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The Multiplier Approach to the Money Supply Process: A Precautionary Note

THE MULTIPLIER MODEL of the money supply, originally developed by Brunner (1961) and Brunner and Meltzer (1964), has become the standard paradigm in macroeconomics and money and banking textbooks to explain how the policy actions of the Federal Reserve influence the money stock. It also has been used in empirical analyses of money stock control and the impact of monetary policy actions on other economic variables.

One important feature of this model is that it decomposes movements in the money supply into the part that is due directly to Federal Reserve policy actions (the adjusted monetary base) and the part that is due to changes in technology and the tastes and preferences of depository institutions and the public (the money multiplier). In this decomposition, the multiplier is assumed to be independent of the policy actions of the central bank. The independence is implicitly predicated on the assumptions that the demands

for both checkable deposits and currency are determined by the same factors, and that individuals can quickly and costlessly alter their holdings of currency and checkable deposits to achieve the desired proportion of the two alternative forms of money.¹ Open market purchases, for example, increase reserves and consequently checkable deposits; but the public simply shifts from checkable deposits to currency until the (unchanged) desired ratio of currency relative to checkable deposits is once again achieved. Because policy actions have no impact on the public's holdings of currency relative to checkable deposits, the multiplier does not depend directly on the policy actions of the Fed.

This article investigates the theoretical and empirical validity of the key feature of the multiplier approach. In theory, the multiplier is independent of the policy actions of the Federal Reserve only if the demands for currency and checkable deposits are determined by identical

¹The notion that the multiplier is independent of Federal Reserve actions—implicit in the work of Brunner and Meltzer (1964, 1968) and, more recently, in Plosser (1991)—has never been demonstrated rigorously with micro-economic principles. The argument presented here that would suggest such independence is implicit in works as early as Fisher (1911).

factors and if, conditional on these factors, these demands are strictly proportional. From an empirical perspective, this condition is necessary but not sufficient; the degree to which the multiplier is influenced by policy actions also depends on the strength of the relationship between policy actions and checkable deposits.

An empirical analysis shows that most of the variability of the observed ratio of currency to checkable deposits is due to variation in checkable deposits, and thereby suggests that the demand for currency is not strictly proportional to the demand for checkable deposits. Prior to the Monetary Control Act of 1980 (MCA), however, the link between reserves and checkable deposits was quite loose—so much so, that the notion that the multiplier is independent of policy actions was operationally valid. Nevertheless, the empirical relevance of this notion has weakened considerably since the implementation of the MCA in the early 1980s. Since then, the relationship between Fed policy actions and checkable deposits and, thus, the multiplier has tightened markedly.

The evidence presented here, that the multiplier is not independent of Federal Reserve actions in the post-MCA period, raises some questions about the appropriateness of using the monetary base as an indicator of the effects of policy actions on the money stock. More important from a policy perspective, it also suggests a modification of the standard approach to money stock control that might yield substantial improvements in effective monetary aggregate targeting.

THE MONEY MULTIPLIER APPROACH: A SIMPLE EXAMPLE

As a starting point for understanding the decomposition of the money supply into the monetary base and the multiplier, note that the narrow money stock, $M1$, is defined as

$$(1) M1_t = TCD_t + C_t,$$

where TCD denotes total checkable deposits and C denotes the currency held by the nonbank public. The monetary base (MB), not adjusted for changes in reserve requirements, is simply the sum of currency and reserves (including

cash in the vaults of depository institutions) in the banking system, R :

$$(2) MB_t = C_t + R_t.$$

Currency, supplied by the Federal Reserve on demand, reflects the portfolio decisions of the public rather than monetary policy actions. Reserves, in contrast, can be affected directly by the Fed's sales or purchases of government securities in the open market.

For simplicity, assume that the Federal Reserve has a simple system of reserve requirements, with required reserves, RR , given by

$$(3) RR_t = rTCD_t, \quad 0 < r < 1,$$

where r denotes the ratio of reserves that must be held against TCD .² A change in the reserve requirement ratio, r , also would constitute a monetary policy action by the Fed.

Furthermore, for simplicity, assume that actual reserves always equal required reserves so that excess reserves are identically zero. With this simplifying assumption, equation 3 can be rewritten as

$$(4) R_t = rTCD_t.$$

The model is completed by assuming that currency is held in some proportion, k , of TCD . That is,

$$(5) C_t = kTCD_t,$$

where the proportion k , hereafter called the k -ratio, is the public's desired ratio of currency to TCD holdings.

Combining equations 1, 2, 4 and 5 produces the monetary base-multiplier representation of the money supply:

$$(6) M1_t = m MB_t,$$

where m , the money multiplier, is given by

$$(7) m = (1+k)/(r+k).$$

According to this representation, a policy action that increases R by one dollar, through open

²Since the Fed eliminated reserve requirements on all non-transaction deposits in December 1990, this representation approximates the current system. For convenience of ex-

position, the discussion to follow abstracts from reserves that depository institutions must hold on government and foreign transactions balances.

market purchases of government securities, increases MB by one dollar and the money stock by m dollars.³

In this representation, policy actions are reflected not only in MB, through changes in R , but in m , through changes in r . With a simple adjustment to MB, however, the effects of policy actions on the money supply can be isolated in one measure. This alternative measure of the monetary base, called the adjusted monetary base, AMB, reflects both changes in R and r . It is constructed by calculating the hypothetical level of reserves that would have been required under the reserve requirements in existence during a chosen base period for the current (actual) level of reservable deposits. With the chosen base period, changes in required reserves due to changes in reserve requirements, r , are added to the monetary base.⁴

Specifically, the AMB is given by

$$(8) \text{AMB}_t = \text{MB}_t + \text{RAM}_t,$$

where the reserve adjustment magnitude, RAM, is defined as

$$(9) \text{RAM}_t = (r^* - r)\text{TCD}_t.$$

This adjustment measures the reserves released or absorbed by changes in r relative to r^* , the required reserve ratio during the base period. In the base period, RAM is zero and $\text{AMB} = \text{MB}$. A decrease in r from its base-period level (r^*) releases reserves into the banking system and thereby increases RAM and AMB. Conversely, an increase in r reflects the reserve drain by reducing RAM and AMB.

Combining equations 1, 4, 5, 8 and 9 yields the following decomposition of $M1$,

$$(10) M1_t = m^* \text{AMB}_t,$$

where

$$(11) m^* = (1+k)/(r^*+k).$$

In this characterization of the money supply process, all changes in monetary policy, through changes in r or R , are reflected in the AMB. Changes in the multiplier reflect only changes in the public's desire to hold currency relative to checkable deposits, changes in the k -ratio.⁵ Because, in this model, the k -ratio is not directly influenced by the policy actions of the Fed, the multiplier is independent of policy.

THE DEMAND FOR CURRENCY, CHECKABLE DEPOSITS AND NEAR-MONIES: WHAT IS THE k -RATIO?

Interest in the currency-deposit ratio dates back to Fisher (1911), who was concerned that the two forms of money had different income velocities. He realized that these two monies are imperfect substitutes: currency is especially useful for making small, "face-to-face" transactions, while checkable deposits provide a convenient means for making large, "out-of-town" transactions.

Fisher reasoned, however, that individuals achieve an "equilibrium" in their holdings of the two forms of money. The notion of a desired or optimal k -ratio is based on the assumption that individuals decide how much of their money holdings they will allocate between currency and checkable deposits, based on both the relative advantages of each in undertaking an individual's planned transactions and their relative holding cost. This ratio was assumed to be a

³Note that because $r < 1$, $m > 1$. If the assumption that excess reserves are not held were replaced by the assumption that they are held in a fixed proportion, e , of TCD, then the denominator of the multiplier would include e as well, so that the multiplier would be smaller than that shown in equation 7.

