms of the behavior of the interest rate. In actual practice, central banks have not usually formulated policy discussions in terms of the behavior of the monetary aggregates. Instead, they have discussed monetary policy in terms of the behavior of the discount rate and its effect on money market rates.[14]

There is, however, a reason to discuss monetary policy in terms of the behavior of the monetary aggregates. The time series behavior of the aggregates translates into the time series behavior of the price level more directly than is the case with the interest rate. A given increase in the trend rate of growth of the monetary aggregates (θ_{trend}) implies the same increase for the trend rate of inflation. An increase in rate smoothing (θ_{smooth}) beyond an optimal value implies an increase in the variability of the price level. Base drift in the monetary aggregates (θ_{drift} different from one) implies base drift in the price level (apart

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[13] The nationwide introduction of NOW accounts in 1981 and their incorporation into M1 altered the character of the public's demand for M1. Because NOWs pay explicit interest, they have caused M1 to become more highly substitutible with deposits used for saving, rather than for transactions. Because that part of M2 that is not included in M1 contains primarily savings-related deposits, M1 including NOWs has become more highly substitutible with the non-M1 component of M2. The result has been to alter the character of the public's M1 demand function. [The character of the M2 demand function has remained unchanged (Hetzel and Mehra, 1988).] As a result, a debate has occurred over the usefulness of M1 in the policy process. Also, M1 has often been accepted as *the* definition of money. Consequently, the debate has often taken the form of whether money can play a role in the formulation of monetary policy when money demand is highly variable. [Angell (1987) and Johnson (1988), for example, have sought replacements, at least temporarily, for money in policy discussions. Their work concentrates on the role of money as an indicator variable.]

[14] In the United States, the Federal Reserve System has modified the traditional discount rate procedure by choosing a combination of the discount rate and borrowed reserves. The market rate is then determined as the sum of the discount rate and some positive amount that is proportional to the level of borrowed reserves.

from whatever drift is allowed to compensate for any permanent component in disturbances to money demand and output). This connection between the time series behavior of the monetary aggregates and the price level holds regardless of the degree of variability in money demand.

The importance of clarifying the implications of monetary policy for the behavior of the price level is increased due to the indirect way the behavior of the price level is produced in actual practice. Typically, the central bank possesses multiple macroeconomic objectives.[15] It has, however, only the two degrees of freedom for pursuing these objectives given by the two parameters (θ_{smooth} and θ_{drift}) that alter the time series behavior of the monetary base. The behavior of the price level (and the monetary aggregates) emerges as a by-product of the trade-offs the central bank must make in order to pursue multiple objectives with a more limited number of degrees of freedom to manipulate in setting the policy process. Furthermore, the central bank's objective function is not made explicit in policy discussions. The trade-offs that must be made in pursuit of multiple objectives are not discussed explicitly. The link between these trade-offs and the price level is obscured when the central bank's objective function is not made explicit in policy discussions and when policy is discussed in terms of interest rates (or a money market proxy). In contrast, the implications for the price level of these trade-offs are clearer when policy is discussed in terms of the monetary aggregates.

Explicit Targets for the Money Stock

Determination of the monetary base in part on the basis of current conditions in the money market obscures the responsibility of the central bank for the behavior of the monetary base, the money stock, and the price level. The consequent endogeneity of the monetary base facilitates special factors explanations of inflation, that is, explanations that confine the causes of inflation to the macroeconomic disturbances that impinge upon the economy.[16] Endogenous determination of the monetary base also obscures the way the central bank gives the money stock and the price level well-defined equilibrium values. In the absence of explicit limitation of the monetary base, the money stock and the price level are made well-defined economic variables by the way the central bank determines the public's expectation of the future price level. This indirectness obscures central bank responsibility.

In order to clarify the way it determines the behavior of prices, the central bank could formulate the policy process in terms of the monetary aggregates. The central bank could select a single definition of the money stock as a substantive intermediate target and explain to the public the relationship that it believes will hold over time between the money stock and an explicitly formulated path for the price level.[17] The central bank could also use the monetary base as the policy variable it sets in order to achieve its intermediate money target. [See Black (1986).]

Conclusion

Clarification of the monetary responsibilities of the central bank requires an explicit statement of the objectives of the central bank and the relative importance attached to these objectives. It also requires an explicit statement of how the central bank believes its monetary policy will achieve its objectives. It is necessary to make explicit the consequences of monetary policy for the behavior of the price level. Hopefully, the model presented in this article will aid in discussion of the monetary responsibilities of the central bank.

