How Important is Money in the Conduct of Monetary Policy? A Comment

Bennett T. McCallum

Carnegie Mellon University and NBER

Preliminary

November 6, 2007

Revised July 23, 2008

I am indebted to Marvin Goodfriend, Edward Nelson, and two referees for comments on earlier drafts of this paper.

1. Introduction

There is hardly any issue of a more fundamental nature, with regard to monetary policy analysis, than whether such analysis can coherently be conducted in models that make no explicit reference whatsoever to any monetary aggregate. Since the use of such models has been common—indeed, standard—in recent years, this issue has been considered by several writers including Alvarez, Lucas, and Weber (2001), Lucas (2006), McCallum (2001), Nelson (2003), and Reynard (2006). Most prominently, Woodford (2006) has devoted a full section of his paper for the Fourth ECB Central Banking Conference (on "The Role of Money") to this particular theoretical topic.[1] Woodford's discussion is meticulously executed and, in most respects, convincing but there are, in my opinion, a few significant points that call for elaboration or modification. The following discussion is intended to provide, in a brief manner, the implied amendments.

2. The Basic Result

Consider the following representation of the simplified three-equation framework that has been widely used over the past several years in monetary policy analysis:

(1) $y_t = b_0 + b_1(R_t - E_t\Delta p_{t+1}) + E_t y_{t+1} + v_t \qquad b_1 < 0,\ b_2 > 0$

(2) $\Delta p_t - \Delta p^{avg} = \beta(E_t\Delta p_{t+1} - \Delta p^{avg}) + \kappa(y_t - \bar{y}_t) + u_t \qquad 0 < \beta < 1,\ \kappa > 0$

(3) $R_t = \mu_0 + \Delta p_t + \mu_1(\Delta p_t - \pi^*) + \mu_2(y_t - \bar{y}_t) + e_t. \qquad \mu_1 > 0,\ \mu_2 > 0$

Here y_t and p_t are logs of output and the price level in period t, so $\Delta p_t = \pi_t$ is inflation while R_t is a one-period nominal interest rate. Also, $\bar{y}_t$ is the flexible-price (or "natural rate") level of y_t. Equation (1) represents a forward-looking "expectational IS" function

[1] The majority of Woodford's paper is devoted to empirical issues that are related to, but logically distinct from, this matter of theoretical principle.

of the type that can be justified by dynamic optimization analysis, as is by now very well known. The stochastic disturbance v_t represents the effects of taste shocks and expected changes in the log of government spending; it is assumed to be exogenous, as are the "cost push" and policy shocks u_t and e_t. (All three are generated by mean-zero covariance-stationary processes.) Strictly speaking, a term involving the expected growth rate of real money balances between t and t+1 should also appear in (1), unless the relevant transaction-cost function is additively separable—which is highly implausible. But my investigation (2001), as well as Woodford's (2003, pp. 111-123), indicates that the effects of this term would be quantitatively unimportant.[2] Equation (2) is a price adjustment relation, based on one of the Calvo type, in which Δp^{avg} is the long-run average inflation rate. Thus the specification used here, equivalent to that in Woodford (2006) with one exception to be discussed shortly, is one in which prices (of those firms that do not have the option to re-optimize in a period) rise during that period at the rate Δp^{avg}.[3] For present purposes it will suffice to treat $\bar{y}_t$ as exogenous, as is usually done in small models, although the present argument would not be altered if investment and therefore $\bar{y}_t$ were endogenized.[4]

Finally, (3) represents a policy rule of the Taylor (1993) type, which has the effect of adjusting upward the interest rate R_t when inflation exceeds its <u>target</u> value π^* and/or the output gap is positive. For best performance the central bank will choose the

[2] This finding is consistent with that of Ireland (2004), which is based on a different method—one involving formal econometric testing, rather than calibration.
[3] Other possibilities are briefly discussed below. This arrangement is often referred to as "indexation." I find this term misleading, as it has been traditionally used to denote the use of explicit adjustments for inflation in formal contracts, designed to make these contracts be effectively expressed in real terms, whereas the adjustments in the recent Calvo-related formulations do not involve actual contracts but instead pertain to reference rates of inflation chosen by price setters for their own use in setting non-contractual prices.
[4] For analyses with endogenous investment, see Woodford (2003, 2005).

parameter μ_0 to equal $\bar{r}$, the long-run average real rate of interest, which is implied by (1) to equal $-b_0/b_1$, presuming that that we are abstracting from growth in $\bar{y}_t$ and government consumption.