⁴See Tatom (1980), for example, who discusses the issue of choosing the appropriate base period in light of changes in the structure of reserve requirements. This theoretic discussion focuses on the measure of the adjusted monetary base constructed at the Federal Reserve Bank of St. Louis. See Garfinkel and Thornton (1991) for a more detailed discussion of this measure and a similar one constructed by the Federal Reserve Board.

⁵In a slightly more realistic model, which allows for the fact that depository institutions must hold reserves on govern-

ment and foreign transaction balances, $m^* = (1+k)/(r^*(1+g+f) + k)$, where g and f denote the ratios of government and foreign transactions accounts to TCD, respectively. If, in addition, excess reserves were held, as described in footnote 2, $m^* = (1+k)/(r^*(1+g+f) + k + e)$. These complications can be ignored, however, because movements in the observed ratio of currency to TCD explain most of the movements in the multiplier, as will be discussed shortly.

function of a number of economic and social variables.⁶

Given these variables, the demands for currency and checkable deposits were thought to be strictly proportional to each other. Moreover, because individuals are free to adjust their holdings of the two monies quickly and costlessly, it was assumed that the actual currency-deposit ratio would deviate from the desired ratio for only a short period of time.⁷ According to this line of reasoning, all changes in the observed currency-to-deposit ratio, denoted here by the K-ratio, are to be interpreted as changes in the desired ratio caused by one of these factors. While not numerically constant, as it was assumed to be in the previous analysis, the k-ratio was viewed as not being directly affected by monetary policy actions.

The following discussion, supported by subsequent empirical analysis, suggests, however, that the observed ratio of currency to checkable deposits can be and has been affected directly by the policy actions of the Federal Reserve.⁸ This effect can emerge without changing the relative advantages of currency and checkable deposits or their relative holding cost.

Substitutability, Holding Costs and the Optimal k-Ratio

There are a number of reasons why one might question the assumption that changes in the observed currency-to-deposit ratio necessar-

ily reflect changes in the optimal k-ratio—that is, changes in the relative holding cost and advantages of currency and checkable deposits. First and perhaps foremost among these is that the demand for either of these forms of money might depend on a number of special factors that are unrelated to the demand for the other. Thus, changes in the relative advantages of these two forms of money might not be empirically important in explaining changes in the ratio of currency to checkable deposits.

For example, many believe that currency has no rival for illegal transactions. The same is true for foreign demand for U.S. currency by countries that need “hard currencies” for their domestic transactions.⁹ To the extent that currency is held for these reasons, independent of factors that determine the demand for checkable deposits, policy actions can induce changes in TCD without affecting currency demand. Consequently, policy can alter the ratio of currency to TCD and, hence, the multiplier.¹⁰

One might also argue that changes in the relative holding cost of the two monies are not especially relevant for explaining observed changes in the currency-to-deposit ratio. The relative holding cost of the alternative monies is given by the difference between the rates of return on the two forms of money.¹¹ The return on holding currency is zero.¹² Although non-interest-bearing checking accounts (demand deposits) have an explicit return of zero, they can yield a

⁶Fisher assumed that the optimal k-ratio depended on real income or wealth, the degree of development of the business sector, population density, relative holding costs and custom and habit. (Checkable deposits were thought to be “superior” to currency, although money in any form was a superior good.) Cagan (1958) extends the list of determinants of the k-ratio considerably. Both he and Hess (1971) attempt to quantify the effects of such factors.

⁷Cagan (1958) recognized that, at times, restrictions might prevent the adjustment of the currency ratio. He explicitly considered the case of financial crises where banks suspended convertibility. He noted, “At these times individuals could not exchange deposits for currency, and the desired currency ratio undoubtedly exceeded the actual ratio...” Without such restrictions, however, individuals are free to adjust their currency holdings to the desired level very quickly and at a low cost.

The assumption that there exists a desired currency-to-deposit ratio and that individuals adjust their actual holdings of currency to their desired level was made operational for models of the money supply process by Karl Brunner and Allan Meltzer in a series of articles. See Brunner (1961) and Brunner and Meltzer (1964, 1968).

⁸It has long been recognized that policy actions can have an indirect effect on the multiplier through the presumed

effect of policy actions on economic variables such as real income or interest rates. It is argued that such variables influence the k-ratio or the other ratios that make it up—particularly, the ratio of excess reserves to total checkable deposits. See Mishkin (1989) for a more detailed discussion of this indirect effect.

⁹Because it is difficult to account for a relatively large amount of the total stock of U.S. currency outstanding, one should not be too surprised to find that, in the aggregate, demand for currency and checkable deposits are not closely related. See, for example, Avery, Elliehausen, Kennickell and Spindt (1986, 1987).

¹⁰This potential influence is illustrated below with an example. To be sure, longer-run movements in the K-ratio might be attributable to some factors that affect the relative advantages for the two forms of money.

¹¹The discussion to follow focuses on the nonbank public's perspective. The relative holding costs to depository institutions generally will differ.

¹²Adjusted for inflation, it is minus the expected rate of inflation. Note that currency used for illegal transactions yields a greater return because of the tax avoidance. For foreigners, currency can yield a return that differs from zero due to the appreciation or depreciation of their home currency relative to the U.S. dollar.

positive implicit return—for example, free toasters for new customers, subsidized accounting and payment services, etc. The return on holding interest-bearing checking accounts is the net interest paid on these accounts plus free payment services.¹³

The relative holding cost of currency and demand deposits, however, is unresponsive to movements in market interest rates because the explicit returns to both assets are identically zero. Surprisingly, the same seems to be true for currency and interest-bearing checking accounts, even since the elimination of Regulation Q ceiling rates in 1986. Interest rates paid on interest-bearing checkable deposits included in TCD have been unresponsive to movements in short-term interest rates.¹⁴ Despite the fact that the explicit holding cost of currency relative to that of checkable deposits has changed little, the observed ratio of currency to checkable deposits exhibited sharp swings during the 1980s. Thus, it is unlikely that changes in the public's holding of currency and checkable deposits are due primarily to changes in their relative holding cost.

The Holding of Currency, Checkable Deposits and Other Financial Assets

Thus, it would not appear that individuals simply shift their money holdings between currency and checkable deposits in response to variations in their relative advantages or holding cost. This conjecture would be reinforced by the fact that currency and especially checkable deposits are substitutes for other "near-money" stores of wealth, for example, money market mutual funds. From this broader perspective, the demands for currency and checkable depos-

its are seen as being determined simultaneously with the demand for near-money assets.¹⁵

An important part of the determination of the ratio of currency to checkable deposits, therefore, is the degree of substitutability between currency and demand deposits on the one hand and between each of these money assets and near-money assets on the other. Although the explicit rates paid on TCD are relatively unresponsive to changes in market interest rates, rates paid on near-money assets can vary markedly with variations in other market interest rates. The effect of these variations on the proportion of M1 held in the form of currency, of course, depends on the degree of substitutability between near-money assets and the two forms of money. If currency is a relatively poor substitute for such assets while TCD is a relatively good one, the ratio of currency to TCD will change with changes in rates paid on such near-money assets because of changes in TCD.

