UNDERSTANDING THE REMARKABLE SURVIVAL OF MULTIPLIER MODELS OF MONEY STOCK DETERMINATION

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INTRODUCTION

Assuming textbook authors reveal their intellectual and pedagogical preferences and beliefs, a careful survey of the leading intermediate textbooks in money and banking and macroeconomics reveals a uniform and virtually universal consensus -- the multiplier model of money stock determination is widely viewed as the most appropriate and presumably most correct approach to the topic. In the leading seller by Mishkin [1992], for example, three chapters and a total of 64 pages (about 8½ percent of the text) are devoted to the development of the multiplier model. In justifying this extensive treatment, Mishkin argues "the complete model is the basis of much of the money supply analysis performed by practicing economists in the private sector and the government" [1992, 359]. Since such consensus is not, in general, an enduring characteristic of monetary economics, one is tempted to "let sleeping dogs lie." The problem is that the multiplier model, whether viewed from an analytical or empirical perspective, is at best a misleading and incomplete model and at worst a completely misspecified model.

The purpose of this paper is to assess the use and usefulness of the multiplier model from both the point of view of Federal Reserve policymaking, especially with regard to the operations of the Trading Desk, and with regard to ongoing theoretical and empirical work outside the Fed. The basic themes examined and developed can be simply stated: (1) ignoring various institutional and structural "details" has devastating implications for a large body of received theoretical and empirical work and the positive and normative economics which motivates and flows from it; and (2) the devastating implications relate mainly to the short-run (1-6 months) relationships among money, reserves (or the monetary base), and interest rates and do not necessarily contradict the proposition that, in general, the Fed, if it so chose, could control the growth of money within ±1-1½ percent range over a 6-12 month period.

DETERMINING VS. CONTROLLING VS. PREDICTING THE MONEY STOCK

Two familiar identities seem to dominate monetary economics: (1) $MV = Y$ and (2) $M = mB$, where M = the money stock (somehow measured), V = velocity, Y = GNP, B = the monetary base, and m = the multiplier. Some have given new meaning to the term "reduced-form" by combining (1) and (2) into (3) $mBV = Y$. This, along with the assumptions that m and V are "predictable" (i.e., stable stochastic processes), are orthogonal with respect to B and each other, and that B is controllable, implies that $Y = f(B)$. Such expressions have provided the basis for a huge volume of empirical research, including the profession's recent infatuation with vector autoregressions, on such issues as the controllability of money, the relationship between the monetary and real sectors of the economy, the relationship between monetary policy and exchange rates, and the effects of policy-induced uncertainty on the economy [McCallum, 1989, Ch. 16]. The attractiveness of such parsimonious expressions is fairly obvious — they are simple, and thus seemingly more tractable than more complicated setups, and the empirical analysis based on such expressions often tracks the data as well as models with more "structure".

Against this background, I would argue that the literature on monetary control (broadly defined) has stagnated over the past decade. Researchers, who have collectively run all the regressions they can think of, cannot understand why the Fed does not guide policy with their models, while the Fed wonders why researchers persist in framing the problem so naively and incompletely and in overselling the robustness of their results. Perhaps surprisingly, despite the much analyzed "breakdown" in the empirical relationship between money and GNP in the 1980s, I would argue that the problem is not primarily empirical, but rather a reflection of two related issues: (1) the fundamentally different time horizons conditioning analysis inside and outside the Fed; and (2) unresolved analytical issues relating to the importance of structural (allocative) detail, in general, and the determination of the money stock, in particular.

The Multiplier Model

The basic features of the multiplier model are well-known. By definition, $m = M/B$ if the monetary base is the relevant reserve aggregate, or $m = M/R$ if total reserves or nonborrowed reserves is viewed as the relevant reserve aggregate. The analysis then proceeds by deriving algebraically the proximate determinants of the multiplier, such as, the excess reserves ratio, the currency ratio, and the time deposit ratio.[1] In a full-blown general equilibrium setting, such as that provided by Brunner and Meltzer [1990], the ratios, and thus the multiplier, are, in turn, hypothesized to depend on such variables as market interest rates, the rates paid on deposits, wealth, reserve requirements, and the variance of rates and reserves.

