The Future of Monetary Aggregates in Monetary Policy Analysis

Edward Nelson*
Monetary Policy Committee Unit, Bank of England

December 2002

Abstract

This paper considers the role of monetary aggregates in modern macroeconomic models of the New Keynesian type. The focus is on possible developments of these models that are suggested by the monetarist literature, and that in addition seem justified empirically. Both the relation between money and inflation, and between money and aggregate demand, are considered. Regarding the first relation, it is argued that both the mean and the dynamics of inflation in present-day models are governed by money growth. This relationship arises from a conventional aggregate-demand channel; claims that an emphasis on the link between monetary aggregates and inflation requires a direct channel connecting money and inflation, are wide of the mark. The relevance of money for aggregate demand, in turn, lies not via real balance effects (or any other justification for money in the IS equation), but on money's ability to serve as a proxy for the various substitution effects of monetary policy that exist when many asset prices matter for aggregate demand. This role for monetary aggregates, which is supported by empirical evidence, enhances the value of money to monetary policy.

Keywords: Taylor rules, inflation, money, monetary aggregates, monetary policy, transmission mechanism.
JEL Classification Numbers: E52; E58.

* Research Adviser to the External Members of the Monetary Policy Committee, MPC Unit, Bank of England, Threadneedle St, London EC2R 8AH, United Kingdom. Tel: +44 207 601 5692. Fax: +44 207 601 3550. Email: ed.nelson@bankofengland.co.uk

For detailed comments on the whole of the paper, I am indebted to Milton Friedman, Peter Ireland, David Laidler, Bennett McCallum, Allan Meltzer, Anna Schwartz, and Lars Svensson. For specific comments and feedback on earlier drafts, I thank participants at the Carnegie-Rochester Conference, November 22–23, 2002, seminar attendees at the Bank of England and the European Central Bank, and Paul De Grauwe, William Dewald, Charles Goodhart, Amit Kara, Stuart Lee, and Magdalena Polan. I thank Kosuke Aoki for providing code and for helpful discussions. The views expressed in this paper should not be interpreted as those of the Bank of England or the Monetary Policy Committee.

1 Introduction

The paper by Taylor (1993) was pivotal in shaping the conduct of monetary policy analysis. Monetary economists had long recognized that central banks in practice treated the nominal interest rate rather than the monetary base or a reserves aggregate as their policy instrument. They had also acknowledged that interest-rate rules that responded to nominal variables in an appropriate manner could deliver low and stable inflation, even if these rules did not respond directly to movements in the money stock.[1] But Taylor put these elements together with an empirical insight, namely, that actual monetary policy decisions could be usefully approximated by a simple interest-rate rule that responded to observed movements in a small set of key variables—inflation and detrended output. Taylor's insight has facilitated the use of small-scale models that analyze monetary policy, the business cycle, and inflation with interest-rate rules (see e.g. the papers in Taylor, 1999).

In itself, the use of a Taylor rule for monetary policy analysis is neutral on the issue of the importance of monetary aggregates. The fact that actual policy is well characterized by a rule with no explicit money term does not preclude a role for monetary aggregates in the transmission of monetary policy or the analysis of inflation. Nevertheless, the literature that has found the Taylor rule a useful way of characterizing monetary policy has also endorsed the use of New Keynesian models that feature no explicit reference to monetary aggregates (e.g. Clarida, Galí, and Gertler, 1999, pp. 1686–1687; Rotemberg and Woodford, 1997, p. 309).[2] It is not difficult to see why this development has taken place: if policy actions can be characterized in terms of movements in interest rates, it is convenient to trace the transmission of policy effects through the reaction of aggregate demand to interest rates. Moreover, some analysts who reject Taylor rules as a useful description of actual monetary policy behavior have nevertheless supported the movement away from the use of monetary aggregates in monetary policy analysis (e.g. Svensson, 2002a).

This paper aims to answer four questions about the future of monetary aggregates in monetary policy analysis, two on the relationship between money and inflation, and two on the transmission mechanism of monetary policy. The questions are:

---

[1] See e.g. Artis (1993), Goodhart (1987), McCallum (1981), and Walters (1988).

[2] It remains standard for money to be included in VAR studies (e.g. Christiano, Eichenbaum, and Evans, 1999; Leeper, Sims, and Zha, 1996). This, however, can be motivated by the fact that policymakers responded to money during the estimation period, and need not imply an explicit role for money in the behavioral equations of the private sector.

(*a*) Do the New Keynesian models referred to above imply that *inflation in the long run* is governed by money growth, as stressed by the quantity theory of money?

(*b*) Can *inflation dynamics* in these models be given a conventional quantity-theory interpretation?

(*c*) Is the *basic transmission mechanism* of monetary policy in these models the same as that in pre-1990s models, which apparently gave a more explicit role to money?

(*d*) Finally, are there *aspects of the transmission mechanism* of monetary policy present in the pre-1990s work that could usefully be added to New Keynesian models?

Throughout, my investigation of these questions will be with the aim of determining whether the behavior of monetary aggregates deserves attention in the decision-making of inflation-targeting central banks that use an interest-rate operating instrument.

At a conference in July 1992, Taylor made his own position clear. While observing that "interest rates are likely to remain the preferred operating instrument of monetary policy," Taylor (1992, p. 12) advised: "The evidence that the large swings in inflation are related to money growth indicates, however, that money should continue to play an important role in monetary policy formulation in the future." The subsequent decade of monetary policy formulation, however, has seen a move away from this prescription, with continuing de-emphasis of money on the part of the Federal Reserve and other central banks, and with the European Central Bank's assignment of a prominent role to money being the basis for sharp criticism from a number of economists (e.g. Begg *et al*, 2002; Galí, 2002; Rudebusch and Svensson, 2002; Svensson 1999a, 1999b, 2002b). Such criticism, on the surface, appears to be justified by current models for monetary policy—which, a variety of observers claim (see Section 2 below), give money much-diminished importance compared to its role in the quantity theory.

In answering the above questions, I make two departures from much recent work on money. First, while money demand behavior is an important element of my discussion, I do not focus on the issue of formal stability of the money demand function. One reason for this is that, as stressed by Rudebusch and Svensson (2002), a stable money demand function does not preclude the optimality of monetary policy arrangements which proceed without any reliance on data on the money stock. Another reason, noted by Lucas (1980), is that

numerical stability of money demand neither implies nor is implied by a close relationship between money growth and inflation. A further reason is that observed instability of empirical money demand functions may reflect omission of important determinants of money demand; but the dependence of money on these determinants gives it an indicator role that may be a reason for continuing to monitor money.

This last reason leads me into the second major departure from other recent approaches to the role of money. Much of this work has highlighted novel and sophisticated properties of models that include a term involving money, either in the policy rule or in the structural equations. For example, Christiano and Rostagno (2001) show how a strategy that includes a monitoring range for money growth serves as an insurance policy against undesirable multiple equilibria. Other studies have evaluated the size of cross-derivative terms involving money in households' utility functions (Andrés, López-Salido, and Vallés, 2001; Ireland, 2001a; McCallum, 2000; Woodford, 2002). My approach is different. I endeavor to determine whether money in current models has the role advanced for it in the work of Milton Friedman, Anna Schwartz, Karl Brunner, and Allan Meltzer. It was, after all, largely the work of these authors that was the basis for the "monetarist counter-revolution" (Friedman, 1970) in the 1960s that changed macroeconomists' views regarding the potency of monetary policy and the importance of monetary aggregates.[3] Focusing on their work helps identify the distinguishing features of current models for monetary policy.[4]

Various combinations of answers to the above questions are possible. One is that current models represent a decisive rejection of the earlier quantity-theory-based analysis, but that this rejection is theoretically and empirically justified. In that case, the answers to (*a*)–(*d*) above are all "no," and, insofar as there is a role for money in monetary analysis, it must be based on a new justification different from those advanced by monetarists. Another answer is that the differences between current models and their monetarist antecedents are more apparent than real, and so an eclectic interpretation of current models indicates that they

[3] As well as being the tenth anniversary of the conference-presentation and publication of the Taylor rule paper, 2002–2003 is the 40th anniversary of the NBER Conference on the State of Monetary Economics, held on April 13–14, 1962, whose proceedings (published February 1963) included Friedman and Schwartz (1963a). According to Brunner (1971a, p. 35), this conference "alerted the profession to a change in the intellectual climate." It also featured the first four-way meeting of Friedman, Schwartz, Brunner, and Meltzer. Like the conference that introduced the Taylor rule, the 1962 conference was held at Carnegie Mellon University (then known as the Carnegie Institute of Technology).

[4] For space reasons, I restrict the scope of this paper in several respects. I do not consider the fiscal theory of the price level (e.g. Woodford, 2001) or liquidity-trap issues. And I do not discuss financial intermediation, in order to focus on properties of money that remain valid even for narrow definitions such as currency or high-powered money.

have standard monetarist properties. Then questions (*a*)–(*c*) should be answered with "yes," and (*d*), "no."[5]

The conclusion suggested by the analysis in this paper, however, is that while current models are partially monetarist, further insights from monetarist analysis could be fruitfully added to New Keynesian models. I argue in Section 2 that present models are consistent with quantity-theory or monetarist approaches regarding their modeling of inflation. The relation between monetary policy and aggregate demand in New Keynesian models is discussed in Section 3, and I argue that, in basic terms, the transmission mechanism is a special case of monetarist models. New Keynesian models lack, however, an important element of most monetarist analysis. This is the notion that a spectrum of yields matters for the determination of aggregate demand *and* money demand. The implication of this model feature is that money conveys information about monetary conditions not summarized by the short-term interest rate.[6] I argue that there is support for adding this model feature to New Keynesian models. In total, the analysis suggests answers of "yes" to (*a*)–(*d*) above.

2 Money and inflation

Taylor (1992, p. 12) concluded that "there is ample evidence in many of the recent experiences with inflation and disinflation to support Friedman's (1992) point that 'substantial inflation is always and everywhere a monetary phenomenon.'" Milton Friedman's famous statement that "inflation is always and everywhere a monetary phenomenon" (appearing originally in Friedman 1963, p. 17)—referred to for brevity here as the AEMP proposition—forms a useful way of organizing the discussion of current views on the relationship between money growth and inflation. Taylor's conclusion

[5] Considering these questions explicitly seems preferable to the approach of Alvarez, Lucas, and Weber (2001), who endorse the empirical validity of the quantity theory, claim that current models reject the quantity theory, then propose their own "new theory" for monetary analysis. Clearly, the validity of the quantity theory hardly justifies a "new theory." And insofar as current models lack worthwhile elements of the quantity theory, it is preferable to isolate those elements directly.