The relevance of this substitutability between TCD and other near-money assets appears to have been heightened by the nationwide introduction of interest-bearing checking deposits in January 1981. Since then, the cross-price or interest elasticity of the demand for checkable deposits has increased. This increase is hardly surprising because the payment of interest on checkable deposits has made them closer substitutes for interest-bearing time and savings deposits. Indeed, some evidence suggests that individuals have shifted a significant portion of their "savings" balances into interest-bearing checking accounts.¹⁶ Because these saving balances are substitutes for savings and money market accounts that have higher explicit returns, the interest elasticity of the demand for checkable deposits should have risen, while the interest elasticity of currency demand should not have changed.¹⁷

¹³Net interest is interest net of service charges. For a discussion of these, see Carraro and Thornton (1986). This explicit return also could be adjusted for inflation.

¹⁴Indeed, interest rates on the interest-bearing portion of TCD, called other checkable deposits (OCD), have changed little during the 1980s. The rate on OCD fluctuated between 5 percent and just over 5.5 percent during our sample period.

¹⁵This consideration raises a fundamental question—namely, what constitutes an appropriate monetary aggregate? In theory, monetary aggregation requires the "monetary" aggregate to be "weakly separable." That is to say, it must behave as a fundamental commodity with respect to consumption and other financial assets. There can be substitution between assets that compose the aggregate, but not between those that compose the aggregate and

those that do not. Some evidence suggests that, while currency and demand deposits satisfy this condition for weak separability, these two assets plus interest-bearing transaction balances do not. See, Fisher (1989), for example. Belongia and Chalfant (1989), among others, however, find that the data are consistent with the notion that the assets included in M1 and a grouping broader than M1 (currency and total checkable deposits) satisfy the weak separability condition. Thus, the empirical results in this line of research are not conclusive.

¹⁶See Sill (1990).

¹⁷See Thornton and Stone (1991) for a derivation of this result. These results are borne out empirically by simple linear regressions of the monthly change in both currency and other checkable deposits on a scale measure and the three-month T-bill rate.

Thus, changes in interest rates, whether policy induced or not, can have an asymmetric effect on the demands for currency and checkable deposits, with a direct effect on the proportion in which the alternative monies are held.¹⁸ Although this asymmetric effect is likely to have played a larger role since the introduction of interest-bearing checking accounts in generating fluctuations in the ratio of currency to TCD, policy has induced changes in this ratio more directly since the MCA (as discussed below).

DEPOSIT SUBSTITUTION AND THE MONEY MULTIPLIER

Provided that the demands for currency and checkable deposits are determined by factors that are independent of one another, monetary policy actions can have a direct influence on the relative holdings of each and, thus, the multiplier.¹⁹ The channel of influence is most easily illustrated in the extreme case where the demand for currency is completely independent of the demand for checkable deposits. That is, equation 5 is replaced with

$$(5') C_t = C,$$

where C is a constant. Equation 1 also can be rewritten as

$$(1') M1_t = (1 + K_t)TCD_t,$$

where, as defined previously, $K_t = (C/TCD)_t$ is the observed ratio of currency to TCD.²⁰

Using equations 1' and 5' in place of 1 and 5, the money supply can be written as

$$(12) M1_t = m_t^{*'} AMB_t,$$

where $m_t^{*'} = [(1 + K_t)/(r^* + K_t)]$.

The crucial difference between this expression and equation 10 is that, here, policy actions af-

fect both the adjusted monetary base and the money multiplier. To see why, consider a policy action involving the purchase of T-bills in the market by the Fed. This policy action increases the stock of reserves and, assuming zero excess reserves, TCD. In the earlier formulation of his model, the K -ratio was assumed to be unchanged; the increase in TCD would be accompanied by a proportionate increase in currency, so that the observed ratio of currency to TCD, K , would not change. Thus, the effect of this policy action on the money stock would be isolated in the monetary base—the multiplier would be unaffected.

In the modified model, however, TCD increases while currency is constant. Consequently, the K -ratio falls and the multiplier, $m^{*'}$, rises. In this instance, the change in monetary policy is reflected both in the adjusted monetary base, because of a change in R , and in the multiplier because of a policy-induced change in K . Although this argument is made in terms of a static model, the main point, that policy can influence the multiplier, would carry over into a more realistic dynamic model. Two of the more salient features of the longer-run consequences of this analysis are taken up in the shaded insert on page 54.

THE RECENT BEHAVIOR OF THE K-RATIO

Figure 1 shows the K -ratio and the observed adjusted monetary base multiplier, $M1/AMB$, from January 1970 to November 1990. Note that the multiplier is essentially the mirror image of the K -ratio; the K -ratio accounts for much of the multiplier's short-run (month-to-month) variability and for the significant shifts in its longer-run "trends." Indeed, as shown in table 1, changes in the K -ratio alone explain over 80 percent of the month-to-month variability in

¹⁸The same would be expected for changes in the level of income. Indeed, Hess (1971) presents estimates indicating asymmetric effects of both changes in interest rates and income on the demands for currency and checkable deposits. It should be emphasized that this effect of changes in interest rates on the k -ratio is not the same as that which was alluded to earlier—i.e., through the relative holding cost of currency and checkable deposits (see footnote 8).

¹⁹Many researchers who have estimated currency demand equations have abstracted from the relationship of currency to TCD. For example, see Hess (1971) and Dotsey (1988).

²⁰Because k is meaningless in this formulation, K_t will not equal k . More generally, currency demand can be thought of as having two components, one related to TCD as embodied in the k -ratio and the other unrelated to TCD. That is, $C_t = C + kTCD_t$. In this more general formulation, the k -ratio is determined solely by the relative holding cost of currency and TCD and the substitutability between them as discussed above.

In this case, $K_t = \frac{C}{TCD_t} + k$. The restriction in (5'),

that $k=0$, is imposed only for illustrative purposes.