Within the portfolio-balance approach to the multiplier and money stock determination pioneered by Brunner and Meltzer, Friedman and Schwartz, and Cagan, the base is assumed to be controllable and exogenous, and thus orthogonal to the multiplier and the determinants thereof. The orthogonality condition, which is perfectly legitimate within the confines of a theoretical model (where setting the covariances equal to zero often facilitates an intuitive discussion of the model's solutions), is crucial for evaluating the empirical work surrounding the multiplier approach. At a somewhat deeper level, the assumed condition flows from the stock-equilibrium theoretical framework and the resulting implication that changes in the short-run flow supply of various assets, including reserves, are generally dominated by the stock of such assets. Accordingly, policy-related changes in reserves, whatever the cause, do not have significant effects on interest rates and asset demands within this framework and thus do not materially affect the various ratios comprising the multiplier.

Given the assumed controllability of the base and the orthogonality restriction, the Fed's ability to control the money stock depends directly on the predictability of the multiplier. Accordingly, researchers have proceeded by modeling the multiplier directly with time series methods or have used such methods to model the component ratios. The resulting time series models are then used along with actual or hypothetical paths for the base to simulate and forecast money stock growth. According to Rasche and Johannes [1987], the findings of such empirical work are clear — the Fed can control the growth of the money stock within a relatively narrow band over a 6-12 month period. Remarkably, these results seem to hold even during periods characterized by substantial financial innovation and deregulation.

The above discussion is presumably quite familiar and needs little elaboration. The questions before us, in light of the many papers which have been written on the multiplier approach, are why does the Fed largely ignore it (the Federal Reserve Bank of St. Louis being a notable exception), and why does it survive?

Critiques of the Multiplier Approach

Critiques of the multiplier approach have seldom been in short supply. The major elements of the critique, many of which are related, are summarized below.

The Multiplier Model is Not Structural, but Rather is a Reduced-Form. First argued by Gramley and Chase [1965], and other adherents to the "New View", such as Tobin [1963], the fundamental question raised was "Is the multiplier model a theory of money *supply*?" If so, a theory of money *demand* is needed to determine the equilibrium money *stock*. If not, then the multiplier approach, and the asset preferences which determine its component ratios, depend directly on money and credit demand and thus implicitly and indirectly on the rate-setting and deposit- and loan-offering functions of depository institutions.

Succinctly stated, the critique emphasizes that the multiplier approach abstracts from the short-run dynamics of adjustment by banks and the public, leaves the role of interest rates implicit rather than explicit, and proceeds on the assumption that movements in the monetary base (or reserves) are orthogonal to fluctuations in the multiplier. The multiplier model, it is argued, implies that deposit expansion is *quantity constrained* through the Fed's control over the *sources* of bank reserves (chiefly, the Fed's portfolio of securities). One of the most forceful and articulate crafters of the critique, Basil Moore, concludes that "as a result, the money-multiplier framework is of no analytical or operational use" [1988, 70].

The consensus view of the staff and policymakers within the Federal Reserve, as revealed in numerous publications [Bryant 1983; Lombra and Kaufman 1984, and references cited therein], embraces much, if not all, of the critique advanced by Moore and others. In particular, the Fed adheres to the view that the system is equilibrated through the movement of interest rates, which, through their effects on banks' revenues and costs, determine banks' and the public's desired asset and liability positions. In this view, money and reserves are "controlled" by using open market operations to affect interest rates which in turn affect demand and thus the *uses* of bank reserves (chiefly, required reserves). The implication, when combined with "the Lucas critique", is that changes in Fed regulations, Fed operating procedures, and the resulting behavior of depository institutions and the public can be expected to alter the process generating the multiplier.

There is little doubt Brunner and Meltzer [1990], for example, recognize that the multiplier is a reduced-form outcome of their rather elegant macro model. Accordingly, they implicitly assume that the myriad of *possible* influences on the multiplier process turn out *in practice* to be rather unimportant. More specifically, the implication is that the relevant time-series models can be easily updated to capture quantitatively important changes in "the rules of the game".