[6] Beside my (2002) paper (discussed in King, 1999, and Svensson, 1999b), recent discussions of the multiple channels of monetary policy, and the implications for the significance of money, include Clouse *et al* (2000) and Goodfriend (2000). Clouse *et al* attribute these ideas to Meltzer (2001) and Tobin (1982); Goodfriend attributes them to Friedman and Meltzer. My own view is that they should be jointly attributed to Brunner, Meltzer, Friedman, and Schwartz, on account of their all having advanced such ideas in the 1960s, e.g. Brunner (1961, p. 53), Brunner and Meltzer (1963, p. 322), Friedman (1961a, pp. 461–463), Friedman and Schwartz (1963a). (The key passage describing these ideas cited in Goodfriend's fn. 32, which he attributes solely to Friedman, is joint work by Friedman and Schwartz (1963a, pp. 59–63).) One reason for not associating such views with Tobin is that he denied that the extra transmission channels gave additional significance to money as an indicator; see Nelson (2002, fn. 31).

appears to have been widely shared in the early 1990s, with McCallum (1990, p. 965) expressing confidence that "there is little professional disagreement with Friedman's position," and Robert Lucas claiming that "a macroeconomic consensus [has been] reached... on the monetary sources of inflation" (quoted in Snowdon, Vane, and Wynarczyk, 1994, p. 226).

Policymakers still appear to adhere to the AEMP proposition. Endorsements of the proposition appear not only in the recent outline by Issing *et al* (2001) of the ECB's monetary policy strategy, but also in statements by policymakers outside the euro area. For example, King (1997, p. 441) states that "inflation is assuredly a monetary phenomenon in the medium term"; Meyer (2001a, p. 5) argues that "[f]ew economists would disagree that inflation is, as Milton Friedman taught us long ago, always and everywhere a monetary phenomenon," and Hubbard (2002, p. 739) observes: "Nobel laureate Milton Friedman once remarked that 'inflation is always and everywhere a monetary phenomenon.'... [T]his is true."

But there have been suggestions that theoretical developments and empirical work of the last decade have shattered support for the AEMP proposition. Alvarez, Lucas, and Weber (2001, p. 219), for example, describe the "consensus [that] has emerged" as "a rejection of the quantity theory." After providing a brief outline of the proposition (Section 2.1), in Section 2.2 I discuss the long-run relations between money growth and inflation suggested by current theory, and in Section 2.3, turn to recent empirical work that claims to find that inflation is not a monetary phenomenon. Other issues relating to money growth and inflation are taken up in Sections 2.4 and 2.5, with Section 2.6 providing some conclusions

2.1 Outline of the AEMP proposition

Here I provide an outline of the proposition that inflation is always and everywhere a monetary phenomenon.[7] Discussions of the AEMP proposition available in the literature that endorse AEMP include those in Friedman's work (e.g. 1963, 1970), McCallum (1990, pp. 965–966), Meltzer (1977, p. 183), and the many editions of Mishkin (2001); the following is based closely on these interpretations.

[7] In this paper, I also refer to this proposition as the "quantity-theory explanation of inflation."

The proposition amounts to the claim that for the central bank to allow a sustained change in inflation of *g* percentage points, it must allow the steady-state money growth rate to change by *g* percentage points. In addition, fluctuations in inflation around its steady-state value are largely explicable by movements in money growth.

There are several qualifications, discussed in greater detail below. First, it is a proposition about inflation, not the price level. Once-and-for-all price-level shocks occur—e.g. from falls in the level of potential GDP.[8] In addition, to establish the money growth/inflation relationship, one must allow for a lag from money growth to inflation. And significant discrepancies between money growth and inflation can occur during periods of lasting shifts in the opportunity cost of holding real balances—from changes in the own rate on money, and as real balances recover in the adjustment to a new low-inflation, lower nominal interest rate regime.

Velocity growth is formally equivalent to monetary growth in its implications for nominal spending growth and inflation. An increase in velocity growth implies lower growth in demand for real money balances per unit of output, which with an unchanged growth in nominal money per unit of output, implies a higher inflation rate. The AEMP proposition does not deny that changes in velocity growth occur over both short and long periods. However, the longer-term changes (excluding those from the Fisher effect) tend to be determined by a set of factors (demographics, innovations in the financial system, etc.) that bear no necessary relationship to the set of factors commonly advanced as non-monetary determinants of inflation (such as union "wage-push" or world inflation). It follows that non-monetary factors must affect the growth of the nominal quantity of money to have a systematic effect on inflation.

2.2 Long-run relations: theory and implications for policy

Let us first consider the validity of the AEMP proposition as a steady-state property. It is convenient, as in McCallum (2001) and Meyer (2001b), to write down the standard New

[8] As price-level shocks, King (1997, p. 438) mentions changes in commodity prices, Meltzer (1977, p. 183), one-time changes in the degree of monopoly power, and Friedman (1992, p. 204) and McCallum (1990, p. 965), movements in the terms of trade. It is important to emphasize in each case that the permanent effect on the price level, for an unchanged nominal money stock, comes from the fact that potential output has been changed, *not* because particular items in the price index directly respond to the shock. King (1997) further mentions indirect tax changes and Meltzer (1981, p. 21), "the imposition or elimination of the distorting influence of price controls." Abstracting from effects on potential output, these events can be regarded as affecting the price level by introducing measurement error into recorded price indices.

Keynesian setup of an IS equation, an expectations-augmented Phillips curve, and a Fisher equation:

$$y_t = \mathrm{E}_t y_{t+1} - \sigma r_t + v_t \tag{1}$$

$$\pi_t = \beta \mathrm{E}_t \pi_{t+1} + \alpha(y_t - y_t^*) \tag{2}$$

$$R_t = r_t + \mathrm{E}_t \pi_{t+1}. \tag{3}$$

Here R is the short-term nominal interest rate, r_t the short-term real interest rate, y_t log output, y_t^* log potential output, π_t quarterly inflation, and the parameters satisfy $\sigma > 0$, $\alpha > 0$, and $0 < \beta < 1$. The variables R_t, r_t, and π_t are expressed as deviations from constant steady-state values; y_t and y_t^*, as deviations from a common steady-state growth path.

McCallum (2001, pp. 146–147) argues that while no explicit term involving money appears in the above model, and solution expressions for inflation would be unchanged by adding a money demand equation to the system, inflation nevertheless can still be regarded as pinned down in the long run by the economy's steady-state nominal money-growth rate (relative to the output growth rate). His demonstration is not repeated here; I will argue in Section 2.3 that this demonstration of money's steady-state role, while valid, understates the closeness of this model to the standard quantity theory.

McCallum's derivation helps address a question raised by Galí (2002, Sect. 3.3). Galí contends that as the long-run money growth/inflation relation is one among several steady-state relations between nominal variables—the Fisher relation between nominal interest rates and inflation being another—it deserves no "special attention." But Galí's analysis takes as given that the average value of inflation is equal to target. In empirical work on inflation dynamics or in theoretical study of optimal stabilization policy, the determination of the average or steady-state inflation rate can be abstracted from.[9] But, as Galí notes, central banks have to be concerned with setting the steady-state rate of inflation, not just minimizing the variability of inflation around its steady-state value. And it is for the former purpose that explicit attention to the long-run inflation/money growth relationship may be

[9] Phillips curves such as Eq. (2) describe the dynamics of inflation around a steady-state value. Empirically, this steady-state value is taken into account via the inclusion of an intercept term (as in Galí and Gertler, 1999) or by removal of a time-varying mean from the data prior to estimation (Coenen and Wieland, 2002). The theoretical studies of Clarida, Galí, and Gertler (1999) and Svensson (2002a) describe welfare-maximizing policy in a model where inflation is expressed as a deviation from its steady-state value.

valuable. Galí treats this relation as only one of several long-run conditions, but there is a key distinction between the money/inflation link and other conditions, such as the Fisher condition. The Fisher relation has a direct counterpart in the equations describing inflation dynamics, namely Eq. (3); there is no extra information from the steady-state Fisher relation. The money growth/inflation link, by contrast, has no counterpart in the equations describing inflation dynamics. Rather, this long-run relation is "buried" in the constant terms of the structural relations that underlie Eqs. (1)–(3), and so is suppressed altogether in the dynamic equations that are expressed in terms of deviations from the steady state. Consequently, the steady-state link between monetary growth and inflation does have a special status that deserves separate consideration from other long-run relations.[10]

A more legitimate basis for not taking the long-run money growth/inflation relationship into account in policymaking would be if the short-run model (1)–(3) were a reasonable description of the data in the presence of moderate changes in the mean of inflation.[11] The money growth/inflation relation would still demand special attention for contemplating and understanding large changes in the mean of inflation, but the short-run model might be adequate for much policy analysis.

Finally, it should be noted that McCallum's steady-state analysis refers to a system that includes a *conventional* money demand function of the form:

$$(m - p)_t = c_0 + c_1 y_t + c_2 R_t + \eta_t, \qquad (4)$$

where $(m - p)_t$ is log real money balances, η_t is a money-demand disturbance, and $c_1 > 0$, $c_2 < 0$. I will argue in Section 3 that a less conventional money demand function, in which the long-term interest rate and other yields appear, is appropriate. This modification, however, would not overturn the model's steady-state property of a unitary link between nominal money growth and inflation.

---

[10] The steady-state growth rate of money relevant for policy may change over time. For example, Brunner (1997, p. 82), Friedman and Schwartz (1982, p. 150), and Meltzer (1987, p. 30) all recognize that changes in financial structure can alter the trend growth of velocity, and that that the money-growth rate relevant for analysis of inflation is one adjusted in light of changes in the velocity trend. The recognition that the steady-state relation can undergo shifts should be distinguished from the claim that the long-run relation deserves no attention in policymaking.

[11] For example, if moderate changes in the mean of inflation have little effect on the length of nominal contracts in the economy, the assumption of a constant value of α in Eq. (2) would remain valid across different mean inflation rates.

2.3 Long-run relations: recent empirical evidence

What of the empirical evidence on money and inflation in the long run? Both Begg *et al* (2002, p. 21) and Svensson (2002b) refer to the recent study by De Grauwe and Polan (DP) (2001) as providing decisive evidence against AEMP. DP's exercises include both cross-country and panel regressions of inflation on money growth using 1970–1999 annual data from "low-inflation" (i.e., less than 10% average) countries. Finding that the estimated coefficient on money growth is low relative to 1.0 and statistically insignificant, DP conclude that "there is no evidence for this statement [i.e., AEMP] in relatively low inflation environments."

A serious omission, however, is that while DP review the empirical literature, they provide no discussion of previous attempts (such as those cited in Section 2.1 above) to *interpret* the AEMP statement itself. Moreover, no paper by Milton Friedman which uses the AEMP phrase is cited or discussed.[12] I suggest that, under the interpretations offered in these papers, DP's rejection of the proposition is unjustified. Reconsidered in light of Friedman's work in the area, their study has limitations regarding data, dynamics, and the theoretical interpretation of the AEMP proposition.