Figure 1
The K-Ratio and the M1 Multiplier
 January 1970-November 1990

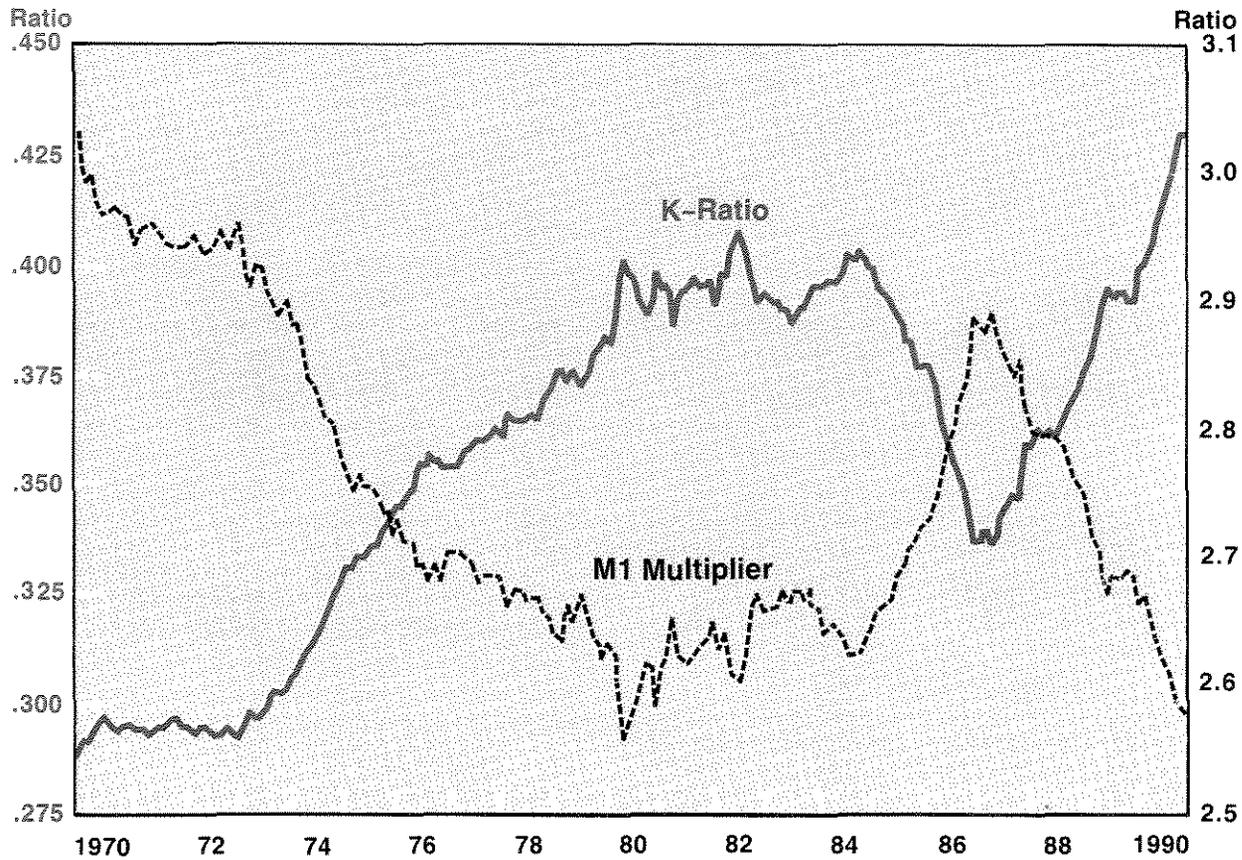


Table 1

Regression Estimates of Changes in the Multiplier on Changes in the K-ratio

Period	Constant	K-ratio	SEE	\bar{R}^2	D.W.
1/1970-12/1980	.000 (0.35)	-4.355* (13.94)	.007	.598	2.47
1/1981-11/1990	.001 (1.84)	-3.714* (23.02)	.005	.818	2.49
3/1984-11/1990	.001 (1.35)	-3.504* (21.66)	.004	.854	3.02

* indicates statistical significance at the 5 percent level.
 Absolute values of t-statistics are in parentheses.

The Long-Run Multiplier?

That the K-ratio does not appear to be stationary (in the sense of being mean-reverting) raises an interesting question of how the magnitude of the multiplier is determined in the long run. Two examples are presented to show that the multiplier is not invariant to monetary policy and the "long-run multiplier" is critically dependent on the specifications of the demands for currency and TCD.

The first example assumes that the demand for real currency is determined solely by real income, while the demand for real TCD is determined both by real income and the nominal interest rate, where TCD is inversely related to the latter. This example captures the notion that the demand for TCD is determined simultaneously with the demands for other near-monies. For simplicity, these demands are assumed to be linear in natural logs, and the income elasticities of the demands for currency and TCD are assumed to be equal. Under these assumptions, the natural log of the K-ratio, $\ln K$, depends solely on the natural log of the nominal interest rate and is positively related to it. By influencing the nominal interest rate, which equals the real rate plus a premium for expected future inflation, monetary policy would affect the long-run multiplier.

To see why, assume that a change in policy raises reserve growth permanently. If this increase results in a permanent increase in the actual and anticipated rates of inflation, the nominal interest rate will rise. The permanently higher level of the nominal interest rate will increase the level of the K-ratio causing a permanent reduction in the multiplier.

The second example assumes that the demand for currency is driven largely by forces external to the domestic economy, say, foreign demand for U.S. currency. It also assumes that the domestic demand for currency is determined solely by the relative holding cost of currency vs. TCD and that this cost is constant. Again, these relationships are assumed to be linear in the natural

logs. If the foreign demand grows at a constant rate, b , then the log of the demand for currency is given by

$$\ln C_t = b t + h \ln TCD_t,$$

where t denotes a time trend and h is a constant.¹ What happens to the the K-ratio in the long run is determined by the relative growth rates of foreign and domestic demands for currency. For example, assume that the demand for nominal TCD is determined solely by nominal income and that nominal income grows at a constant rate, d —at least in the long run. If d is less than or equal to $b/(1-h)$, the K-ratio will rise without bound and the multiplier will approach unity. If d is greater than $b/(1-h)$, the K-ratio will approach zero and the multiplier will approach $1/r^*$, where r^* is the base-period reserve requirement (see the text for more details).

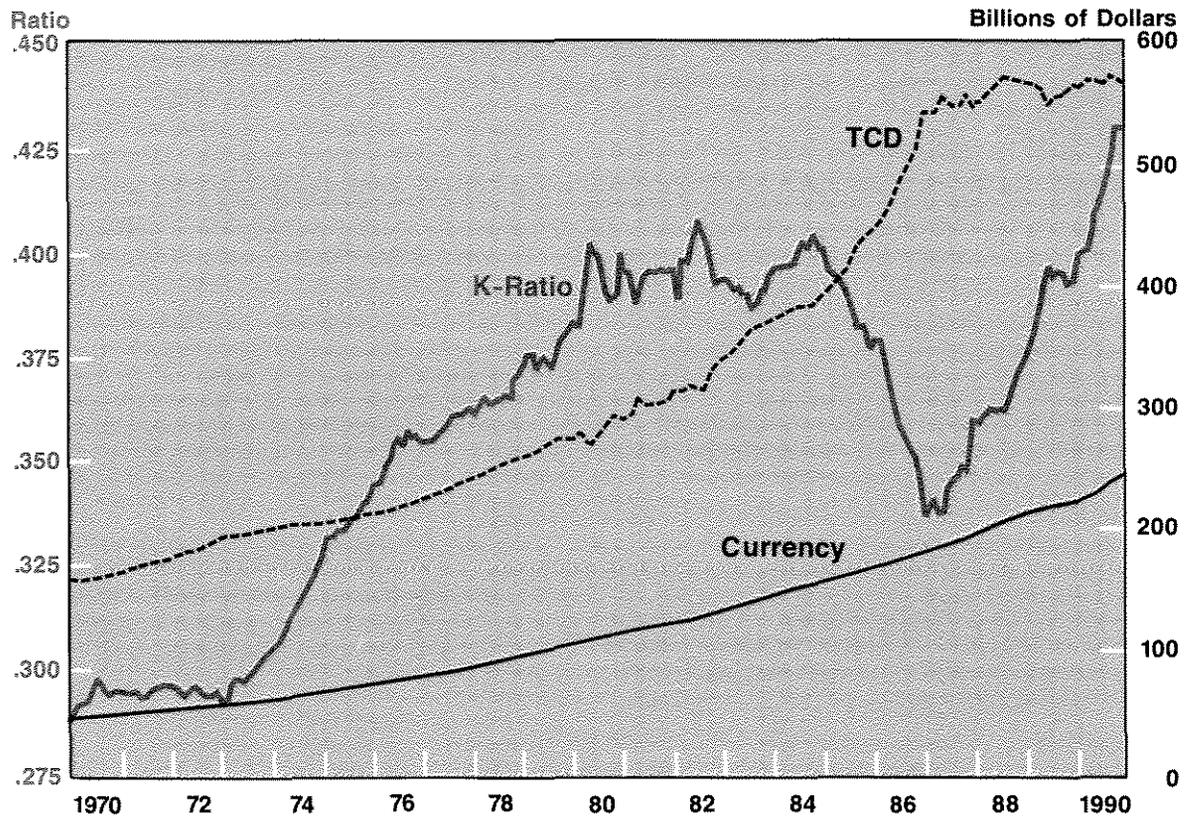
Note, however, that, in this example, the long-run multiplier is not independent of policy actions. For example, assume that $d > b/(1-h)$ so that the multiplier is approaching $1/r^*$. Now assume that a change in policy reduces the growth rate of TCD and, thus, the rate of inflation and the growth rate of nominal income. At the very least, this policy change would cause the multiplier to approach its long-run equilibrium value more slowly, as it drives down d . Indeed, if the growth rate of TCD slowed to the point where $d < b/(1-h)$, the long-run multiplier could converge to 1 rather than $1/r^*$.