Clearly, the system (1) – (3) includes no monetary aggregates. Yet it is complete, in the sense that the three relations govern time paths for the three endogenous variables, y_t, Δp_t, and R_t. It would be possible to add to the system a (base) money demand relation such as[5]

$$(4) \qquad m_t - p_t = c_0 + c_1 y_t + c_2 R_t + \eta_t, \qquad c_1 > 0,\ c_2 < 0$$

and doing so would be entirely consistent with standard mainstream analysis, as is fully recognized by Woodford (2006). Nevertheless, this step would be superfluous, from the perspective of explaining the behavior of y_t, Δp_t, or R_t, if (3) governs policy behavior. From that perspective, the only function of (4) would be to specify the amount of base money that is needed to implement the policy rule (3). Thus policy analysis involving y_t, $\bar{y}_t$, Δp_t, and R_t can be carried out without specifying a money demand function such as (4) or collecting measurements on the stock of money.[6]

Nevertheless, in this system, the average rate of inflation $\Delta p^{avg} = E\Delta p_t$ is determined by monetary policy to equal the (distinct) target value π^* that is specified by the interest rate policy rule (3). To see that, begin by applying the unconditional expectation operator to each term in (2), thereby finding average values of zero for $\Delta p_t - \Delta p^{avg}$, $E_t\Delta p_{t+1} - \Delta p^{avg}$, and therefore $y_t - \bar{y}_t$. Then using $E(y_t - \bar{y}_t) = 0$ in the

[5] Here $m_t = \log M_t$, with M_t = the nominal money stock. For present purposes we can think of the latter both as base money and as the relevant monetary aggregate that facilitates transactions.
[6] It would of course be entirely possible that the central bank uses a money supply rule to govern its policy actions, in which case a money demand function such as (4) would be a necessary component of the system.

policy rule (3), we have $ER_t = \mu_0 + E\Delta p_t + \mu_1(E\Delta p_t - \pi^*)$ or $E(R_t - E\Delta p_t) = \mu_0 + \mu_1(E\Delta p_t - \pi^*)$. Then if the central bank sets μ_0 equal to $\bar{r} = E(R_t - \Delta p_{t+1})$, as mentioned above, we have $0 = \mu_1(E\Delta p_t - \pi^*)$. For any positive value of μ_1, then, the average inflation rate will conform to π^* in the steady state. Thus, whatever value the central bank chooses for the target inflation rate π^*, provided that it sets $\mu_0 = \bar{r}$ and $\mu_1 > 0$, the average inflation rate Δp^{avg} will have to conform to π^*, assuming that the behavior of the system is learnable and dynamically stable, which it will be if the policy parameters μ_1 and μ_2 are set to satisfy the Taylor Principle [as explained in Woodford (2003, pp. 252-261)].[7] This result requires, of course, that the central bank has the ability to set R_t as it wishes, a matter that will be discussed below.

As stated above, there is one way in which the system that I have just discussed differs from that used in Woodford (2007). It is that Woodford takes the target inflation rate to be a random walk, rather than a constant. The effect of this is that it becomes inadmissible to take unconditional expectations, as I have done, or indeed use language that refers to average inflation rates, average values of R_t, etc. That makes it possible for an analyst to deny the validity of statements pertaining to average inflation rates, since inflation in this setup is formally nonstationary. But the substance of the argument here is basically the same as in Woodford's, except variations are measured relative to zero in my exposition and relative to the current value of a random-walk variable in Woodford's. As the variance of the innovation in his random walk approaches zero, the difference disappears. And presence of a positive variance is not something that he would recommend to central bankers, I would guess.

[7] Also see McCallum (2003, pp. 1159-1161). My views on the problem of indeterminacy are slightly different from Woodford's, but that issue is a distinct topic from the matter at hand.