Reserves (and the Monetary Base) in Practice Have Been Endogenously Determined. This contention, which is related to the lagged reserve accounting scheme in effect from September 1968 to February 1984 and the Fed's interest rate operating procedure in effect for virtually the entire post-Accord period, implies the multiplier model is completely irrelevant for the determination of the money supply [Goodfriend, 1982; Hetzel, 1987; Lombra and Kaufman, 1984; 1992; Friedman, 1990].

The effect of lagged reserve accounting, regardless of the operating procedure, is easily illustrated within the following simple weekly model.

(1) $R_t^d = \alpha_0 + \alpha_1 i_t + \alpha_2 M_{t-2} + u_t$

(2) $NBR_t^d = R_t^d - BR_t^d$

(3) $BR_t = \gamma_0 + \gamma_1 (i_t - i_{FR}) + w_t$

(4a) $NBR_t = \overline{NBR}$

(4b) $i_t = \overline{i}_t$

(4c) $BR_t^s = \overline{BR}$

(5) $M_t^d = \beta_0 + \beta_1 i_t + \beta_2 Y + v_t \qquad \beta_1 < 0 < \beta_2$

where
R_t^d = banks' demand for total reserves (during week t)
i_t = "the" interest rate
M_{t-2} = money stock two weeks ago
NBR_t^d = banks' demand for nonborrowed reserves
BR_t = banks' demand for borrowed reserves
i_{FR} = Federal Reserve discount rate
NBR_t^s = supply of nonborrowed reserves
Y = income (assumed exogenous)

Equation (1) is a demand function for total reserves. It reflects banks' demand for required reserves, which is a function under lagged reserve accounting, of the money stock two weeks ago (and, under contemporaneous reserve accounting, a function of the current money stock), and banks' demand for excess reserves, which may be a function of the interest rate (and perhaps other variables impounded in the constant term). Equation (2) is an identity; banks' demand for nonborrowed reserves, which reveals itself in the Federal funds market, is equal to the demand for total reserves minus banks' demand for borrowed reserves. The latter, as shown in equation (3), is determined by the difference between the market interest rate and the discount rate. Equations (4a), (4b) and (4c) depict the three operating strategies utilized by the Fed since 1970: equation (4a), fixing the Federal funds rate (1970 through September 1979, and currently); equation (4b) fixing the supply of nonborrowed reserves over a week (October 1979 through mid-1982); equation (4c) setting an objective for borrowed reserves (late 1982 through late 1980s).[2]

If the Fed is following a funds rate procedure within a lagged reserve accounting scheme, the equilibrium quantity of money, reserves and the interest rate are determined by equations (1), (4b), and (5). In effect, the rate-setting equation (4b) is the money supply function, and thus *within the confines of this model*, the quantity of money and reserves are demand determined.[3] Renormalizing equation (1) to make M a function of R (or the base), as is the case at least implicitly within multiplier models, is a specification error which confounds cause and effect. By construction, reserves are dependent on the error term (u_t), and thus are endogenously determined.

If the Fed is following a nonborrowed reserves procedure within a lagged reserve accounting world, equations (1), (2), (3), (4a), and (5) are relevant. Clearly, within this model there is no simple, direct linkage between the supply of nonborrowed reserves and the money stock. The dynamics work through the demand for borrowed reserves and the demand for money. Of course, the "shock-absorbing" properties of the system do change, with non-zero draws of the relevant error terms having some effect on rates as well as quantities. Nonetheless, the multiplier model, which abstracts from such dynamics and policy-induced changes in the shock-absorbing properties of the system, remains irrelevant to the *determination* of the money stock. Furthermore, the quantity of total reserves (or the monetary base), through the effects of shock-induced changes in banks' borrowings from the discount facility, remain endogenously determined.[4]

Once we move to a multi-week setting, the Fed's reactions to shocks in terms of resetting the target value of their operating instrument is also relevant. A simple representation of such a feedback mechanism within the funds rate operating regime is captured by equation (6), which is, in effect, a dynamic version of equation (4b), given a target for the money stock (M^*).