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[15] The *Federal Reserve Act* stipulates that the Federal Open Market Committee should set its ranges for the monetary aggregates "taking account of past and prospective developments in employment, unemployment, production, investment, real income, productivity, international trade and payments, and prices" [Board of Governors(1984)].

[16] See Cullison (1988) for a discussion of the possible influence on monetary policy of special factors explanations of inflation in the 1970s.

[17] In order to make the money stock a substantive intermediate target, it would be necessary to make the decision whether to allow base drift in its targeted value an explicit part of the decision-making process.

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APPENDIX

Equation (1) is an IS function. It shows the combinations of real output and the real rate of interest that equate the public's desired saving and investment.

$$(1)\quad y_t = d_0 + d_1[r_t - (E_t p_{t+1} - p_t)] + w_t \qquad d_1 < 0 < d_0$$

Real output is y_t; the interest rate r_t; and the price level p_t. (All the variables are logarithms, except for r_t.) The subscript t indicates the time period. E is the expectations operator with the subscript indicating the time period at which the expectation was formed. The variable w_t is a serially-uncorrelated, zero-mean random shock. Equation (2) is an aggregate supply function.

$$(2)\quad y_t^s = d_2 + d_3[p_t - E_{t-1}p_t] \qquad 0 < d_2, d_3$$

The public's supply of goods varies positively with its error in predicting the contemporaneous price level. It is assumed that this monetary nonneutrality arises from one-period contracts specified in nominal terms.

Next, equate the IS function (1) and the aggregate supply function (2) in order to eliminate output y_t; solve the resulting expression for r_t; and simplify the notation for the coefficients and error term (q_t is a transformation of w_t and remains a serially-uncorrelated, zero-mean random error).

$$(3)\quad r_t = (E_t p_{t+1} - p_t) + c_1 + c_2[p_t - E_{t-1}p_t] + q_t \qquad c_2 < 0 < c_1$$

The market for the quantity of money is described by a money demand function and a money supply function. The money demand function is

$$(4)\quad m_t^d = p_t + a_0 + a_2 r_t + a_4 y_t + v_t. \qquad a_2 < 0 < a_0, a_4$$

Nominal money demand (m_t^d) depends positively upon the price level (p_t) and real output (y_t) and negatively upon the market rate of interest (r_t). The variable v_t is a serially-uncorrelated, zero-mean random shock.

The money supply function is

$$(5)\quad m_t^s = b_1 + B_t + b_2 r_t + x_t. \qquad 0 < b_1, b_2$$

B_t is the (log of the) monetary base. The term b_1 is a constant that captures the effect on the money-multiplier of the legal required reserve ratio. The term $b_2 r_t$ captures the effect on the multiplier of the interest sensitivity of excess-reserves and currency-deposit ratios. The variable x_t is a serially-uncorrelated, zero-mean shock to the value of these ratios.

Equation (6) describes the behavior of the central bank.

$$(6)\quad B_t = B_{t-1} + \theta_1[r_t - E_{t-1}r_t] - \theta_2[B_{t-1} - E_{t-2}B_{t-1}] + \theta_3$$

The central bank specifies three parameters (the three θs) that determine the time series behavior of the monetary base. The parameter θ_3 is the trend rate of growth of the base. The parameter θ_1 determines the interest elasticity of the monetary base. It specifies the extent to which the central bank smooths movements of the market interest rate around a reference level $E_{t-1}r_t$. The central bank cannot smooth the market rate around an arbitrary level. It is constrained to smooth around the prior period's expectation of the market rate. This expectation is the sum of the expected real rate and of the trend rate of inflation. (The solution of the model is determinate only for this value.) Specifically, the central bank must smooth the market rate around the value $(c_1 + \theta_3)$, which is $E_{t-1}r_t$ from (3). The variable $[r_t - (c_1 + \theta_3)]$ measures innovations (unpredictable changes) in the market rate. Interest-rate innovations cause the central bank to produce innovations in the monetary base, which, from (6), equal θ_1 times the interest rate innovations.