3. Amendments

The foregoing section contains essentially the same result as that presented by Woodford (2006, pp. 6-15). His argument is developed somewhat differently but is, clearly, fundamentally similar. Nevertheless, several points need to be noted. First, it is often the case that the standard model is written with the following price-adjustment relation instead of the version (2):

(2') $\Delta p_t = \beta E_t \Delta p_{t+1} + \kappa(y_t - \bar{y}_t) + u_t$

Then if the same analysis as above is conducted it is readily found that the average (steady state) inflation rate will equal $\frac{\pi^*}{1+[\mu_2(1-\beta)/\mu_1\kappa]}$, rather than π^*. In this case the "trend" inflation rate is directly affected by the central bank's inflation target but differs from the latter unless $\pi^* = 0$, as long as $\mu_2 > 0$ and μ_1 is finite, by an amount that also depends upon $(1 - \beta)/\kappa$. It would, in this case, still be possible for the central bank to achieve its desired average inflation rate by means of policy rule (3), but that rate would not equal the "target" rate in (3). This discrepancy was mentioned in McCallum (2001), which developed a result basically similar to that given above.

In this regard, Woodford (2006) mentions the McCallum (2001) paper in the context of an analysis by Edward Nelson, which attributes to McCallum the following significant point: "although no explicit term involving money appears in the above model, …, inflation nevertheless can still be regarded as pinned down in the long run by the economy's steady-state money growth rate (relative to the output growth rate)" (Nelson, 2003, p. 1035). Woodford (2006, pp. 12-13) expresses disagreement with Nelson, contending that McCallum's argument was concerned with the suggestion that the trend inflation rate could be pinned down by the system's price-adjustment relation (such as (2)) alone.[8] In that regard, Woodford is evidently correct—i.e., that is what my referenced argument was discussing, not Nelson's substantive point given in quote marks at the start of this paragraph. But Woodford's argument is presented in a manner that seems to imply that the point being made by Nelson—i.e., that inflation could be regarded as pinned down by the steady state rate of money growth[9]—is itself incorrect. Nelson's substantive point is correct, however, if one ignores the exogenous random-walk component of the target inflation rate and provided that the model under discussion includes a conventional money-demand relationship of the form (4), which is fully consistent with the argument developed by Woodford, as he emphasizes (2006, pp. 14-15). This can be seen from a first-differenced version of (4) as follows. In a steady state, R_t must be constant and the growth rate of output must be constant so the steady state value of $\Delta m_t - \Delta p_t$ can differ from $c_1 \Delta y$ only by a constant amount reflecting technical progress in the transactions technology. Nelson's only "mistake," therefore, was in generously attributing his point to McCallum (whose position in other writings, not cited by Nelson (2003), could be understood to imply such a point).

One reader has asked, in what sense can inflation be regarded as "pinned down by the steady state rate of money growth" if it is determined, as argued above, by the central bank's inflation target? The answer is that the absence of money illusion implied by the private-sector relations (1) and (2) requires that the steady-state values of money growth and target inflation must be consistent with each other. Thus, if the central bank implements policy by means of an interest rate rule like (3), then it is simultaneously

[8] Woodford, Nelson, and McCallum all agree that this suggestion is incorrect.
[9] Relative, of course, to output growth and technical progress in the payments industry.

committing to supply (base) money at a particular average growth rate.[10] That is, π^* and $E(\Delta m_t)$ are intimately related from a long run (steady state) perspective.

4. Modifications

The argument developed in Section 2 presumes that the central bank can, in fact, set the short-term interest rate R_t as it chooses, at least on average. In a monetary economy, with the aggregate M_t serving as a medium of exchange and R_t being the relevant opportunity-cost variable in the demand function (4), that controllability is well established by arguments that rely on the central bank's position as a monopoly supplier of base money. Furthermore, this controllability is well established, even under conditions in which there is very little base money other than currency, by the analysis in Woodford (2001), which utilizes reference to the availability of "channel" systems that involve standing facilities that put both a floor and a ceiling on some short-term rate that will be closely linked to R_t.