The first misinterpretation of AEMP pertains to DP's main evidence for the low-inflation economies, namely regressions based purely on cross-country averages. With each country represented in the regression by single 30-year means of money growth and inflation, DP find no relationship between the two series. Note first that such cross-country regressions have no implications for whether inflation and money growth are closely related over time in each country. The only issue, therefore, is whether the AEMP proposition is intended to account for cross-country differences in inflation in the manner that DP specify. DP's cross-country regressions implicitly impose the restriction that the steady-state growth rate of desired real balances relative to income is constant across countries. But advocates of AEMP clearly did not make this claim (see e.g. Brunner, 1997, p. 96; Friedman, 1983, p. 4; Meltzer, 1987, p. 30). Rather, the benchmark noninflationary steady-state money-growth rate was accepted as varying by country, on account of different velocity trends implied by each economy's financial structure. DP's cross-country results for low-inflation

[12] The AEMP phrase does not appear in Friedman and Schwartz (1963b), the only work authored or coauthored by Friedman that is cited by De Grauwe and Polan (2001).

economies—which Begg *et al* (2002) focus upon—therefore have no bearing on the AEMP proposition.[13]

Regarding data, DP use M1 and M2 growth rates computed from *International Financial Statistics* annual series. These money definitions have a large deposit component, and *IFS* data on these aggregates are subject to numerous statistical breaks, including those due to reclassification of nonbank deposits as bank deposits, nondeposit liabilities as deposits, and time deposits as demand deposits. In addition, variations in the payment of interest on deposits tend to produce jumps in particular monetary aggregates. Sympathizers with and critics of the quantity theory would surely grant that the conceptual definition of money is one that is invariant to these breaks, and so the appropriate monetary aggregate in empirical work is one that either adjusts for the breaks or excludes the affected components of money. For this reason, Friedman and Schwartz (1970, p. 145) recommended using currency as the definition of money in cross-country studies. This recommendation remains compelling today, and so DP's failure to consider results for currency is a serious drawback.

Regarding dynamics, Friedman's long-held position is that the peak response of inflation to money growth is with a lag of over a year (see Batini and Nelson, 2001). DP's panel regressions, however, are of inflation on same-period money growth. Nor do their regressions that use multi-year averages of inflation and money growth allow for lags in a satisfactory manner.[14] The material effect of allowing for lags is shown below.

A final issue regarding interpretation is that DP take a negative correlation between money growth and velocity growth (observed in the low-inflation countries) as *ipso facto* inconsistent with AEMP. Such negative correlations *can* be inconsistent with AEMP under certain circumstances. For example, if monetary policy has no effect on aggregate demand, then a monetary policy easing leads both to a rise in money growth and a fully offsetting and permanent movement of velocity growth. Such a feature of the data would rule out any role for monetary policy in controlling inflation, let alone any attention to monetary

---

[13] A similar judgement pertains to the earlier work of Haldane (1997, pp. 86–89) who, like DP, used 30-year averages of inflation and money growth and found that the money growth/inflation correlation was weaker for low-inflation countries.

[14] DP's panel regressions using multi-year averages take means of inflation and money growth over synchronous periods. Clearly, a regression of the average of inflation from years $t-j$ to $t+j$ on money growth over the same period regresses inflation on *future* money growth as much as it does on *past* money growth. In fact, the situation is worse than that, because *IFS* data on money are end-of-year while prices data are year-averages, so period-t prices data in effect lead the period-t money data.

aggregates.[15] But other factors consistent with the AEMP proposition can produce a negative money growth/velocity growth correlation. Most notably, a protracted fall in nominal interest rates, associated with the aftermath of a disinflation, reduces the cost of holding real balances and so generates data characterized by higher money growth, slower velocity growth and unchanged inflation. Such a pattern of money/velocity behavior is, as Wicksell (1906, p. 152) observed, "in complete agreement with the Quantity Theory." The cost dimension to velocity behavior was noted explicitly in Barro's (1982, p. 101) and McCallum's (1990, p. 966) expositions of the AEMP proposition.

De Grauwe and Polan (2001) reject interest rates as the source of the negative money growth/velocity growth correlation, on the grounds that "the liquidity effect of an increase in the money growth… occurs only in the short run" and cannot account for patterns that affect a 30-year dataset. The problem here is a concentration on falls in the nominal interest rate from the liquidity effect—which would be transitory in nature—at the expense of falls from the *Fisher* effect, which would be permanent, and—in the case of a protracted and erratic disinflation—could easily leave an imprint on long runs of annual data. Declining nominal yields due to the Fisher effect, and the resulting lowered cost of holding real balances, readily account for negative money growth/velocity growth correlations, for as Friedman (1985) notes, "[a] break in the trend of velocity... has been observed whenever and wherever accelerating inflation has been succeeded by disinflation."

Let us now consider the empirical inflation/money growth relationship in light of the above points. Using Batini and Nelson's (2001) data for the US, a regression of annual CPI inflation (π^A_t) on contemporaneous annual M2 growth (μ^A_t) produces:

$$\pi^A_t = \underset{(0.004)}{0.036} + \underset{(0.047)}{0.211}\ \mu^A_t, \quad R^2 = 0.052, \tag{5}$$

(Sample period January 1970–August 2001; Newey West standard errors in parentheses.) The money-growth coefficient, while positive and highly significant, is far from unity, in that respect apparently supporting DP's conclusions. But if one instead allows explicitly for lags by regressing inflation on M2 growth two, three, and four years earlier, the result is:

$$\pi^A_t = \underset{(0.003)}{-0.006} + \underset{(0.041)}{0.257}\ \mu^A_{t-24} + \underset{(0.048)}{0.376}\ \mu^A_{t-36} + \underset{(0.040)}{0.182}\ \mu^A_{t-48}, \quad R^2 = 0.555, \tag{6}$$

[15] As Friedman and Schwartz (1982, p. 207) note, this view of monetary policy was prevalent in the UK prior to the 1970s (and also the US; see Hetzel, 1998, and Meltzer, 1998, for recent discussions), but surely has no following today, even among critics of monetary aggregates.

with a coefficient sum of 0.814 (s.e. 0.101) on money growth, decidedly more favorable to the quantity theory.[16] Allowing for dynamics moves the results for the UK in a similar, though less striking, manner: a regression of annual consumer price (RPIX) inflation on contemporaneous base money growth[17] for January 1970–August 2001 produces a coefficient of 0.883 (0.188), while that of inflation on base growth two years earlier delivers 1.020 (0.145).[18]

If one uses annual base money growth in the US case, a regression of inflation on contemporaneous money growth delivers a slope coefficient of –0.438 (s.e. 0.103).[19] Replacing current money growth with growth two years earlier, and including an intercept dummy from 1982 to capture the average effect of disinflation on velocity growth, lead to a coefficient on money growth that is positive, but only 0.221 (s.e. 0.080). Other evidence for the US establishes, however, that money base growth is significant in predicting aggregate demand (Nelson, 2002); and that there was a high degree of stability in the demand function for the base in the twentieth century (Anderson and Rasche, 2001; Meltzer, 1998)—indeed, probably more so than for M2. This evidence suggests that changing opportunity cost of holding base money, due to adjustment to a noninflationary regime, has been a pervasive feature of the final 20 years of the sample, disguising the underlying unitary relationship between base growth and inflation. The resulting discrepancies between base growth and inflation are, as argued above, not inconsistent with the AEMP proposition, and reflect a property of velocity behavior noted by Wicksell a century ago.

2.4 Inflation dynamics: the Phillips curve

"Of course, it is not money as such which drives up prices." This observation of Karl Brunner (1969, p. 26) has been restated constantly in recent criticism of monetary aggregates. Typically, the criticism has taken the form of noting that current models, like

---

[16] Batini and Nelson (2001) and Leeper and Roush (2002) document the resilience to sample period of the correlation between inflation and prior M2 growth. Batini (2002) reports similar results using euro area data.
[17] For the UK, base money is the preferred measure of money in empirical work for precisely the Friedman-Schwartz (1970) reasons mentioned earlier, and is endorsed by Brunner (1997, p. 136) on the same grounds.
[18] Allowing for lags in the UK case has a more important impact if a longer span of data is considered. Using annual data for 1834–2000 on inflation and base money growth, a regression of inflation on current money growth produces coefficient 0.496 (0.142), while a regression of inflation on the prior two years' base growth yields coefficient sum 0.754 (0.184).
[19] Again, the Batini-Nelson data, which employ the Anderson-Rasche (2001) domestic base series where available, are used.

earlier non-optimization based models, have Phillips-curve specifications in which prices are adjusted in light of current and prospective market conditions. These conditions are expressed in terms of the output gap or marginal cost; no explicit term involving money appears. The implication would appear to be that those who advocate using money in the analysis of inflation must believe that money enters these price-setting specifications directly, and should provide empirical evidence to that effect. Thus Svensson (1999a, p. 114) states that a "rational role for monetary aggregates" in an inflation-targeting framework is as indicators "whose usefulness exclusively depend[s] on their performance in predicting inflation." To this end, he points to the evidence of Estrella and Mishkin (1997) that "money has essentially no predictive power beyond lags of inflation and output in forecasting inflation." Similarly, Galí (2002, Sect. 3.4) maintains that "a rationale for the emphasis on monetary aggregates and inflation" requires "a direct link between money and inflation."

But quantity theorists recognized, as Galí and Svensson do, that in a sticky-price world, monetary actions operate via effects on real aggregate demand.[20] Accordingly, a structural price-setting equation in which the sole forcing process is a measure of excess demand or cost pressures is in harmony with a quantity-theory account. As Artis and Lewis (1985, p. 213) put it: "There is no necessary contradiction between allowing a substantial role to 'money' in inflation and describing its determinants in the conventional way [i.e. using Phillips curves or markup equations]."[21] Put differently, using a Phillips curve to describe inflation dynamics is entirely consistent with inflation being a monetary phenomenon.[22]

Once it is recognized that the route from money growth to inflation is not a direct one, it is less compelling to regard inflation as related to money growth in the long run only. By amalgamation of the money demand function, Phillips curve, and policy rule, it is possible to obtain a reduced-form expression for the dynamics of inflation in which money-growth

---

[20] The case where the marginal utility of consumption depends on real money balances provides only a partial exception. Ireland (2001a) and Woodford (2002) show that this modification introduces a term in money into the Phillips curve. This term appears because money now enters the expression for potential GDP. As in the standard case, there is no term in money in the Phillips curve once the output gap is defined appropriately, i.e. as the percentage difference between actual and flexible-price real GDP.

[21] Batini and Nelson (2001, p. 391) provide references giving similar statements. See also Friedman (1970, p. 15), Friedman and Schwartz (1982, pp. 60–61), Laidler (1982, p. 13), Harrington (1983, p. 65), and Meyer (2001b, p. 4).