The third term on the right side of (6) measures the extent to which the central bank offsets, in the contemporaneous period, last period's innovation in the monetary base. There are two general cases. In one case, θ_2 differs from one, so that there is not an exact offset to last period's innovation. The monetary base then behaves like a random walk with a persistence over time given by θ_3. In the second case, θ_2 is one so that the central bank offsets exactly last period's innovation. In this case, $E_{t-2}B_{t-1}$ can be defined as $\theta_0 + \theta_3(t-1)$, where t is the number of time periods that have elapsed since a base period 0. The constant θ_0 is the (log of the) monetary base at time 0. This expression defines a path for the monetary base that grows over time at the rate θ_3 and around which the monetary base fluctuates.

The model's equations are listed below. [Equation (7) comes from substituting y_t^s from the aggregate supply function (2) into (4), the money demand function, and simplifying the notation for the coefficients.]

$$(7)\quad m_t^d = p_t + a_1 + a_2r_t + a_3[p_t - E_{t-1}p_t] + v_t \qquad a_2 < 0 < a_1, a_3$$

$$(8)\quad m_t^s = b_1 + B_t + b_2r_t + x_t \qquad 0 < b_1, b_2$$

$$(9)\quad B_t = B_{t-1} + \theta_1[r_t - (c_1 + \theta_3)] - \theta_2[B_{t-1} - E_{t-2}B_{t-1}] + \theta_3$$

$$(10)\quad r_t = (E_tp_{t+1} - p_t) + c_1 + c_2[p_t - E_{t-1}p_t] + q_t \qquad c_2 < 0 < c_1$$

The model is completed with a cost function [from Goodfriend (1987)] for the central bank. Var is variance.

$$(11)\quad C = \beta\ \text{var}[p_t - E_{t-1}p_t] + \gamma\ \text{var}[E_tp_{t+1} - p_t] \qquad 0 < \beta, \gamma$$

With the assumption that money demand equals money supply and the assumption of rational expectations, equations (7)-(10) can be solved for m_t, p_t, r_t, and B_t. The solutions for the contemporaneous price level prediction error $[p_t - E_{t-1}p_t]$ and for expected inflation $[E_tp_{t+1} - p_t]$ are substituted into (11). With these substitutions, the central bank's cost function is expressed in terms of the θ parameters that characterize the behavior of the monetary base. The central bank chooses these parameters in order to minimize (11).

The θ parameters that minimize (11) are

$$(12)\quad \theta_1 = a_2 - b_2 + [(1 + a_3)\sigma_q^2]^{-1}[(1 - c_2)\sigma_{v-x}^2]$$

$$(13)\quad \theta_2 = 1.$$

σ_q^2 and σ_{v-x}^2 are the variance of q_t and $(v_t - x_t)$. [See Poole (1970, p. 208) for a solution for θ_1 in a static model.] The model does not determine a value for θ_3. Note that the values of θ_1 and θ_2 that minimize (11) also minimize each term of (11) separately. Consequently, the β and γ parameters do not enter into the expression for the θs. The central bank is not forced to trade off among conflicting objectives.

Consider now the cost function (14).

$$(14)\quad C = \alpha\ \text{var}[r_t - (c_1 + \theta_3)] + \beta\ \text{var}[p_t - E_{t-1}p_t] + \gamma\ \text{var}[E_tp_{t+1} - p_t] \qquad 0 < \alpha, \beta, \gamma$$

The θ values that minimize this cost function involve the α, β and γ parameters. The central bank chooses the process for generating the monetary base in a way that reflects the relative importance it assigns to achieving conflicting objectives. With (14), the optimal rate smoothing parameter θ_1 is larger than the θ_1 in (12). The base drift parameter θ_2 is in general different from one. Its value is greater or less than one depending upon the parameters of the cost function (14) and the structural parameters of the model. For example, θ_2 is less than one if α and γ are large and the magnitude of c_2 is large.

(The structural parameters of the model, a_2, a_3, b_2, and c_2, are functions of the θ parameters. Different objective functions imply different structural coefficients [Lucas (1976)].) For some issues, it is important to model how the policy process affects the structural relationships that summarize the economy. For example, the model incorporates a money demand function and a money supply function. Sargent (1981a) and Goodfriend (1983) discuss, respectively, the way in which a change in the monetary policy process affects the structural form of the money demand function and the money supply function. The major policy issue of interest here is the way different objective functions affect the general time series behavior of the price level. For this issue, the main assumption that must be made is that the signs of the structural parameters remain unchanged when the policy process that generates the monetary base changes.