Of course, there are a number of other interesting possibilities. The major points that, even in the long run, the multiplier depends on monetary policy and that the exact value of the long-run multiplier between 1 and $1/r^*$ depends critically on the specifications of the demands for currency and TCD are nonetheless valid. Before a meaningful "long-run" representation of the multiplier can be obtained, it is necessary to specify carefully both the demand for currency and the demand for TCD.²

¹The parameter h might be thought of as the log of the optimal k-ratio, reflecting only the relative advantages and costs of currency and TCD.

²Note that, because the multiplier is bounded, M1 and AMB must be cointegrated.

Figure 2
The K-Ratio, Currency and TCD



changes in the multiplier since the implementation of the MCA.²¹ The MCA tightened the link between the K-ratio and the multiplier by reducing or eliminating other sources of variation in the multiplier.²² While the MCA was implemented in a series of steps from November 1980 to September 1987, its major features were almost fully implemented by February 1984.²³ Since then, changes in the K-ratio alone explain over 85 percent of changes in the multiplier.

The Relationship Between Total Checkable Deposits and the K-Ratio

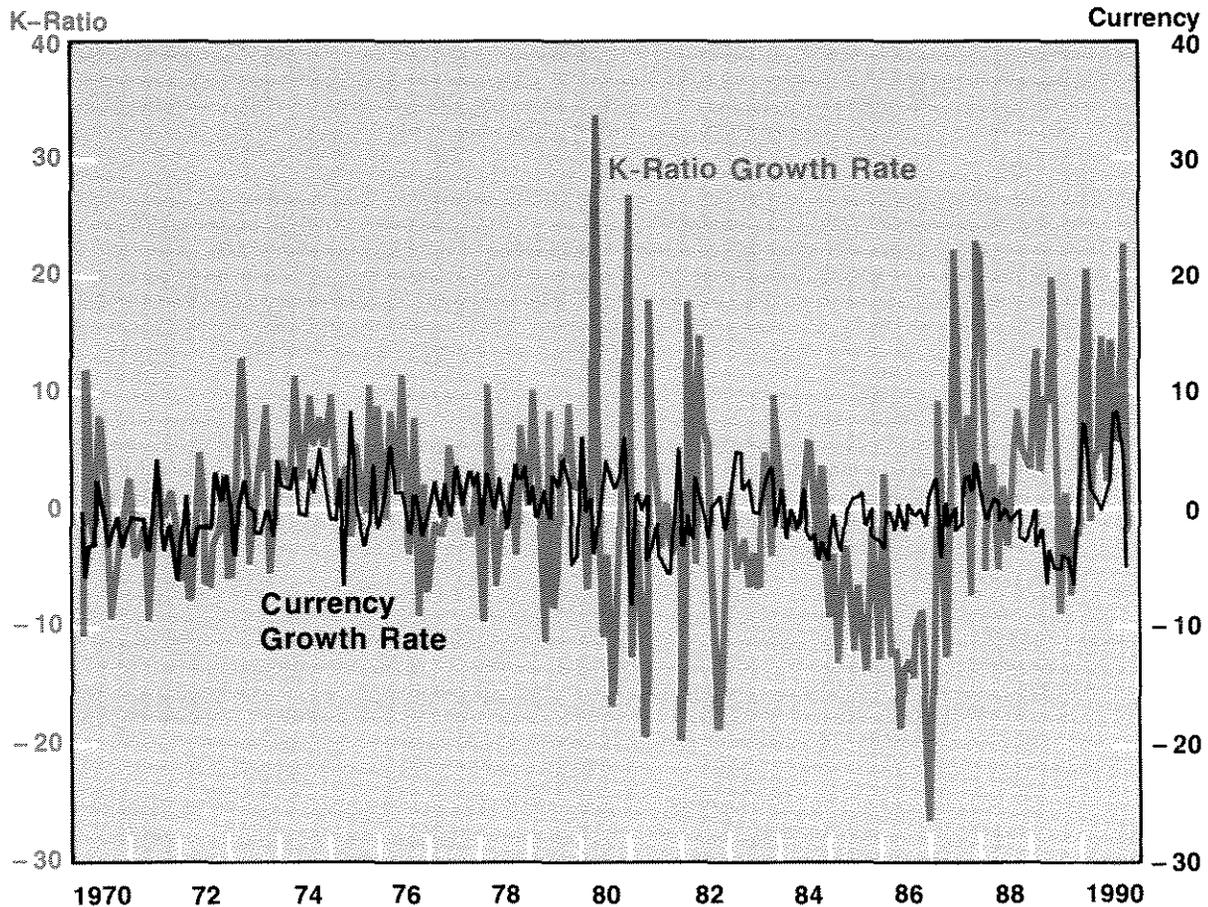
Figure 2 shows the K-ratio, currency and TCD. The behavior of these series suggests that changes in the trend of the K-ratio are associated more closely with changes in the trend of TCD than with changes in the trend of currency growth. For example, the sharp rise in the

²¹The Durbin-Watson statistic for each of the equations indicates significant, negative first-order serial correlation. Because we are primarily interested in the explanatory power of changes in the K-ratio as measured by the adjusted R-square, however, maximum likelihood estimates of the equations adjusted for serial correlation are not reported here. Nonetheless, there are no substantive differences between the maximum likelihood estimates and those reported in table 1.

²²See Garfinkel and Thornton (1989) for details.

²³The MCA was first implemented in November 1980 and was fully phased-in by September 1987. The empirically significant features of the act were completed with the Fed's adoption of contemporaneous reserve requirements in February 1984, so the sample was broken at this point. See Garfinkel and Thornton (1989) for a discussion of these changes and their effect on the multiplier.