(6) $i_t = g_0 + g_1 (M - M^*)_{t-1}$

The Fed first sets the interest rate at g_0, where g_0 is derived from equation (5), given a projection for income ($\hat{Y}$), and that $E(v) = 0$.

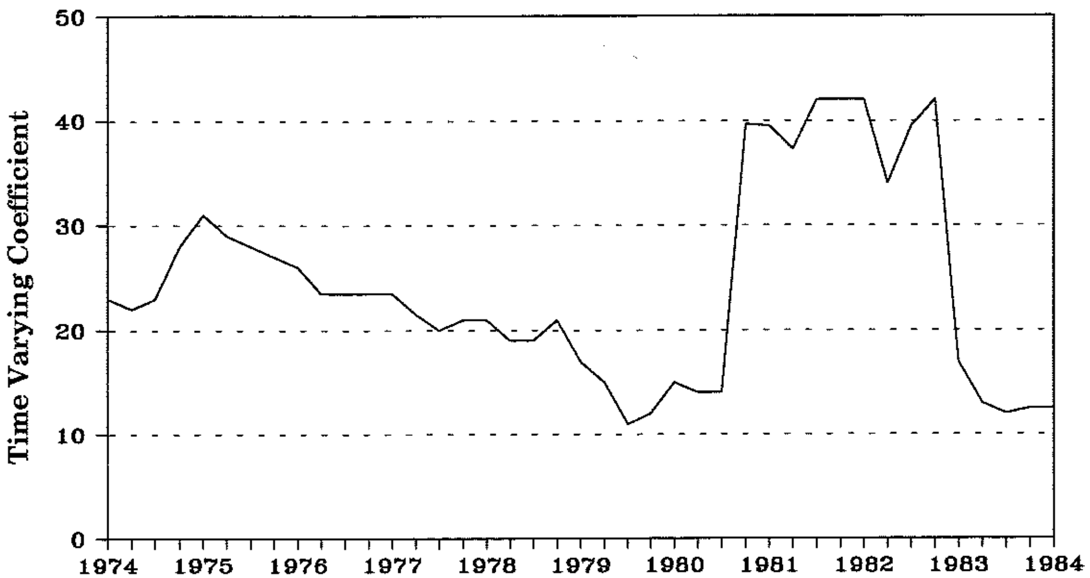
(7) $g_0 = (\beta_o + \beta_2 \hat{Y} - M^*) / \beta_1$

As incoming data suggest the actual money stock is deviating from its target, i_t is adjusted by g_1.

Given that M-M^* *within a week* is by definition the result of unanticipated movements in demand, g_1 determines the degree to which reserve supply responds. Accordingly, *g_1 determines the degree of interdependence between money supply and money demand.* In the limit, either $g_1 = 0$ and the money supply function is perfectly elastic at g_0, or g_1 is large enough to produce a perfectly inelastic money supply function at M^*, and the interest rate is demand determined.[5]

The message is straightforward: the specific operating procedure ("policy rule") employed by the Fed and the reserve accounting regulations governing bank reserve management play a crucial role in determining causal relationships and system dynamics. The fact that the Fed's regulations and operating procedure have changed over time further complicates the econometric challenges facing researchers in this area. To illustrate, Figure 1 [Karamouzis and Lombra, 1989] shows how the g_1 coefficient from

FIGURE 1
Time Varying Estimates of GI



equation (6), estimated using a Kalman filter algorithm, varies over time. More specifically, a one percentage point deviation of money growth from target last quarter elicited a change in the funds rate which varied between 10 and 40 basis points. At a minimum, such variation suggests that fixed-parameter structural models, and even time series models, fitted across different regimes and regulatory structures may not be very reliable.[6]

The typical response to this element of the critique is easily characterized: since the multiplier models continue to predict well, such allocative and institutional detail is relatively unimportant.

The Predictive Accuracy of Multiplier Models is Considerably Overstated. There are several levels to this particular aspect of the critique. *First*, there is some debate over what constitutes a "small" vs. "large" error. More specifically, should the one-month errors be annualized? Should the monthly errors be averaged over several months? Obviously, if the errors are not annualized and tend to cancel out somewhat over a quarter (as seems to be the case), the multiplier model will appear to perform better than otherwise.