However, Woodford (2006) contends that while his analysis, analogous to that of Section 2 above, is consistent with the existence of a money demand function of the type given in (4), this analysis would also be valid for an economy in which there is no money—i.e., a "cashless" economy in which there is no asset that is a generally-accepted medium of exchange serving to facilitate transactions for its holders.[11] Thus, while the model's equations (1)-(3) are consistent with (4), they are also according to Woodford "… compatible with a world in which there is no special role for money in facilitating transactions, and hence no reason for money not to be perfectly substitutable with any

[10] This assumes that the rates of output growth and technical progress in payments are fixed. Similarly, the $E\Delta p_t = \pi^*$ result in Section 2 assumes that $r = -b_0/b_1$ is fixed.
[11] For Woodford, the definition of money in this case becomes the asset that serves as a medium of account (with a specified quantity being the unit of account), not the medium of exchange.

other similarly riskless nominal asset…" (2006, p. 14). Note that the case hypothesized not only rules out (e.g.) household demand for currency, but also banking system holdings of central-bank liabilities that provide clearing (transaction) services to individual banks.[12] In my opinion the claim becomes, in this last case, questionable.

Thus we are concerned now with a case in which advances in information technology have become so extensive that "there is no demand for settlement balances at the central bank because final settlement can be provided by the private sector" (King, 2001, p. 379). Woodford (2001, pp. 254-259) argues that even under such conditions the central bank can control short-term interest rates by varying the rate of interest that it would pay on reserve balances kept at the central bank so that some such balances would be held even if they provided no transaction-facilitating services. In effect, the argument is that the overnight market rate will move together with the central bank's rate on reserves, as a result of the optimality condition for private asset holders that the interbank rate equals the reserve-balance rate plus the marginal service yield on reserves (with the latter equaling zero).[13] Goodfriend (2002, p. 81) reaches a similar conclusion.

The just-mentioned equality is necessary for private optimality, however, only under the proviso that private asset holders choose positive quantities of both of the assets—interbank balances and reserves—in question. While there is little reason to doubt the argument of Freedman (2000), to the effect that in actual practice central banks will continue to be dominant providers of settlement services for the foreseeable future, in principle it is possible that private suppliers would supplant central banks in this

[12] Woodford (2001, p. 254) makes it clear that this is part of his definition of a cashless economy.
[13] This equality is a particular case of a marginal-yield condition stating that for all assets (of equal riskiness) held in positive quantities by private agents, the sum of the marginal pecuniary yield and marginal service yield must be the same.

activity (if, say, some private supplier had more skilled technicians).[14] Then, with respect to that (unrealistic) case, there is one component of Woodford's argument that seems unsatisfactory in principle, namely, his statement that "the unit of account in a purely fiat system is defined in terms of the liabilities of the central bank" (2000, p. 257). Certainly the liabilities of the central bank would be a leading contender for the role of the medium of account (MOA) in an economy with no medium of exchange (MOE), but there is no necessity that it be the one that prevails. Prices will, in a market economy, be quoted in terms of whatever medium market participants find most convenient. Just as central bank currency can be supplanted by some other MOE if its supply is managed too badly (e.g., under hyperinflation conditions), the central bank's contender for the MOA can conceivably lose out to a private challenger. And it is the unit of account actually prevailing in market transactions that is of macroeconomic importance; it is stickiness in terms of prices used in actual transactions that is relevant for the definition of real rates of interest that influence aggregate demand.[15] Thus it is not clear that the central bank can control the interest rate(s) of macroeconomic importance—R_t in equation (1)—in a world in which there is no monetary aggregate that facilitates transactions and hence serves as the dominant medium of exchange and, as a consequence, also becomes the medium of account.[16]

[14] With respect to the realistic situation, Goodfriend's (2002) argument emphasizes that the central bank's role as provider of clearing services is thought to be contestable in practice largely because many central banks pay no interest on reserves, thereby taxing their own product whenever nominal rates are positive.
[15] In this discussion I am taking it for granted that the relevant concept of "price level" in a non-monetary economy is that implied by the MOA. In some writings, I have suggested that the meaning of "price level" is questionable—i.e., needs to be explicitly considered—in an economy with no MOE.
[16] This argument, whose conclusions are somewhat related to those of Benjamin Friedman (2000), does not constitute a claim that the unit of account will not be expressed in terms of a central-bank liability; it is a claim that Woodford (2006) does not establish that it will. The following passage of his from an earlier paper expresses at least partial agreement: "The special feature of central banks, then, is that they are entities the liabilities of which happen to be used to define the unit of account in a wide range [continued]