Figure 3
Deviations of the Growth Rates of the K-Ratio
and Currency from Their Means
 January 1970 thru November 1990



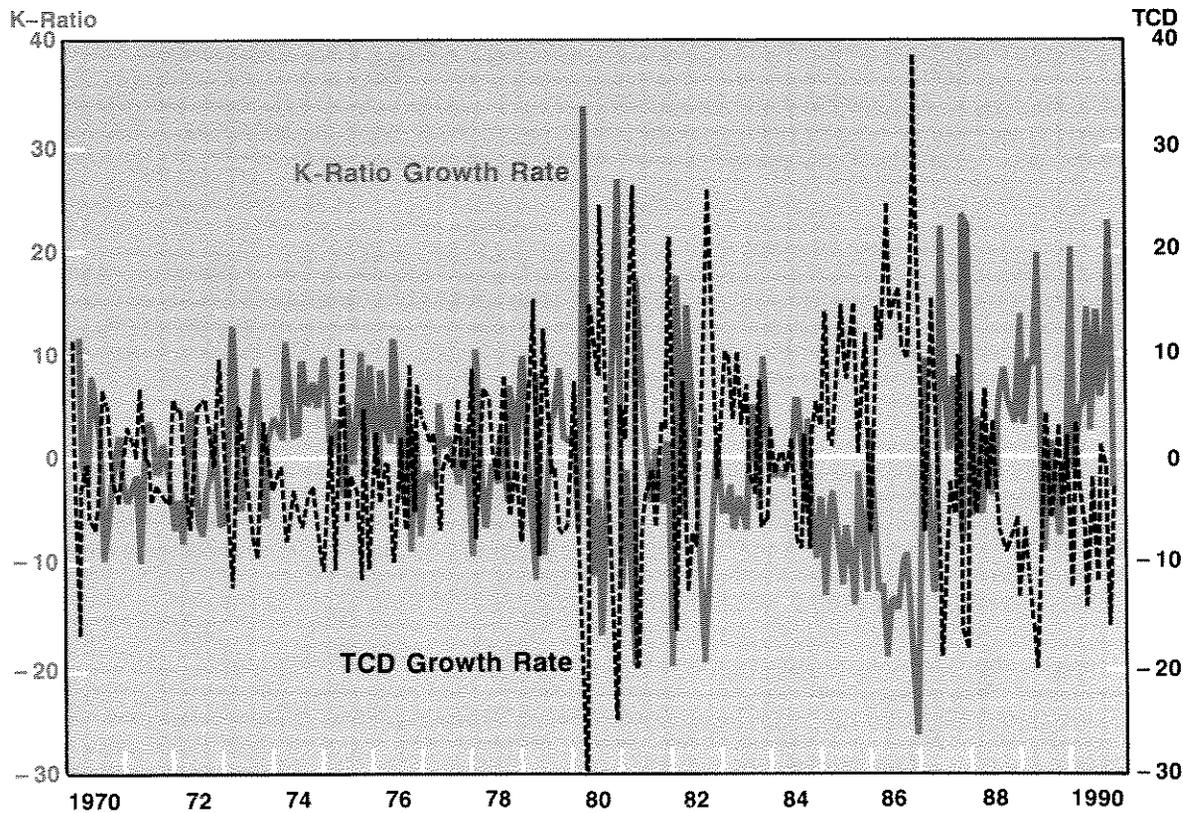
K-ratio in the early 1970s is associated with a slowing in the growth of TCD. The decline in the K-ratio in the early 1980s and its subsequent rise are clearly associated with a sharp acceleration in the growth of TCD followed by a sharp deceleration in its growth.

That TCD accounts for much of the short-run variation in the K-ratio also is evidenced by figures 3 and 4, which show, respectively, deviations of the growth rate of the K-ratio from its mean and deviations of the growth rates of currency and TCD from their respective means. As

shown in the figures, the month-to-month variability in the growth of TCD is considerably larger than that of currency. The variability of TCD more closely matches the variability of the K-ratio than does the variability of currency. While the growth rates of the K-ratio and TCD are highly, inversely related, there is little positive association between the growth rate of the K-ratio and the growth rate of currency.

This observation is verified in table 2, which shows the simple correlations between the monthly annualized growth rates for currency

Figure 4
Deviations of the Growth Rates of the K-Ratio
and Total Checkable Deposits From Their Means
 January 1970 thru November 1990



and the K-ratio and for TCD and the K-ratio for four periods of roughly equal length between January 1970 and November 1990. If variation in the K-ratio were simply due to shifts between currency and TCD, its variation would be equally attributable to variation in currency and TCD.

This is not the case, however. The growth rates of currency and the K-ratio were positively correlated during only two of the four periods. They were negatively correlated in the other two, although the correlations are not significantly different from zero. In contrast, there is a strong, consistent negative correlation between the growth rate of TCD and the K-ratio during all four of the periods. Figures 3 and 4 and the correlations reported in table 2 clearly suggest that month-to-month variability in the

Table 2
Correlations Between the Monthly
Growth Rate of the K-Ratio and the
Monthly Growth Rates of Currency and
TCD

Period	K-ratio and currency	K-ratio and TCD
1/1970-12/1974	.368*	-.901*
1/1975-12/1979	-.016	-.911*
1/1980-12/1984	-.112	-.955*
1/1985-11/1990	.265*	-.951*

* indicates statistical significance at the 5 percent level.

K-ratio is driven largely by movements in TCD.

Finally, as shown in figure 4, periods of persistent deviations in the growth rate of TCD above (below) its mean are associated with persistent deviations of the growth rate of the K-ratio below (above) its mean. Consequently, both the short and long-run movements of the K-ratio are associated with movements in TCD rather than currency. The apparent importance of TCD in influencing the K-ratio suggests that K-ratio changes have not occurred simply because of variations in the relative advantages and holding cost of currency and TCD. That is to say, changes in the K-ratio have not been a simple result of the public's desire to shift the composition of M1 between currency and checkable deposits.

The Link Between Total Checkable Deposits and Reserves

Movements in the multiplier appear to be determined primarily by movements in the K-ratio, which, in turn, appear to be determined primarily by changes in TCD. The question that remains is what determines the stock of TCD outstanding? The models of the money supply presented above provide a simple answer: given the reserve requirement ratio, TCD is determined solely by the amount of reserves supplied by the Federal Reserve. This strong link arises in this model because reserves are assumed to be held only to support checkable deposits.²⁴

Prior to the MCA, commercial member banks were required to hold reserves against all time

and saving deposits, while non-member banks and other depository institutions were not required to hold reserves against their transaction deposits in M1. Because of these factors, the link between TCD and reserves was not particularly strong. In reducing or eliminating reserve requirements on a number of non-transaction accounts and extending reserve requirements to all depository institutions, however, the MCA significantly strengthened the relationship between TCD and reserves.

The effect of the MCA is illustrated in table 3, which shows the results of simple linear regressions of *changes* in TCD on *changes* in total reserves, TR, for several periods between January 1970 and November 1990.²⁵ The regression equations in this table (and in subsequent ones) are intended to be illustrative and should not be interpreted as alternative models for the money supply process. (See the appendix for details.) In all cases but the initial phase-in of the MCA, there is a statistically significant relationship between changes in TCD and TR. The strength of the relationship, as measured by the adjusted R-square, however, increases after the implementation of the MCA.²⁶ The adjusted R-square increases from .06 before the MCA to .67 after the MCA. All of this improvement emerges in the period after February 1984, when the adjusted R-square increases further to .83.²⁷ Moreover, the reciprocal of the estimated coefficient on TR is .124, very close to the marginal reserve requirement of .12 during the latter period. Indeed, the null hypothesis that this coefficient is equal to $1/.12$ cannot be rejected at the 5 percent significance level (the t-statistic is 0.62).

²⁴In reality, of course, depository institutions hold excess reserves and are required to hold reserves on transaction deposits other than those included in M1.

²⁵The total reserves measure used here is total reserves adjusted for reserve requirement changes, prepared by the Federal Reserve Board.

²⁶The Durbin-Watson statistic for the first time period suggests that there is significant first-order positive serial correlation, as would be expected given the likelihood of misspecification (see the appendix). Maximum likelihood estimates of this equation adjusting for first-order serial correlation confirm this result. The estimated coefficient of first-order serial correlation is $-.314$ with a t-statistic in absolute value of 3.29. Nevertheless, the parameter estimates after adjusting for serial correlation are generally close to those reported in table 3, and they are statistically significant. More important, the adjusted R-square only increases to .147; hence, the dramatic rise in the adjusted R-square in the 1980s is not due to the fact that total reserve captures the autoregressive part of TCD.