[22] As Milton Friedman observes in October 31, 2002 comments on the preceding paragraphs, "What would it mean for money of itself to drive up prices?… What drives up prices is spending by the holders of money, driven by many factors, of which the quantity of money that they happen to have at the moment is one."

terms appear prominently.[23] No direct role for money is required; rather, money growth can be considered, as in Harrington (1983, pp. 65–66), Walters (1988, p. 279) and Batini and Nelson (2001, p. 387), a "quantity-side" indicator of the monetary conditions induced by central-bank policy. Open market operations by the central bank raise money growth and lower nominal yields; with inflation persistence, real yields fall in the short run and produce variations in real aggregate demand relative to potential GDP, and so in inflation. This perspective provides a counterexample to Svensson's (1999b, p. 215) contention that the correlation between money growth and inflation emerges only from the long-run money demand function having a unit coefficient on prices. Variations in the opportunity-cost variables that enter both the money demand function and the economy's IS function are associated with movements in both real money and real aggregate demand, and so help in generating a money growth/inflation correlation.[24] One can agree with Svensson's (1999b, p. 215) observation that "M2 has no direct role in the transmission mechanism," without sharing his conclusion that money growth and inflation are uncorrelated "at the horizon relevant for monetary policy."

Money growth thus explains inflation dynamics via the effect of monetary policy on real aggregate demand relative to potential GDP. The ability to view inflation dynamics in this way underlies the traditional analysis of the accommodation issue—that is, the implications for inflation of a nonmonetary event (such as an increase in government spending or an oil price increase). Textbook treatments (e.g. Lipsey and Chrystal, 1999, pp. 512–516) characterize these events as producing ongoing inflation only if the monetary authority "accommodates," permitting a rise in money growth. So, for example, an oil shock permanently raises the price level via the reduction in potential output, but only leads to ongoing inflation if the central bank follows policies that allow nominal money growth (relative to output growth) to rise permanently following the oil shock. Other pressures on the price level can be treated analogously. The same analysis says that a shift in the level of government spending alongside unchanged money growth can affect the price level permanently via its effect on potential output and by producing a one-time change in the opportunity cost of holding real balances, but cannot produce ongoing inflation.[25]

---

[23] See Rotemberg (1996, p. 512, Eq. (11)). A similar representation would result if Rotemberg's framework was generalized to incorporate an interest-elastic money demand function and a Taylor rule to describe policy behavior.

[24] This issue is taken up in Section 3 below.

[25] For permanent changes in government spending, one would not expect large effects on the opportunity cost of holding money, as the natural real interest rate is insensitive to such changes in infinite-horizon models.

More recent expositions (e.g. CGG, 1999) instead characterize the accommodation issue directly in terms of central banks permitting a move in the output gap, avoiding any analysis of money. In principle, this approach is unambiguously more useful, since velocity movements distort growth in nominal money per output unit as an indicator of inflationary pressure. But this superiority may be less clear in practice: deviations of measured output gaps from their conceptual counterparts may be as quantitatively important as velocity movements. A key reason for this, even abstracting from difficulty in measuring the trend in GDP, is that the cyclical component of potential output responds to unobserved real shocks. Indeed, a dichotomy in CGG's (1999, p. 1687) analysis is that "large unobservable shocks to money demand" are advanced as a reason for "not even bother[ing] to include a money aggregate" in modeling; yet their analysis of optimal monetary policy is framed in terms of whether policy should accommodate certain real shocks—which are, of course, in practice large and unobservable, with an unknown mapping between these shocks and potential GDP.[26] Certainly, estimates of these real shocks should be constructed, as CGG (1999, pp. 1684–1685) recommend; but once problems in measuring potential are acknowledged, the advantage of conducting analysis of accommodation issues without reference to money is less obvious. In short, policymakers' knowledge of output-gap behavior may not be superior to their knowledge of velocity behavior, and so they may find it useful to consult money-growth data in evaluating whether they are following policies consistent with maintenance of inflation on target.

To reemphasize the main point, however: the quantity theory does *not* claim, and the importance claimed for monetary aggregates in the determination of inflation does *not* rest on, a direct channel linking money growth and inflation. Accordingly, I would not expect the money growth terms in Eq. (6) to remain significant once terms in the output gap were added to the specification.[27] And I would interpret the evidence in Estrella and Mishkin (1997) that money does not matter in inflation equations, conditional on real activity terms, as simply reaffirming evidence against flexible-price models, not as evidence against the monetary origins of inflation. Conversely, the evidence in Gerlach and Svensson (2002) that money terms do provide explanatory power for inflation over and above that contained in measured output gaps, suggests measurement error in the latter, as well as a positive correlation between money growth and the true output gap. What is clear is that tests of the significance of terms in money in inflation equations that include output-gap terms are not a

[26] Problems in measuring this cyclical component of potential GDP would remain even if the errors in conventional real-time measures of the output gap, stressed by Orphanides (2000), could be reduced.
[27] This includes leads of the output gap, which matter via the expected future inflation term in Eq. (2).

valid basis for evaluating the quantity theory or for judging whether there should be a role for money in monetary policy decisions.

2.5 Inflation and the monetary regime

Svensson (2002b, p. 2) argues that:

"the well-known high long-run correlation between money growth and inflation… is often misunderstood. Since it is a correlation between two endogenous variables, it says nothing about the direction of causality… Indeed, the direction of causality is determined by the nature of the monetary policy pursued. For instance, under successful strict money-growth targeting, money growth would be stable and in a sense exogenous to inflation. Then one can argue that endogenous inflation is caused by exogenous money growth. However, under successful strict inflation targeting, inflation would be stable and in a sense exogenous to money growth. Then one could argue that endogenous money growth is caused by exogenous inflation."

I do not feel that such a regime-dependent interpretation of the money growth/inflation relationship is necessary. Certainly, monetarists in the 1960s acknowledged that actual policy made money growth a state of the economy, yet they found it useful to regard inflation as governed by money growth behavior.[28] In this spirit, the AEMP proposition can be applied symmetrically across regimes. For example, the following features have characterized conditions in the US and the UK for most of the last half-century:

(i) Under all monetary policy regimes, inflation has been an endogenous variable that is dependent on developments in potential output, aggregate demand, etc.

(ii) Monetary aggregates such as the monetary base, M1, or M2, have never been used as the policy instrument, which has instead been primarily a short-term nominal interest rate; and the regime in force has always been one that implies that money growth expands or contracts in response to real shocks hitting the economy.

[28] Among many examples, see Brunner (1969, p. 27), Friedman and Schwartz (1963b, p. 581), and Schwartz (1969, p. 4). Notably, in comments on the present paper, Milton Friedman writes, "under a flexible exchange rate, money can be exogenous, but again that depends on the monetary policy pursued."

(iii) The fact that money has not been used as the policy instrument has not, of course, implied that the path of money growth is invariant to monetary policy decisions. On the contrary, these decisions imply a pattern of money-growth behavior. For example, for a given path for real shocks, an open market operation undertaken with the aim of raising the policy rate will also slow money growth—in the case of the monetary base, both because the growth rate of reserves is reduced directly, and because households are discouraged from adding to their currency holdings by the higher nominal interest rate. In that sense, the money stock or money growth can be regarded as a "quantity-side" indicator of the monetary conditions put in place by central-bank policy, even when money is not the policy instrument.[29] Of course, fluctuations occur in money growth not related to interest-rate movements; and some of these—e.g. due to changes in the own rate on money or to money demand shocks—will not be of interest to policy, and tend to weaken the value of money as an index of monetary conditions. But other fluctuations—e.g. due to changes in current or prospective movements in aggregate demand or, as argued in Section 3, to changes in yields on alternatives to money beside short-term securities—will tend to improve the value of money as an indicator.

Based on (i) above, the characterization of inflation targeting as corresponding to "exogenous inflation" seems inappropriate; the *target* may be exogenous, and inflation will be stable *ex post* if the target is met, but the target is met through monetary policy decisions, which determine inflation endogenously by offsetting shocks to the output gap and other variables.[30] And from (ii) and (iii), we need not regard money-growth targeting as the only regime in which money growth can serve as a measure of policy stance.

Seemingly anomalous episodes also become explicable under the above quantity-theory interpretation. Woodford (2001, p. 674) characterizes the Korean War period as one where

---

[29] As Goodhart (1987, p. 254) puts it, "a particular level and path for the monetary base impl[y] a given level and path for interest rates, and vice versa." One can cast this relationship in terms of impulse response functions. A contractionary monetary policy shock leads to a declining profile for the impulse response for the money stock and a rising profile for the interest-rate response, regardless of whether the policy rule uses money or the interest rate as the instrument. Similarly, for real shocks that affect the natural rate of interest, one can characterize whether monetary policy is "accommodating" either in terms of the response of money or the response of interest rates to the shock. For example, monetary policy accommodation of a positive IS shock can be characterized either as a flat interest-rate response or as a rise in the money stock.

[30] While, as Poole (1994, p. 95) and Svensson note, a successful strict inflation-targeting regime should lead to a zero correlation between money growth and inflation, there are several grounds for expecting positive and significant correlations between money growth and inflation under inflation targeting in practice (see Batini and Nelson, 2001, p. 388). As discussed in the Section 2.3 above, the conclusion that the two series are uncorrelated empirically in low-inflation countries is unwarranted.

the Federal Reserve had an interest-pegging regime in the face of fiscal deficits. He argues that "the government budget affects the general level of prices, and *only because prices change* does it also affect the money supply (as higher prices result in higher [nominal] money demand, which the Fed passively accommodates under such a regime). Thus one cannot explain the change in the price level as being due to the increase in the money supply." One could say with equal validity: "Under the interest-rate pegging regime, the Fed offsets upward pressure on interest rates by money creation, and *only because the regime is one that permits the money supply to expand* do fiscal deficits create significant inflation." Interest-rate pegging is simply a special case of an interest-rate rule. And the relationship between money and inflation that emerges under an interest-rate rule is just a special case of the quantity theory. As usual, the money-supply path observed is a consequence of central-bank policy.[31]

One final illustration of the pitfalls of reinterpreting the AEMP statement according to monetary regime is provided by Germany's interwar hyperinflation. During that period, the Reichsbank Governor publicly regretted that the authorities were not creating money at the rate required by the needs of trade (Robbins, 1979, p. 57). No doubt, much of the monetary expansion that occurred once the German hyperinflation was in effect *could* be regarded as accommodation by the authorities of higher quantity of nominal money demanded by the private sector. But surely no-one would disagree that the hyperinflation and its continuation were the result of runaway monetary growth.[32]

2.6 Money and inflation: conclusions

1. The proposition that inflation is always and everywhere a monetary phenomenon (AEMP) remains valid in present-day models, and can be applied both to the analysis of inflation dynamics and of the determination of steady-state inflation.

2. The AEMP proposition can be given a similar interpretation irrespective of monetary policy regime.

---

[31] As Allan Meltzer puts it (in October 10, 2002 comments): "For most issues we want to address (as opposed to estimation), it matters very little whether I say: 'The central bank created too much money growth,' or 'The central bank held the interest rate too low for too long and this induced excess money growth.'" See also Meltzer (1976, p. 612).

[32] Milton Friedman (correspondence October 31, 2002) comments that "a comparable and in some ways clearer example is the gold standard," a regime which (as discussed in Friedman and Schwartz, 1982, pp. 325, 626) implies an endogenous money stock, but not a clear-cut direction of causality between money and nominal income.