Part of the difficulty here relates to the different time horizons or control horizons prevailing in and outside the Fed. Naturally enough, the Trading Desk, for example, is concerned with the here and now and tends to emphasize the difficulty in projecting the factors affecting reserve supply, the often erratic course of banks' demand for excess reserves and borrowed reserves within and across reserve maintenance periods, and more generally, the short-run volatility and associated unpredictability of the multiplier. Put another way, the "long run" on Wall Street, and perhaps even Liberty Street

(the home of the Federal Reserve Bank of New York), often seems much shorter than the horizons conditioning the empirical work and policy evaluations conducted outside the Fed. Needless to say, such differences help to account for the frequent failure to communicate effectively. As Benjamin Friedman once pointed out, critical reactions by policymakers and their staffs to academic work, "at times give the impression that the Federal Reserve can precisely control no variable familiar in the discussions of monetary economists" [1977, 92].

The *second* level of this aspect of the critique is more analytical. It is argued by Lindsey, et al. [1984] and Bryant [1983], for example, that the endogeneity of the base and the multiplier raises serious questions about the robustness and reliability of the empirical work surrounding the multiplier approach. When Lindsey, et al., attempt to correct empirically for the biases introduced by assuming exogeneity and orthogonality within the confines of several alternative models, they find that multiplier models overstate considerably the precision of short-run monetary control. In addition, Bryant [1983, 78] argues against averaging out the resulting large monthly errors because it begs the question of whether the variability of the money stock, and presumably other variables such as interest rates, matter.[7] As Bryant concedes, however, if the policy prescriptions flowing from the multiplier approach are taken to imply that the Fed can control money growth fairly closely over a year or so, then "the deed can be done" [1983, 79].

In the end, this debate is a vivid example of recent discussions about the "rhetoric of economics" — involving, in particular, the realism of assumptions, the use and misuse of signifiance tests, the role of priors, and the relationship between prediction and hypothesis testing.[8] Simply recognizing this helps one distinguish among the competing arguments.

SO WHY DOES THE MODEL SURVIVE?

A decade ago Herschel Grossman wrote an informative paper on the remarkable survival of non-market-clearing models [1983]. In addition to playing off his title, I found it useful to compare the basic thrust of his analysis to that presented above. Basically, he argued that non-market-clearing models survive because the market-clearing approach has not been all that successful empirically and because non-market-clearing models have evolved theoretically to the point where the natural-rate hypothesis and rational expectations are routinely included.

Remarkable parallels are evident in the case of multiplier models of money stock determination as compared to structural models. First, the multiplier models, given the longer time horizons emphasized, have continued to track monetary growth reasonably well [Rasche and Johannes 1987]. Second, and perhaps more importantly, recent expositions of the multiplier model have conceded many of the points raised by the critique. For example, Garfinkel and Thorton conclude "that the multiplier is affected by policy actions suggests that money stock control using the multiplier model would be enhanced by taking the effect of policy actions on the multiplier into account" [1991, 62]. At even a deeper level, consider the following from Brunner and Meltzer [1990,359-393]:

> "Models in which money...is determined exogenously...cannot clarify issues about monetary control" [359]; "...differences in monetary regimes

are associated with differences in supply conditions of the source base" [375]; within an interest rate operating procedure, "...the base replaces the interest rate as an endogenous variable" [390]; "Substantial and persistent reverse causation occurs most often when central banks, under fixed exchange rates or interest rate control policies, supply base money on demand" [393].

Third, the structural approach emphasizing demand-side considerations, which has dominated Federal Reserve analysis of money stock determination, did not hold up well during the late 70s and early 80s — the period of significant financial innovation and deregulation. More specifically, Karamouzis and Lombra [1989] found that the root mean square error for the Fed staff's quarterly M1 forecasts over the 1979-1982 period was 5½ percentage points (at an annual rate), more than twice as large as the projection errors for the 1970s. A major part of the difficulty was at the theoretical level. The dynamic rate-setting behavior of depository institutions, and the likely implications for such rate setting of the confusion between permanent and transitory shocks, emphasized by Brunner and Meltzer, was initially ignored.[9]

Against this background, once one takes account of the Fed's several missions and the resulting focus on the short run, in general, and on the financial system's "plumbing" (e.g., reserve accounting schemes, reserve carryovers, discount window administration, overdrafts, and wire transfers), in particular, the Fed's seeming disdain for the multiplier model is more easily understood.