²⁷The switch from lagged to contemporaneous reserve accounting in February 1984 might explain some of this apparent improvement. To account for this possibility, the change in TCD was regressed on both the contemporaneous and lagged change in TR. In no case was the coefficient on lagged TR statistically significant from zero at the 5 percent level. Indeed, the results differed little from those reported in table 3. That the switch from lagged to contemporaneous reserve requirements is of no significant consequence is consistent with the conjecture of Thornton (1983) and the empirical evidence presented by Garfinkel and Thornton (1989). The relationship between TR and TCD will likely become even stronger given the recent elimination of reserve requirements on all time and savings deposits.

Table 3
Regression of Changes in TCD on Changes in Total Reserves

Period	Constant	Total reserves	SEE	R ²	D.W.
1/1970-12/1980	.795* (5.72)	1.870* (3.10)	1.418	.062	1.35
1/1981-11/1990	.742* (3.42)	7.264* (15.64)	2.081	.674	2.23
1/1981-2/1984	1.765* (3.81)	2.704 (1.92)	2.414	.067	2.06
3/1984-11/1990	.441* (2.09)	8.082* (19.90)	1.676	.832	1.94

* indicates statistical significance at the 5 percent level.
 Absolute values of t-statistics are in parentheses.

Table 4
Regression Estimates of Changes in the Multiplier on Changes in Total Reserves

Period	Constant	Total reserves	SEE	R ²	D.W.
1/1970-12/1980	-.003* (2.86)	-.003 (0.67)	.011	.004	1.70
1/1981-11/1990	-.004* (3.28)	.016* (6.77)	.011	.275	2.12
1/1981-2/1984	.002 (0.77)	-.003 (0.42)	.014	-.023	1.82
3/1984-11/1990	-.006* (6.05)	.020* (11.07)	.007	.603	2.31

* indicates statistical significance at the 5 percent level.
 Absolute values of t-statistics are in parentheses.

The Effects of Policy Actions on the Multiplier and the Money Stock

The above analysis suggests that policy actions could exert a strong effect on the multiplier in the 1980s. Table 4 shows that this is the case. Changes in TR account for 60 percent of the variation in the multiplier since March of 1984. The table also shows that, because of the loose link between reserves and total checkable de-

posits, the assumption that policy actions had no effect on the multiplier was a reasonable working assumption before the adoption of the MCA. Indeed, changes in the multiplier are uncorrelated with changes in TR during the period ending December 1980.

These results suggest that there should be a dramatic change in the relationship between M1 and TR in the 1980s. Simple regressions of changes in M1 on changes in TR and changes in

Table 5
Regression Estimates of the Change in M1 on the Change on
Total Reserves and the Change in the Adjusted Monetary Base

Period	Constant	Total reserves	Adjusted monetary base	SEE	R ²	D.W.
1/1970-12/1980	1.328*	2.079*		1.529	.066	1.28
	(8.86)	(3.20)				
	-.185		2.513*	1.312	.312	1.54
	(0.74)		(7.73)			
1/1981-11/1990	1.868*	7.251*		2.149	.659	2.13
	(8.34)	(15.12)				
	-.280		2.773*	2.939	.361	1.39
	(0.53)		(8.23)			
1/1981-2/1984	2.613*	2.910		2.554	.070	2.00
	(5.33)	(1.95)				
	1.113		1.839*	2.369	.200	1.86
	(1.51)		(3.20)			
3/1984-11/1990	1.696*	7.995*		1.746	.817	1.73
	(7.73)	(18.89)				
	-1.023		3.158*	3.138	.407	1.33
	(1.43)		(7.48)			

* indicates statistical significance at the 5 percent level.
 Absolute values of t-statistics are in parentheses.

the AMB, reported in table 5, bear this out.²⁸ TR explains a relatively small amount of the variation in changes in M1 before MCA and over 80 percent of the variation of changes in M1 since early 1984. The table also shows that the explanatory power of the monetary base has increased since the MCA, as would be expected.²⁹ Nonetheless, the explanatory power of the AMB declined significantly relative to that of TR.

IMPLICATIONS FOR MONETARY POLICY

Prior to the MCA, when it appeared that the multiplier was independent of policy actions,

a rather simple, straightforward approach to money stock control was implied—namely, to target the level of the adjusted monetary base consistent with a money-stock target conditional on a forecast of the multiplier, where the multiplier forecast was not conditional on the target setting for the monetary base. This notion also implied that the adjusted monetary base is the best indicator of the effects of policy actions on the money stock.

The realization that the multiplier is *not* independent of policy actions suggests that the monetary base might not be the best indicator of policy actions on the money stock and that revising the simple empirical models of the

²⁸Again, the Durbin-Watson statistics indicate significant serial correlation, especially when the AMB is used as the independent variable. In no case did an adjustment for serial correlation using a maximum likelihood technique alter any of the substantive results presented in table 5. That is, these results too suggest that there is a marked increase in the explanatory power of TR in the 1980s and

that changes in TR explain much more of the variation in changes in M1 in the 1980s than do changes in the AMB, even allowing for significant first-order serial correlation.

²⁹See Garfinkel and Thornton (1989) for a discussion of this point.

money supply process to account for the effects of policy actions on the multiplier could result in improved money stock control. These issues are discussed briefly in this section.

The Adjusted Monetary Base as an Indicator of Policy Actions on the Money Stock

The adjusted monetary base continues to reflect all policy actions—changes in both reserves and reserve requirements; however, it does not fully capture the effects of these actions on the money stock. Indeed, changes in M1 are now more closely linked to changes in TR than to changes in the AMB. Consequently, it now appears that total reserves, adjusted for reserve requirement changes, is a better indicator of the effects of monetary policy actions on the money supply than is the adjusted monetary base.

Furthermore, the quantity of currency outstanding is demand-determined. Consequently, unlike adjusted reserves, the adjusted monetary base can give misleading signals of the course of monetary policy when there are exogenous shifts in the demand for currency.

To take a concrete example, currency growth accelerated markedly beginning about December 1989.³⁰ This acceleration was accompanied by a sharp acceleration in the growth of the adjusted monetary base from 3.4 percent in 1989 to 8.4 percent in 1990. Such a sharp rise in base growth would tend to indicate that monetary policy had eased. But the growth of adjusted reserves and, thus, TCD indicate a substantially weaker easing of policy. TCD increased at a 1.2 percent rate in 1990 compared with a -1.3 percent rate in 1989. Of course, the apparent exogenous increase in the demand for

currency caused the K-ratio to rise and the multiplier to fall, so that M1 grew slowly relative to the monetary base during the period.³¹ Because there is now a closer link between TR and M1 than between the AMB and M1 and because TR is less likely to give misleading signals, TR is likely to be a better indicator of both monetary policy and the effects of policy changes on the money stock.

The Multiplier Approach to Money Stock Control

That the multiplier is not independent of policy actions also has important implications for the multiplier approach to money stock control. Taking this approach, the target level of M1 is achieved by forecasting the multiplier, then supplying the amount of the adjusted monetary base necessary to hit the desired M1 target.³² If, however, the multiplier is a function of open market operations, policymakers must also predict the effect of their actions on the multiplier. That is to say, the multiplier approach to money control should be modified to take account of the effects of policy actions on the multiplier. Taking account of such effects undoubtedly will improve money control over the simple approach that assumes independence between the multiplier and policy actions. The magnitude of this improvement depends on how accurately the effects of policy actions on the multiplier can be forecast. To the extent that variations in the multiplier are largely explained by variations in the k-ratio and these variations are, in turn, largely influenced by policy (especially in the post-MCA period), such a modification could produce a substantial improvement in money stock control.³³

³⁰While the exact cause of this acceleration remains unclear, many attribute it (at least in part) to currency exports to South American and Eastern bloc countries.