3. The quantity theory neither justifies, nor relies upon, the presence of explicit terms involving money in the economy's price-setting relations. Evidence that money growth enters significantly when added to empirical Phillips curves suggests misspecification or mismeasurement problems for those equations, rather than a structural role for money.

4. The long-run relation between inflation and money growth is of relevance to central banks in considering the implications of their policies for the steady-state rate of inflation; and this long-run relation does deserve special attention as it has no direct counterpart in the key equations governing inflation dynamics.

The above conclusions are closer to those of Taylor (1992) quoted in the introduction than to most of the recent literature's discussion of money. There is agreement with McCallum (2001) that current models imply a steady-state role for money in the determination of inflation, and, in contrast to Galí's (2002) conclusion, I argue there are grounds for highlighting that role. But McCallum understates the extent to which current models allow inflation dynamics to be modeled using money growth; the inflation dynamics in these models does not amount to a rejection of the quantity theory. Rotemberg and Woodford's (1997, p. 309) description of money as having "no role" in determining inflation in New Keynesian models refers to the absence of explicit terms in money in the IS and Phillips curves; it remains the case that whether policy allows nonmonetary shocks to affect money growth is decisive in determining whether those shocks shift inflation.

Nevertheless, most of the disagreement expressed here with recent discussions of money and inflation is more with the letter than the spirit. Advocates of current models have exaggerated the contrast with an approach that analyzes inflation in terms of money growth. But insofar as a key message of Galí (2002), McCallum (2001), Svensson (1999a, 2002b), and others is that the control of inflation around its steady-state value can be accomplished by a monetary policy framework that does not respond explicitly to monetary aggregates, I would not disagree.[33] There is no merit in Alvarez *et al*'s (2001, p. 219) claim that a "new theory" is required to provide an underpinning for the inflation-targeting frameworks observed in practice.

It has been argued above that recent rejections of the AEMP proposition reflect misinterpretations. The AEMP proposition indicates what a central bank must allow to

[33] As argued above, ensuring that the actual steady-state value of inflation corresponds to the target rate *does* lend itself to a role for money.

happen to money growth in order for inflation to proceed. It does not require a belief that money demand is perfectly stable or that monetary aggregates play, or should play, an explicit role in either price-setting or policy decisions. Appropriately interpreted, it is an uncontroversial proposition, which explains why Mishkin (2001, pp. 671–672)—a critic of giving monetary aggregates a role in policymaking (see Estrella and Mishkin, 1997)—can conclude: "Recognizing that by inflation we mean a continuing increase in the price level at a rapid rate, most economists agree with Milton Friedman that 'inflation is always and everywhere a monetary phenomenon,'" and why Harry Johnson (1975, p. 14) observed of the quantity-theory explanation of inflation, "the monetarists don't have a simple model, they have truth."

3. Money and the transmission mechanism

This section discusses the relationship between monetary policy and aggregate demand, and the implied role for money. Section 3.1 establishes that real balance effects are not an issue of dispute, then Section 3.2 turns to the crucial issue, namely the role that money can play when both aggregate demand and money demand are functions of several interest rates. Section 3.3 provides a brief demonstration of the implications of this role for money in a modified New Keynesian model, while Section 3.4 provides some conclusions.

3.1 Real balance effects

It was argued in Section 2 that the relevance of monetary growth for inflation did not depend on the presence of explicit terms involving the money stock in the Phillips curve. In considering the role of money in the transmission mechanism, we can therefore focus on the aggregate demand side of macroeconomic models. I first consider the following issue: Do theories that emphasize the significance of money for aggregate demand require that terms involving the money stock should be added to the IS function (1)?

Many discussions of monetarist vs. nonmonetarist views of the transmission mechanism do proceed on this basis. As Brunner (1971b, p. 56) observed: "One frequently encounters arguments which juxtapose the Keynesian view centered on the interest rate mechanism with an alternative view centered on the money supply." In particular, both in the literature that Brunner described, and in more recent discussions, many analysts attribute to the monetarist view a belief in the quantitative importance of the real balance effect, i.e. the stimulus to consumption or aggregate demand from the increment to real financial wealth

that occurs when the real monetary base increases. Walsh (1998, p. 213), for example, argues that "[d]uring the Keynesian/monetarist debates of the 1960s and early 1970s, some monetarists argued for a direct wealth effect that linked changes in the money supply directly to aggregate demand." More recently, Andrés, López-Salido, and Vallés (2001), Ireland (2001a), McCallum (2000, p. 883) and Woodford (2002, Ch. 2) have looked at the dependence of the marginal utility of consumption on real money balances.[34] These studies uniformly find that the role for money in the IS equation that arises from nonseparable utility is quantitatively negligible. Similarly, work on the traditional real balance effect in macroeconomic models established that it was unimportant (e.g. Dornbusch and Fischer, 1994, p. 126), owing to the negligible contribution of base money to financial wealth.

Since theory and evidence do not provide support for an important real money balances term in the IS function, is the monetarist view of the transmission mechanism rejected? A careful reading of the work by key monetarists indicates that the answer is no. In this regard, an important distinction must be made between arguing that there are many transmission channels of monetary policy—as Friedman, Schwartz, Brunner, and Meltzer certainly did[35]—and claiming importance for the real balance effect—which they did not. Friedman (1972, p. 947) stated unambiguously, "I never have believed that the real balance effect is of much empirical significance," while Brunner and Meltzer's model of the transmission mechanism was one in which monetary policy can stimulate the economy through means other than short-term interest rates, and "does not depend on the real-balance effect" (Brunner and Meltzer, 1968, p. 29).

In fact, not only was the traditional real balance effect not central to monetarist work, but monetarists also did not claim that terms involving money appeared directly in the structural equations describing aggregate demand determination. Brunner (1971b, p. 56) noted of his model: "The money supply does not even occur as a variable in the system"—i.e., his IS equation contained no explicit term involving money—and this view of the transmission mechanism was shared by other monetarists. Thus Mayer (1978, pp. 7–8), reviewing the monetarist literature, noted that "one can reformulate the monetarist story in terms of the interest rate," while Friedman and Schwartz (1982, p. 58) described monetary

[34] Woodford (2002) interprets this dependence as the counterpart in an infinite-horizon model to the real balance effect. Ireland (2001b), however, derives a distinct real balance effect in an infinite-horizon optimizing model that does not require nonseparability in utility.

[35] As Artis (1993, p. 238) notes, "[t]he monetarist literature of the 1960s is full of suggestions to [the] effect" that "the focus on a narrow set of interest rates unduly restricts the perception of what monetary policy can (and does) do." For specific references, see footnote 6 above.

expansion as "rais[ing] the price of assets and reduc[ing] interest rates," their difference with Keynesian analysis being that "market rates… [are] only a small part of the total spectrum of rates that are relevant" for aggregate demand. The significance of the money stock emerges in this analysis not via a direct real balance effect on aggregate demand, but because money can serve as an index of the "spectrum of rates"—or, as Meltzer (2001, p. 125) puts it, "real money balances capture the many channels of monetary transmission."[36]

Before discussing this role of money in more detail, the key point should be emphasized that a "monetarist" model does not require either the existence of the real balance effect or any explicit term involving the money stock in the IS equation. Similarly, evidence that nonseparability in utility is unimportant does not provide relevant evidence against monetarist views of the transmission mechanism. And the proxy role for money arises from its ability to serve as an index of substitution effects, rather than wealth effects of monetary policy. This emphasis on substitution rather than wealth effects is consistent with present models.

It might nevertheless be noted that the fact that only a single interest rate appears in the IS function, Eq. (1), itself constitutes a rejection of monetarist views of the transmission mechanism. I would, however, argue against this interpretation. Eq. (1) is only a baseline specification; plausible generalizations, such as detailed modeling of physical capital formation, would mean more asset prices appearing explicitly in the model structure. More generally, use of models in which only the short rate appears should not be regarded as a rejection of the empirical importance of multiple transmission channels. Consider, for example, Dornbusch's (1980, p. 71) view that monetary policy has "effects through changes in explicit or implicit real interest rates on aggregate demand." This is a clear endorsement of Friedman and Schwartz's (1963a, p. 61) outline of the transmission mechanism, according to which the interest rates relevant for aggregate demand are a "broad construct, covering explicit or implicit rates on the whole spectrum of assets." Yet in Dornbusch and Fischer's (1994, Ch. 4) exposition of the transmission mechanism, the only interest rate relevant for aggregate demand is the yield on short-term securities. This simply illustrates the principle that, while recognizing many distinct assets "is clearly correct for some purposes…, disaggregation provides benefits but also costs, so two-asset models will often

[36] See also Friedman and Schwartz (1970, p. 126).

prove convenient and satisfactory" (McCallum and Nelson, 1999a, pp. 298–299).[37] For this reason, some monetarist work specifies only a single rate in the IS equation—e.g. Brunner, Cukierman, and Meltzer (1980), where the focus is on aggregate supply behavior.

Another important respect in which Eq. (1) is consistent with the basic transmission channels stressed by monetarists comes through its forward-looking nature. The expected-future-output term in (1) renders expectations of future real short rates—and so the real long rate—relevant for the private sector's current spending decision. In this respect, the model's transmission mechanism is broader than textbook IS-LM analysis in which only the short rate is relevant for spending decisions, and represents a shift in the direction advocated by monetarists. Indeed, this forward-looking property of aggregate demand allows a potentially important role for money as an indicator of macroeconomic conditions. This role for money, however, cannot be separated from the issue of the specification of the money demand function in present models. As I now discuss, this is one area where current models do differ sharply from the specification advocated by monetarists.

3.2 The monetarist transmission mechanism

Accepting that monetary policy exerts effects on aggregate demand by affecting a variety of yields does not, by itself, imply attaching greater significance to the money stock. Under what conditions will monetary aggregates have the properties claimed of them by monetarists—namely that they are a good index of the movements in yields that drive the economy? It is here that New Keynesian models do differ sharply from monetarist analysis, and where the former could most benefit from modification. This section lays out the argument, then Section 3.3 demonstrates its potential quantitative importance by applying the optimal-indicator framework of Aoki (2002) and Svensson and Woodford (2002).

I argue that a vital element of monetarist analysis absent from current models is the money demand function of Friedman (1956), where a spectrum of yields enters the money demand function. This is in contrast to the LM function both of traditional textbook analysis and current models, in which the return on short-term nominal securities is the sole opportunity-cost variable. A Friedman-style money demand function can produce the property that money summarizes monetary conditions not contained in short-term interest rates.

[37] This is also the position of Brunner (1989, p. 210). Anna Schwartz (in December 11, 2002 comments) notes that modern two-asset models do distinguish between nominal and real interest rates, which represents an advance on much of the policy discussion that monetarists criticized in the 1960s and 1970s.

Essentially, if the same spectrum of yields enters both the IS and the LM equations, then the behavior of money could be a useful proxy for the yields.