On the academic side, the simplicity and tractability of the multiplier approach, like that of the Keynesian multiplier (relating changes in national income to changes in autonomous spending) are attractive pedagogically. However, unlike the Keynesian multiplier, which is typically "unlearned" in higher level courses, the money multiplier model lives on with model-builders who are confirmed adherents to the Law of Parsimony and skilled in the use of Occam's Razor. The high correlations and identities so tightly linking reserves (or the base) and money over the longer run provide all the comfort most empiricists need to proceed as if the concerns noted above matter little.

Where does this leave us? If, as Goodhart [1989, 136] claims, "the information content of the multiplier model is remarkably slight," one might be tempted to conclude that the demise of the model as an engine of analysis—empirical as well as theoretical—is inevitable. However, as McCloskey has argued, "the doubting and falsifying method, enshrined in the official version of econometric method, is largely impractical" [1985, 14]. The implication is that here, as elsewhere in the discipline, it is doubtful that the ready availability of data banks, computer terminals, and regression runners, will produce definitive evidence which falsifies the multiplier model.

NOTES

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1. For example, consider a simple case where currency and time and savings deposits are ignored: $R = RR + ER$, $RR = qD$, $ER = eD$, where R = total reserves, RR = required reserves, ER = excess reserves, q = reserve requirement on checkable deposits, $e = ER/D$. Combining the various expressions and rearranging yields, $[(1/(q+e)]R$ where $1/(q+e)$ is "the multiplier." See Rasche and Johannes [1987] and Garfinkel and Thorton [1989] for more complete derivations which take account of the many complexities, including changes in various financial regulations thought relevant to understanding the motion of the multiplier.
2. See Gilbert [1985] for elaboration.
3. Different models would, of course, yield qualitatively different conclusions. For example, explicit consideration of the credit market, as in Brunner and Meltzer [1990], would make the demand for credit as well as the demand for money relevant to the equilibrium solution. Similarly, incorporating a dynamic demand function for borrowed reserves, as in Goodfriend [1983], and expectational effects more generally, would alter the simple solution in the text.
4. The borrowed reserves procedure, in effect to a greater or lesser degree from mid-1982 through the late 1980s, is analogous to the funds rate procedure in terms of the solution for the money stock and the relevance of the multiplier model. More specifically, the Fed "controls" borrowing by "controlling" the spread between the funds rate and the discount rate. Holding the discount rate constant, therefore, the Fed must fix the funds rate.
5. Within the confines of the model developed in the text, $M\text{-}M^* = (\beta_2\epsilon+v) + [g_1(\beta_2\epsilon+v)\beta_1]$ where $\epsilon = Y\text{-}\hat{Y}$. If $M\text{-}M^*=0$ in the face of disturbances, then $g_1=-1/\beta_1$ which is greater than zero since $\beta_1<0$.
6. Cosimano and Jansen [1988] confirm this conjecture in an interesting paper.
7. Lombra and Struble [1979] address some aspects of this problem, as did a Federal Reserve Staff Study of the New Monetary Control Procedure [February 1981]. Neither found much evidence that volatility per se matters. Mascaro and Meltzer [1983], however, do find evidence that volatile monetary growth in the short run, without credible precommitment to a longer-run monetary target, does increase uncertainty and raise long-term interest rates.
8. See McCloskey [1985] for elaboration.
9. See, for example, Davis [1982], and the literature cited therein. Since then, of course, the Federal Reserve Bank of New York and the Federal Reserve Board staff have been at the forefront in analyzing the sluggish adjustment of deposit rates by depository institutions. See, for example, Moore, Porter and Small [1988] and the literature cited therein.

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