³¹An equally interesting, but less frequently discussed, episode occurred during 1989 when, after remaining fairly constant, currency growth slowed abruptly. During this period, the K-ratio rose rather than fell, as one might expect given the apparent shift in the demand for currency. The increase in the K-ratio was driven by negative growth in reserves and, hence, TCD during this period.

³²See Balbach (1981), Hafer, Hein and Kool (1983), and Johannes and Rasche (1979, 1987) for a discussion of this approach and for alternative methods that have been used to forecast the money multiplier.

³³Note that the multiplier approach can be more difficult to implement. Most notably, the control problem becomes

nonlinear. One alternative approach would be to simply forecast the level of currency, then supply the reserves necessary to hit a target level of TCD. The target level of TCD would have to be consistent with both the M1 target and the forecast level of currency. Whether this or the multiplier approach, suitably modified to account for the effect of policy actions on the multiplier, would provide greater monetary control is an empirical issue well beyond the scope of this paper. Both approaches will produce forecast errors when there are unexpected shifts in the demand for currency. The real issue is whether better estimates of the K-ratio can be obtained by estimating the numerator and denominators separately than estimating them together. This is an empirical issue. Nevertheless, this alternative approach could be simpler to implement and might provide superior control if reasonably accurate forecasts of currency can be made.

SUMMARY

This article has examined closely the standard multiplier model of the money supply process, specifically questioning the view that the adjusted monetary base multiplier is independent of the policy actions of the central bank. Because the demand for currency depends on a number of factors that are unrelated to the demand for checkable deposits (and vice versa) and because the stock of checkable deposits has been more closely tied to the quantity of reserves supplied by the Federal Reserve since the implementation of the MCA, changes in monetary policy result in changes in the ratio of currency to checkable deposits and, consequently, changes in the multiplier. Hence, the Federal Reserve's monetary policy actions are reflected both in the adjusted monetary base and the money multiplier.

Theoretical considerations suggest that the multiplier has never been independent of policy. The elimination of reserve requirements on some non-transaction accounts and the extension of Federal Reserve reserve requirements to all depository institutions has greatly increased the association between checkable deposits and reserves. These changes have increased significantly the association between changes in monetary policy actions and changes in the multiplier. 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. How much improvement can be expected with this modified approach and how effective alternative approaches to monetary control can be is left as a topic for further research.

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Appendix

A Model of the Money Supply Process

One might be tempted to interpret the regression equations in the text as representing alternative models of the money supply process; however, the reader is cautioned not to do so. Indeed, as the article suggests, some existing models of the money supply process are misspecified. This appendix illustrates the bias of some of the regression equations estimated in the article.

The discussion in the paper suggests that, since the MCA, there is a very simple linear relationship between TCD and TR of the form

$$\text{TCD}_t = a + b\text{TR}_t + e_t,$$

where the coefficients a and b are constants and e is a residual error that is assumed to be white noise. The error term arises because some reserves are held against transaction deposits not included in TCD and because depository institutions hold excess reserves. The constant term, a , enters the equation because a lower reserve requirement for a tranche of checkable deposits exists and because some of the variables omitted from this equation might have non-zero means. If TR is correctly adjusted for changes in reserve requirements, including the annual change in the deposit tranche, then the coefficients a and b should be constant, where b is the reciprocal of the marginal reserve requirement—that is, $b = 1/.12 = 8.33$. The discussion and the empirical evidence in the paper further suggest that currency holdings are independent of TCD, so that C_t is simply exogenous from the perspective of money stock control.

If this representation is true, then a regression of M1 on the monetary base is misspecified, because it imposes a restriction that is inconsistent with the process generating the data. To see this, consider the following regression specification:

$$(A.1) \text{M1}_t = g + \text{sMB}_t + q_t.$$

Given the definitions of M1 and MB, this equation can be rewritten as

$$(A.2) C_t + \text{TCD}_t = g + h\text{TR}_t + jC_t + q_t.$$

With the restriction $h=j$, equation A.2 is identical to equation A.1. The above analysis, however, suggests that the coefficient h should equal 8.33 and the coefficient j should equal 1. If this is the case, imposing the restriction that these coefficients are equal will be resoundingly rejected by the data.

To test this hypothesis, first-difference specifications of equations A.1 and A.2 are estimated using monthly data for the period from March 1984 through November 1990. These estimates use Federal Reserve Board data for the adjusted monetary base and total reserves, adjusted for changes in reserve requirements. These data come close to satisfying the identity that the monetary base is equal to the currency component of the money supply plus total reserves. These estimates are presented in table A.1. In the unrestricted version of the equation, neither the null hypothesis that $h = 8.33$ nor the null hypothesis that $j=1$ can be rejected at the 5 percent significance level. The t -statistic for the test that $h=8.33$ is .59 and the t -statistic for the test that $j=1$ is .25. Hence, it is not surprising that the restriction that $h=j$ is soundly rejected by the data.

It is interesting to note that imposing this restriction biases the coefficient of the monetary base multiplier away from its true value. The estimated multiplier of 4.005 is nearly 50 percent larger than its average value during this period. This bias emerges because of an omitted variable.

To see this, note that equation A.2 could be rewritten as either

$$(A.3) \text{M1}_t = g + h\text{MB}_t + (j-h)C_t + q_t$$

or

$$(A.4) \text{M1}_t = g + j\text{MB}_t + (h-j)\text{TR}_t + q_t.$$

Hence, equation A.1 can be obtained by omitting C_t from equation A.3 or TR_t from equation

Table A.1
Estimates of Equations A.1 and A.2

Constant	Δ AMB	Δ TR	Δ C	SEE	\bar{R}^2	D.W.
-2.099* (2.49)	4.005* (7.48)			3.138	.407	1.10
.590 (1.21)		8.090* (19.67)	.908* (2.51)	1.690	.828	1.93

*indicates statistical significance at the 5 percent level.
Absolute values of t-statistics are in parentheses.

Table A.2
**Estimates of Regression of Δ TCD on Δ TR and Δ C:
March 1984 - November 1990**

Constant	Δ TR	Δ C	SEE	\bar{R}^2	D.W.
.581 (1.19)	8.069* (19.67)	-.115 (0.32)	1.685	.830	1.93

*indicates statistical significance at the 5 percent level.
Absolute values of t-statistics are in parentheses.

A.4. In the former case the estimate of h is biased downward (4.005 vs. 8.33); in the latter case the estimate of j is biased upward (4.005 vs. 1). Furthermore, the equation exhibits serial correlation, a common indicator of misspecification.

These results are not too surprising given that the demand for currency appears to be independent of the demand for TCD, as illustrated in table A.2, which shows the results of a regression of changes in TCD on changes in TR and changes in C. The coefficient on the change in C is negative, indicating a substitution between

TCD and currency, but is not significantly different from zero. Given this independence, it is hardly surprising that regressions of changes in M1 on TR and changes in TCD on TR produce nearly identical results. Comparing the results in table A.1 with those in table 5 shows that the coefficient is biased downward slightly when M1 is regressed on TR. This occurs because C_t is omitted from the right-hand side of the equation and because of the weak negative association between changes in both C_t and TCD_t , and hence, changes in TR_t .