In the most broad specification of Friedman's demand function, the yields that are relevant for money demand include yields beside those observed in securities markets, such as the returns on physical assets like property (e.g. Friedman and Schwartz, 1982, pp. 39–40, 261, and Laidler, 1982, p. 113). Empirically, this is likely to be an important advantage of money, since monetary aggregates are probably more directly observable than the complete set of yields that matter for aggregate demand. For the present discussion, however, it is useful to concentrate (as in Nelson, 2002) on a version of Friedman's money demand function that differs from the standard LM relation only in emphasizing the nominal return on long-term securities rather than the short-term return as the cost variable.[38] A money demand specification of this form was the baseline empirical specification used by Meltzer (1963), while Brunner (1983, p. 50) argued that the fact that "[a]spects of term structure are explicitly recognized" in Friedman's analysis is a key reason why "[h]is formulation is not subsumable under a Keynesian view of the transmission mechanism."

The Friedman money demand function is decidedly out of favor in current theoretical analysis. Analysis of money demand functions based on optimizing analysis, such as McCallum and Goodfriend (1987) and Lucas (1988), rejects Friedman's specification both in its general form and in the specific form where the long-term interest rate is a relevant opportunity-cost variable. McCallum and Goodfriend argue that Friedman's analysis did not constitute a "formal theory of money demand" (1987, p. 779), and, from their analysis of optimizing behavior in the Sidrauski-Brock model, find the current short rate to be the relevant opportunity-cost variable. Lucas (1988, pp. 142, 150–151) similarly concluded that the only cost variable for money demand should be the current short rate, and that a money demand function incorporating other yields would be nonstructural. Yet this theoretical expectation has been contradicted by the empirical findings of Anderson and Rasche (2001) and Meltzer (1998), who document a close relationship between monetary base velocity and the long-term interest rate in the United States over the twentieth century. These results have been buttressed by Gerlach and Svensson's (2002) finding that the long-term interest rate enters a money demand equation estimated on euro area data. All in all, empirical work documents a robust role for the long-term interest rate in the LM relation.

[38] Early Keynesian work also focussed on the long-term rate, as King (1999, p. 39) notes.

In fact, a money demand function in which the long-term interest rate is the most relevant opportunity-cost variable *can* be justified by optimizing analysis. Modest portfolio adjustment costs imply dynamics in money demand adjustment; and, in an optimizing model, such dynamics imply that expected future short rates, and so the long rate, are relevant for today's money-demand decision. The model used now features such a money demand function.

3.3 Application: the value of money to monetary policy

In Nelson (2002), I showed that a general demand function of the Friedman/Meltzer form conferred on money significant information in predicting output not contained in short-term interest rates.[39] Here I reconsider the information content in money by reexamining my model in light of recent work by Aoki (2002) and Svensson and Woodford (2002) on optimal monetary policy when current private-sector shocks are not observable to the central bank. This focus on the efficient use of information sheds light on the short-run role of money in monetary policy. Stabilization of inflation around target without reference to money is feasible, but is it desirable? Or does attention to money provide information that aids stabilization?

Coenen, Levin, and Wieland (CLW) (2001) and Dotsey and Hornstein (DH) (2001) consider the information content of money using the Svensson-Woodford methods in an environment where current output is not observed. In contrast to these papers, I investigate the optimal commitment policy. There are also fundamental differences between the model specification and information structure employed here and those in CLW and DH. CLW's model, particularly its IS-LM block, is not based on optimizing behavior. In addition, CLW assume symmetric information on the part of the private sector and monetary authority which, as discussed below, is problematic in an optimization-based model. DH assume asymmetric information and their model is optimization-based, but they employ a conventional money demand function such as Eq. (4), according to which the quantity of money demanded is a static or backward-looking function of short-term nominal interest rates and output. Variation in money not associated with current or prior short-rate and output movements is uninteresting noise—money demand shocks—that undermines the value of money as an indicator.[40]

---

[39] In a formal multivariate analysis, Leeper and Roush (2002) produce additional support for this result.
[40] Similarly, the role advocated by Söderström (2001) for money growth depends on money being a linear combination solely of current (or current and lagged) values of the nominal interest rate and nominal GDP.

Suppose, however, that the true money demand function is of the Friedman-Meltzer type. Then some of the variation in money not explicable using standard money-demand functions reflects movements in yields beside current short-rate movements, as well as reactions to expected future income. These variations in money, rather than being noisy money demand shocks, are useful to policymakers because they are informative about future movements in output. I now demonstrate the impact of using a Friedman-Meltzer type money demand specification on the value of money to policymakers.

The model includes Eqs. (1)–(3). The structural equations of the model are completed by the money demand function

$$(m - p)_t = \mu_1 E_t(m - p)_{t+1} + \mu_2(m - p)_{t-1} + \mu_y y_t + \mu_R R_t + \eta_t, \qquad (6)$$

where the forward-looking terms and lags arise from portfolio adjustment costs. Because money does not appear in Eqs. (1)–(3), the model continues to have the standard property of New Keynesian models that money does not enter explicitly as a state variable in the solutions for output and inflation unless policymakers respond to money. Other methods of putting the long-term interest rate into the money demand function would, however, imply an explicit term in money in the households' optimality conditions for optimal bond-holding, and so also in the solution expressions. Suppose we introduced explicit long-term government securities as in Woodford (2001, Sect. 1.3) and, furthermore, allowed for imperfect substitutability between assets. To be specific, suppose that, for prudential reasons, households were unwilling to acquire long-term securities without simultaneously adding to their holdings of base money by a fraction of the increase in bond holdings.[41] Then the expression for wealth in the household's period budget constraint would be augmented by a term such as $f(M_t/B^L_{t+1})$, where $f_1(\bullet) > 0$, M_t is the household's nominal money holding at the end of period t, and B^L_{t+1} denotes nominal long-term bond holdings carried over into t+1; and derivatives of this function would appear in the household's first-order conditions for money and long-term bond holdings. Analogous assumptions could be made about household acquisition of equity, foreign exchange, or other assets. Such self-

[41] That money might serve such a prudential function is in keeping with Friedman and Schwartz's argument that money has a role as a temporary abode of purchasing power separate from its function of facilitating current-period transactions (e.g. Friedman, 1961b, p. 263; Friedman and Schwartz 1970, pp. 112, 125, 137; 1982, pp. 24, 39, 262). In an interview with the present author on January 22, 1992, Friedman expressed the view that the temporary-abode function was more important than the medium-of-exchange function, citing as an example the increases in households' desired real quantity of money during wartime emergencies. This perspective was also clear in a 2001 press interview (Campbell, 2001) in which Friedman observed, "there's no doubt that one of the effects of Sept. 11 will be to increase the demand for cash balances."

imposed "reserve requirements" on households' asset acquisition have the dual effect of bringing these asset yields into the money demand function, as in Friedman (1956), and putting terms involving money into the arbitrage conditions governing asset-price behavior. Thus, a Friedman-style money demand function renders "risk premia" for long-term government debt or foreign exchange functions of the quantity of money, as noted by Brunner (1989, pp. 209–210), King (1999, pp. 39–41) and Meltzer (1999, p. 274). However, to emphasize that the value of money to policymakers does not depend on its presence in the structural equations, I do not make use of this extension and instead use model (1)–(3) plus (6). For present purposes, it is not necessary to depart from the assumption of perfect asset substitutability, as Eq. (6) takes us sufficiently close to a general Friedman-style demand function.

As in Aoki (2002), I use the social loss function:

$$E_t \sum_{j=0}^{\infty} \beta^j [\pi_{t+j}^2 + a(y_{t+j} - y_{t+j}^*)^2], \tag{7}$$

which is consistent with private sector utility maximization (see Woodford, 2002).[42]

With private-sector behavior given by Eqs. (1)–(2) and private-sector shocks known to the central bank, complete stabilization of the output gap and inflation is possible. This can be achieved if monetary policy reacts to lagged information and current shocks in such a way as to make the real rate r_t coincide with its natural value each period. When, however, current shocks are not observable to the monetary authority, complete stabilization is infeasible, as discussed by Aoki (2002) and Svensson and Woodford (2002). The asymmetric-information assumption used in these papers is an attractive one in a representative-agent model where shocks arise from the private sector. Since, as Aoki notes, innovations in potential output y_t^* reflect shocks to private productive capacity, it follows from the representative-household setup that the aggregate potential GDP shock is known to the private sector. And the IS disturbance v_t should certainly be known to private agents, if interpreted as a shock to the household's period utility function.[43]
Following Aoki (2002), I assume that the central bank in period t does not observe current shocks but does have accurate observations on all lagged data and shocks, and, in addition, observes a vector Z_t of "noisy" observations on certain period-t data. In Aoki's framework, Z_t consists of error-ridden observations y_t^O and π_t^O on current log output y_t and inflation π_t.

[42] Utility from real balances is neglected in calculating welfare.
[43] See McCallum and Nelson (1999a, 1999b) for a derivation of Eq. (1) that implies this interpretation of v_t.

I augment this information set by assuming that the central bank can observe current-period nominal money growth Δm_t. Its observation on this variable is without error, but, since the money demand function (6) contains a money demand shock term η_t, money growth is "noisy" from the perspective of extracting information about variables beside money.

As Aoki shows, in this environment, the optimal monetary policy under commitment takes the form:

$$4 \cdot R_t = 4 \cdot r_t^*{}_{|t-1} + \mathbf{r}(Z_t - Z_{t|t-1}) + \Lambda \phi_{t-1} \ , \qquad (8)$$

where $4 \cdot R_t$ is the annualized nominal interest rate, $r_t^*{}_{|t-1}$ is the period $t-1$ expectation of the period-t natural real interest rate,[44] Λ is a vector of response coefficients to the lagged Lagrange multipliers ϕ_{t-1} that appear in the central bank's first-order conditions under commitment, and **r** is a vector of optimal responses to the indicators.

In calibrating the model, I set the money-demand adjustment coefficients to $\mu_1 = 0.47$ and $\mu_2 = 0.48$, in line with my 2002 paper. I set the remaining coefficients to imply long-run scale and interest elasticities of 1.0 and -0.5, and assume a white-noise money demand shock η_t with standard deviation 1%. I follow Aoki in setting the Phillips curve parameters to $\beta = 0.99$ and $\alpha = 0.024$, and the weight a in the welfare function (7) to 0.047. However, Aoki's calibration of the intertemporal elasticity of substitution (σ), based on Rotemberg and Woodford (1997), implies extremely interest-sensitive aggregate demand—out of line with most empirical estimates, and too high to respect a cross-equation restriction which links the IS and money demand elasticities. I use a more moderate value of $\sigma = 0.5$. For the v_t and y_t^* processes, I assume AR(1) parameters of 0.33 and 0.99 respectively, with corresponding innovation standard deviations 1.1% and 0.7%—again, more in line with econometric estimates than are Aoki's choices (see e.g. Ireland, 2001a; McCallum and Nelson, 1999b). Following Aoki, y_t^O and π_t^O are assumed to differ from y_t and π_t by white-noise measurement errors with standard deviations 0.89% and 0.35% respectively.