5. Conclusions

It should be stressed that the foregoing discussion is concerned only with issues involving the coherence of models without money as a matter of theoretical principle; nothing has been said about the relative effectiveness in practice of strategies or operating procedures based on interest rate and monetary aggregate instruments. The investigations in McCallum (2000), despite being somewhat dated, lead me to the tentative opinion that narrow monetary instruments such as the monetary base would probably be superior to interest rates. But that is a different matter, and one much too large to be considered in this note. For the issues at hand, the outline of the argument given above is as follows. (i) In a monetary economy, one with a medium of exchange, the central bank can control nominal interest rates and the long-run average inflation rate can be pinned down by the target inflation rate that enters a Taylor-style rule for the interest rate that the central bank uses as its instrument. With a standard money demand function, however, there must be consistency between this target inflation rate and the average rate of growth of the money supply. (ii) In a non-monetary, cashless economy with no medium of exchange, by contrast, the foregoing claim cannot be made with theoretical assurance because it is not clear that central bank liabilities will serve as the medium of account or, consequently, that the central bank can control the interest rates that are of macroeconomic importance.

of contracts …. There is perhaps no deep, universal reason why this need be so; nor, perhaps, is it essential that there be one such entity per national political unit" (Woodford, 2000, p. 258).

References

Alvarez, Fernando, Robert E. Lucas, Jr., and Warren Weber, 2001. "Interest Rates and Inflation," American Economic Review 91(2), 291-225.

Freedman, Charles, 2000. "Monetary Policy Implementation: Past, Present and Future—Will Electronic Money Lead to the Eventual Demise of Central Banking?" International Finance 3(2), 211-227.

Friedman, Benjamin M., "Decoupling at the Margin: The Threat to Monetary Policy from the Electronic Revolution in Banking," International Finance 3(2), 261-272.

Goodfriend, Marvin, 2002. "Interest on Reserves and Monetary Policy," Federal Reserve Bank of New York Economic Policy Review 8, 77-84.

Ireland, Peter N., 2004. "Money's Role in the Business Cycle," Journal of Money, Credit, and Banking 36(6), 969-983.

King, Mervyn, 2001. "Commentary," Economic Policy for the Information Economy. Federal Reserve Bank of Kansas City.

Lucas, Robert E., Jr, 2006. "Panel Discussion: Colloquium in Honor of Otmar Issing," presented at ECB colloquium "Monetary Policy: A Journey from Theory to Practice." Frankfurt: European Central Bank.

McCallum, Bennett T., 2000. "Alternative Monetary Policy Rules: A Comparison with Historical Settings for the United States, United Kingdom, and Japan," Federal Reserve Bank of Richmond Economic Quarterly 86(1), 49-79.

__________________, 2001. "Monetary Policy Analysis in Models Without Money," Federal Reserve Bank of St. Louis Review 83(4), 145-160.

_________________, 2003. "Multiple-Solution Indeterminacies in Monetary Policy Analysis," Journal of Monetary Economics 50(5), 1153-1175.

Nelson, Edward, 2003. "The Future of Monetary Aggregates in Monetary Policy Analysis," Journal of Monetary Economics 50(5), 1029-1059.

Reynard, Samuel, 2006. "Maintaining Low Inflation: Money, Interest Rates, and Policy Stance," Journal of Monetary Economics 54(5), 1441-1471.

Taylor, John B., 1993. "Discretion versus Policy Rules in Practice," Carnegie-Rochester Conference Series on Public Policy 39, 195-214.

Woodford, Michael, 2000. "Monetary Policy in a World Without Money," International Finance 3(2), 229-260.

________________, 2001. "Monetary Policy in the Information Economy," in Economic Policy for the Information Economy. Kansas City, MO: Federal Reserve Bank of Kansas City.

_________________, 2003. Interest and Prices: Foundations of a Theory of Monetary Policy. Princeton: Princeton University Press.

_________________, 2005. "Firm-Specific Capital and the New Keynesian Phillips Curve," International Journal of Central Banking 1(2), 1-46.

_________________. 2006. "How Important is Money in the Conduct of Monetary Policy?" Presented at ECB conference, "The Role of Money: Money and Monetary Policy in the Twenty-First Century," Frankfurt: European Central Bank. Journal of Money, Credit, and Banking, forthcoming.