Using Aoki's (2002) fixed-point algorithm, I obtain the optimal responses in rule (8) to the indicators both in the case $\mu_1 = 0$ and $\mu_1 = 0.47$.[45] These cases have the same impact income and short-rate elasticities for money demand, but in the $\mu_1 > 0$ case, money demand also

[44] An explicit expression for r_t^* (in terms of current v_t and y_t^* and expected next-period y_t^*) is obtained by evaluating Eq. (1) under price flexibility.

[45] An appendix (available on request) describes the generalization of Aoki's solution procedures required to accommodate the endogenous state variable $(m - p)_{t-1}$.

depends on the long rate, and so on an additional interest rate relevant for aggregate demand. The results are given in Table 1. Relative to the $\mu_1 = 0$ case, the optimal response of policy to money growth rises by about a third. In effect, a model specification in which money serves as a proxy for yields beside the short rate has enhanced the value of money to monetary policy, even though this specification has not added money to the structural IS or Phillips curve relationships. In the words of Brunner (1971b, p. 57): "The role of the money stock as an indicator is thus shown to be totally independent from its occurrence as a variable in the system."

Table 1. Optimal coefficients on indicators in interest-rate rule (8)

	Coefficient in **r** response vector on		
	$(\pi_t^O - \pi_{t\|t-1}^O)$	$(y_t^O - y_{t\|t-1}^O)$	$(\Delta m_t - \Delta m_{t\|t-1})$
$\mu_1 = 0$	0.262	3.631	0.170
$\mu_1 = 0.47$	0.262	3.631	0.235

Note: Numbers in the table give the optimal monetary policy responses to news in data on inflation, output, and nominal money growth, both in the case of a standard money demand function ($\mu_1 = 0$) and a function incorporating Friedman-Meltzer features ($\mu_1 > 0$).

3.4 Money and the transmission mechanism: conclusions

1. In contrast to the case of inflation dynamics, where there is no theoretical expectation that money has explanatory power for inflation given the output gap, there are grounds for expecting money to have information about aggregate demand for given short-term interest rates.

2. This expectation is based on the possibility that money might serve as a proxy for a variety of yields that matter for aggregate demand. This indicator or proxy role for money is consistent with monetarist models of the Brunner-Meltzer or Friedman-Schwartz variety. Those authors were clear that in their framework, the structural equations for aggregate demand determination had many relative prices and yields, but no explicit money term.

3. In particular, monetarist models do not insist on the importance or presence of a real-balance or wealth effect of money on aggregate demand.

4. Equally, models in which the only effect of monetary policy is via a short-term interest rate are, by themselves, not inconsistent with the quantity theory, although they may neglect empirically important channels of monetary policy.

5. A key modification to current models that would enhance the role of money is to generalize money demand functions so that, as in Friedman (1956), they include opportunity-cost variables beside the nominal short rate. Such a modification is consistent with empirical work on money demand.

4. Conclusions

The detailed conclusions of this paper are given in Sections 2.6 and 3.4 above. Here I simply observe that for cyclical analysis the most fruitful area in which money can play a greater role is as a proxy for yields that matter for aggregate demand, some of which do not have a ready counterpart in securities-market interest rates. Associated with this is a more general specification of New Keynesian models to include, as in Friedman (1956), a spectrum of cost variables in the household's money-holding decision. The proposed modification does not overturn the legitimacy of concerns about the problems of measuring money in practice. But measurement and instability problems are not isolated to relationships involving money; the IS and Phillips curve relations also involve unobservable shock terms, and it is likely that both the shock processes and the structural parameters in these equations exhibit some nonconstancy. Nor does the contention—which the analysis above has endorsed—that money does not appear explicitly in either the Phillips curve or IS function, justify not bothering to model money. The information imparted to money by its relationship to yields that matter for aggregate demand, gives money value to monetary policy, even when money is absent from the key structural relationships.

References

Alvarez, Fernando, Robert E. Lucas, Jr., and Warren E. Weber (2001). "Interest Rates and Inflation," *American Economic Review* (*Papers and Proceedings*) 91, 219–225.

Anderson, Richard G., and Robert H. Rasche (2001). "The Remarkable Stability of Monetary Base Velocity in the United States, 1919–1999." Federal Reserve Bank of St. Louis Working Paper 2001–08.

Andrés, Javier, J. David López-Salido, and Javier Vallés (2001). "Money in an Estimated Business Cycle Model of the Euro Area." Bank of Spain Working Paper No. 121.

Aoki, Kosuke (2002). "Optimal Commitment Policy under Noisy Information." CEPR Discussion Paper No. 3370.

Artis, Michael J. (1993). "The Role of the Exchange Rate in Monetary Policy: The Experience of Other Countries." In A. Blundell-Wignall (ed.), *The Exchange Rate, International Trade and the Balance of Payments*. Ambassador Press. 208–264.

Artis, Michael J., and Mervyn K. Lewis (1985). "Inflation in the United Kingdom." In V.E. Argy and J.W. Nevile (eds.), *Inflation and Unemployment: Theory, Experience and Policy-Making*. Allen and Unwin. 200–220.

Barro, Robert J. (1982). "United States Inflation and the Choice of Monetary Standard." In R.E. Hall (ed.), *Inflation: Causes and Effects*. University of Chicago Press for NBER. 99–110.

Batini, Nicoletta (2002). "Euro Area Inflation Persistence." Manuscript, Bank of England.

Batini, Nicoletta, and Edward Nelson (2001). "The Lag from Monetary Policy Actions to Inflation: Friedman Revisited," *International Finance* 4, 381–400.

Begg, David, Fabio Canova, Antonio Fatas, Paul De Grauwe, and Philip R. Lane (2002). "Surviving the Slowdown," *Monitoring the European Central Bank* 4, CEPR.

Brunner, Karl (1961). "Some Major Problems in Monetary Theory," *American Economic Review* 51, 47–56.

Brunner, Karl (1969). "The Drift into Persistent Inflation," *Wharton Quarterly*, Fall, 23–34. Reprinted in T. Lys (ed.), *Monetary Theory and Monetary Policy: The Selected Essays of Karl Brunner*, *Volume 2*. Cheltenham, 1997. 142–151.

Brunner, Karl (1971a). "The Monetarist View of Keynesian Ideas," *Lloyds Bank Review* (October), 35–49.

Brunner, Karl (1971b). "A Survey of Selected Issues in Monetary Theory," *Swiss Journal of Economics and Statistics* 107, 1–146.

Brunner, Karl (1983). "Has Monetarism Failed?," *Cato Journal* 3, 23–62.

Brunner, Karl (1989). "The Disarray in Macroeconomics." In F. Capie and G.E. Wood (eds.), *Monetary Economics in the 1980s*. Macmillan. 197–233.

Brunner, Karl (1997). "Selected Shadow Open Market Committee Position Papers, 1979–87." In T. Lys (ed.), *Monetary Theory and Monetary Policy: The Selected Essays of Karl Brunner*, *Volume 2*. Cheltenham. 80–141.

Brunner, Karl, Alex Cukierman, and Allan H. Meltzer (1980). "Stagflation, Persistent Unemployment and the Permanence of Economic Shocks," *Journal of Monetary Economics* 6, 467–492.

Brunner, Karl, and Allan H. Meltzer (1963). "Predicting Velocity: Implications for Theory and Policy," *Journal of Finance* 63, 319–354.

Brunner, Karl, and Allan H. Meltzer (1968). "Liquidity Traps for Money, Bank Credit, and Interest Rates," *Journal of Political Economy* 76, 1–37.

Campbell, Ian (2001). "Friedman Opposes Stimulus Package." United Press International, October 9.

Christiano, Lawrence J., Martin Eichenbaum, and Charles L. Evans (1999). "Monetary Policy Shocks: What Have We Learned and to What End?." In J.B. Taylor and M. Woodford (eds.), *Handbook of Macroeconomics, Vol 1A*. North Holland. 65–148.

Christiano, Lawrence J., and Massimo Rostagno (2001). "Money Growth Monitoring and the Taylor Rule." NBER Working Paper No. 8539.

Clarida, Richard, Jordi Galí, and Mark Gertler (1999). "The Science of Monetary Policy," *Journal of Economic Literature* 37, 1661–1707.

Clouse, James, Dale Henderson, Athanasios Orphanides, David Small, and Peter Tinsley (2000). "Monetary Policy When the Nominal Short-Term Interest Rate Is Zero." FEDS Discussion Paper 2000–51.

Coenen, Günter, Andrew T. Levin, and Volker Wieland (2001). "Data Uncertainty and the Role of Money as an Information Variable for Monetary Policy." ECB Working Paper No. 84.

Coenen, Günter, and Volker Wieland (2002). "A Small Estimated Euro Area Model with Rational Expectations and Nominal Rigidities." CEPR Discussion Paper No. 3574.

De Grauwe, Paul, and Magdalena Polan (2001). "Is Inflation Always and Everywhere a Monetary Phenomenon?" CEPR Discussion Paper No. 2841.

Dornbusch, Rudiger (1980). "Response to Questionnaire on Monetary Policy." In House of Commons Treasury and Civil Service Committee, *Memoranda on Monetary Policy*. HMSO. 69–73.

Dornbusch, Rudiger, and Stanley Fischer (1994). *Macroeconomics*. 6th edition. McGraw Hill.

Dotsey, Michael, and Andreas Hornstein (2001). "Should a Monetary Policy Maker Look at Money?" Manuscript, Federal Reserve Bank of Richmond.

Estrella, Arturo, and Frederic S. Mishkin (1997). "Is There a Role for Monetary Aggregates in Monetary Policy?," *Journal of Monetary Economics* 40, 279–304.

Friedman, Milton (1956). "The Quantity Theory of Money: A Restatement." In M. Friedman (ed.), *Studies in the Quantity Theory of Money*. University of Chicago Press. 3–21.

Friedman, Milton (1961a). "The Lag in Effect of Monetary Policy," *Journal of Political Economy* 69, 447–466.

Friedman, Milton (1961b). "The Demand for Money," *Proceedings of the American Philosophical Society* 105, 259–264.

Friedman, Milton (1963). *Inflation: Causes and Consequences*. Asia Publishing House.

Friedman, Milton (1970). "The Counter-Revolution in Monetary Theory," IEA Occasional Paper No. 33. Reprinted in M. Friedman, *Monetarist Economics*. Blackwell, 1991. 1–21.

Friedman, Milton (1972). "Comments on the Critics," *Journal of Political Economy* 80, 906–950.

Friedman, Milton (1983). "Monetarism in Rhetoric and in Practice," *Bank of Japan Monetary and Economic Studies* 1, 1–14.

Friedman, Milton (1985). "The Fed's Monetarism Was Never Anything But Rhetoric," *Wall Street Journal* (December 18), 29.

Friedman, Milton (1992). *Money Mischief*. Harcourt Brace Jovanovich.

Friedman, Milton, and Anna J. Schwartz (1963a). "Money and Business Cycles," *Review of Economics and Statistics* 45, 32–64.

Friedman, Milton, and Anna J. Schwartz (1963b). *A Monetary History of the United States, 1867–1960*. Princeton University Press.

Friedman, Milton, and Anna J. Schwartz (1970). *Monetary Statistics of the United States*. Columbia University Press.

Friedman, Milton, and Anna J. Schwartz (1982). *Monetary Trends in the United States and the United Kingdom: Their Relation to Income, Prices, and Interest Rates, 1867–1975*. University of Chicago Press.

Galí, Jordi (2002). "Monetary Policy in the Early Years of EMU." Manuscript, Universitat Pompeu Fabra.

Galí, Jordi, and Mark Gertler (1999). "Inflation Dynamics: A Structural Econometric Analysis," *Journal of Monetary Economics* 44, 195–222.

Gerlach, Stefan, and Lars E.O. Svensson (2002). "Money and Inflation in the Euro Area: A Case for Monetary Indicators?" CEPR Discussion Paper No. 3392.

Goodfriend, Marvin (2000). "Overcoming the Zero Bound on Interest Rate Policy," *Journal of Money, Credit, and Banking* 32, 1007–1035.

Goodhart, Charles A.E. (1987). "Comment on 'Monetary Policy.'" In R. Dornbusch and R. Layard (eds.), *The Performance of the British Economy*. Oxford University Press. 253–255.

Haldane, Andrew G. (1997). "Designing Inflation Targets." In P. Lowe (ed.), *Monetary Policy and Inflation Targeting*. Ambassador Press. 74–112.

Harrington, R.L. (1983). "Monetarisms, Real and Imaginary: A Review Article," *Manchester School* 51, 63–71.

Hetzel, Robert L. (1998). "Arthur Burns and Inflation," *Federal Reserve Bank of Richmond Economic Quarterly* 84, 21–44.

Hubbard, R. Glenn (2002). *Money, the Financial System, and the Economy*. 4th edition. Addison Wesley.

Ireland, Peter N. (2001a). "Money's Role in the Monetary Business Cycle." NBER Working Paper No. 8115.

Ireland, Peter N. (2001b). "The Real Balance Effect." NBER Working Paper No. 8136.

Issing, Otmar, Vítor Gaspar, Ignazio Angeloni, and Oreste Tristani (2001). *Monetary Policy in the Euro Area*. Cambridge University Press.

Johnson, Harry G. (1975). "Summing Up." Remarks at Conference on the Monetary Mechanism in Open Economies, Helsinki, August 9. Mimeographed.

King, Mervyn A. (1997). "The Inflation Target Five Years On," *Bank of England Quarterly Bulletin* 37, 434–442.

King, Mervyn A. (1999). "Challenges for Monetary Policy: New and Old." In *New Challenges for Monetary Policy*. Federal Reserve Bank of Kansas City. 11–57.

Laidler, David (1982). *Monetarist Perspectives*. Philip Allan.

Leeper, Eric M., and Jennifer E. Roush (2002). "Putting 'M' Back in Monetary Policy." Manuscript, Indiana University.

Leeper, Eric M., Christopher A. Sims, and Tao Zha (1996). "What Does Monetary Policy Do?," *Brookings Papers on Economic Activity* 27, 1–63.

Lipsey, Richard G., and K. Alec Chrystal (1999). *Principles of Economics*. 9th edition. Oxford University Press.

Lucas, Robert E., Jr. (1980). "Two Illustrations of the Quantity Theory of Money," *American Economic Review* 70, 1005–1014.

Lucas, Robert E., Jr. (1988). "Money Demand in the United States: A Quantitative Review," *Carnegie-Rochester Conference Series on Public Policy* 29, 137–167.

McCallum, Bennett T. (1981). "Price Level Determinacy with an Interest Rate Policy Rule and Rational Expectations," *Journal of Monetary Economics* 8, 319–329.

McCallum, Bennett T. (1990). "Inflation: Theory and Evidence." In B.M. Friedman and F.H. Hahn (eds.), *Handbook of Monetary Economics, Volume II*. North Holland. 963–1012.

McCallum, Bennett T. (2000). "Theoretical Analysis Regarding a Zero Lower Bound on Nominal Interest Rates," *Journal of Money, Credit and Banking* 32, 870–904.

McCallum, Bennett T. (2001). "Monetary Policy Analysis in Models Without Money," *Federal Reserve Bank of St Louis Review* 83, 145–160.

McCallum, Bennett T., and Marvin Goodfriend (1987). "Demand for Money: Theoretical Studies." In J. Eatwell, M. Milgate, and P. Newman (eds.), *The New Palgrave: A Dictionary of Economics*. Macmillan. 775–781.

McCallum, Bennett T., and Edward Nelson (1999a). "An Optimizing IS-LM Specification for Monetary Policy and Business Cycle Analysis," *Journal of Money, Credit and Banking* 31, 296–316.

McCallum, Bennett T., and Edward Nelson (1999b). "Performance of Operational Policy Rules in an Estimated Semi-Classical Structural Model." In J.B. Taylor (ed.), *Monetary Policy Rules*. University of Chicago Press. 15–45.

Mayer, Thomas (1978). "The Structure of Monetarism (I)." In T. Mayer *et al*, *The Structure of Monetarism*. W.W. Norton. 1–25.

Meltzer, Allan H. (1963). "The Demand for Money: The Evidence from the Time Series," *Journal of Political Economy* 71, 219–246.

Meltzer, Allan H. (1976). "The Monetary Approach to Inflation and the Balance of Payments: Theoretical and Empirical Contributions at the Leuven Conference," *Kredit und Kapital Supplement* 3, 579–617.

Meltzer, Allan H. (1977). "Anticipated Inflation and Unanticipated Price Change," *Journal of Money, Credit, and Banking* 9, 182–205.

Meltzer, Allan H. (1981). "Tests of Inflation Theories from the British Laboratory," *The Banker* (July), 21–27.

Meltzer, Allan H. (1987). "On Monetary Stability and Monetary Reform," *Bank of Japan Monetary and Economic Studies* 5, 13–34.

Meltzer, Allan H. (1998). "Monetarism: The Issues and the Outcome," *Atlantic Economic Journal* 26, 8–31.

Meltzer, Allan H. (1999). "Commentary: Monetary Policy at Zero Inflation." In *New Challenges for Monetary Policy*. Federal Reserve Bank of Kansas City. 261–276.

Meltzer, Allan H. (2001). "The Transmission Process." In Deutsche Bundesbank (ed.), *The Monetary Transmission Process: Recent Developments and Lessons for Europe*. Palgrave. 112–130.

Meyer, Laurence H. (2001a). "Inflation Targets and Inflation Targeting," *Federal Reserve Bank of St Louis Review* 83, 1–13.

Meyer, Laurence H. (2001b). "Does Money Matter?," *Federal Reserve Bank of St Louis Review* 83, 1–15.

Mishkin, Frederic S. (2001). *The Economics of Money, Banking, and Financial Markets*. 6th edition. Addison Wesley.

Nelson, Edward (2002). "Direct Effects of Base Money on Aggregate Demand: Theory and Evidence," *Journal of Monetary Economics* 49, 687–708.

Orphanides, Athanasios (2000). "The Quest for Prosperity Without Inflation." ECB Working Paper No. 15.

Poole, William (1994). "Monetary Aggregates Targeting in a Low-Inflation Economy." In J.C. Fuhrer (ed.), *Goals, Guidelines, and Constraints Facing Monetary Policymakers*. Federal Reserve Bank of Boston. 87–121.

Robbins, Lionel (1979). *Against Inflation*. Macmillan.

Rotemberg, Julio J. (1996). "Prices, Output, and Hours: An Empirical Analysis Based on a Sticky Price Model," *Journal of Monetary Economics* 37, 505–533.

Rotemberg, Julio J., and Michael Woodford (1997). "An Optimization-Based Econometric Framework for the Evaluation of Monetary Policy," *NBER Macroeconomics Annual* 12, 297–346.

Rudebusch, Glenn D., and Lars E.O. Svensson (2002). "Eurosystem Monetary Targeting: Lessons from US Data," *European Economic Review* 46, 417–442.

Schwartz, Anna J. (1969). "Why Money Matters," *Lloyds Bank Review* (October), 1–16.

Snowdon, Brian, Howard R. Vane, and Peter Wynarczyk (1994). *A Modern Guide to Macroeconomics*. Edward Elgar.

Söderström, Ulf (2001). "Targeting Inflation with a Prominent Role for Money." Sveriges Riksbank Working Paper No. 123.

Svensson, Lars E.O. (1999a). "Monetary Policy Issues for the Eurosystem," *Carnegie-Rochester Conference Series on Public Policy* 51, 79–136.

Svensson, Lars E.O. (1999b). "How Should Monetary Policy Be Conducted in an Era of Price Stability?" In *New Challenges for Monetary Policy*. Federal Reserve Bank of Kansas City. 195–249.

Svensson, Lars E.O. (2002a). "What Is Wrong with Taylor Rules? Using Judgment in Monetary Policy through Targeting Rules." Manuscript, Princeton University.

Svensson, Lars E.O. (2002b). "A Reform of the Eurosystem's Monetary-Policy Strategy Is Increasingly Urgent." Briefing paper for the Committee on Economic and Monetary Affairs, European Parliament.

Svensson, Lars E.O., and Michael Woodford (2002). "Indicator Variables for Optimal Policy under Asymmetric Information." Manuscript, Princeton University; *Journal of Economic Dynamics and Control*, forthcoming.

Taylor, John B. (1992). "The Great Inflation, the Great Disinflation, and Policies for Future Price Stability." In A. Blundell-Wignall (ed.), *Inflation, Disinflation, and Monetary Policy*. Ambassador Press. 9–31.

Taylor, John B. (1993). "Discretion versus Policy Rules in Practice," *Carnegie-Rochester Conference Series on Public Policy* 39, 195–204.

Taylor, John B. (ed.) (1999). *Monetary Policy Rules*. University of Chicago Press.

Tobin, James (1982). "Money and Finance in the Macroeconomic Process," *Journal of Money, Credit, and Banking* 14, 171–203.

Walsh, Carl E. (1998). *Monetary Theory and Policy*. MIT Press.

Walters, Alan A. (1988). "Monetary and Fiscal Policy in the UK." In W. Eltis and P. Sinclair (eds.), *Keynes and Economic Policy*. Macmillan. 271–294.

Wicksell, Knut (1906). *Lectures on Political Economy, Volume II: Money*. Trans. E. Classen, 1935. Routledge.

Woodford, Michael (2001). "Fiscal Requirements for Price Stability," *Journal of Money, Credit, and Banking* 33, 669–728.

Woodford, Michael (2002). *Interest and Prices: Foundations of a Theory of Monetary Policy*. Manuscript, Princeton University.