Exploring the Effects of Capital Movements on M1 and the Economy

The increased integration of international financial markets and the development of a more open U.S. economy raise the question of whether international factors are now influencing the traditional money-income and money-inflation relationships to a larger degree than in the past. This question takes on added importance because the relationships between money and other economic variables, usually estimated with only domestic variables, have been quite unstable in recent years. Hence, it seemed to be an appropriate time to explore in some detail the possibility that these empirical relationships have been significantly influenced by international factors, in particular by capital movements.

In recent years, financial markets have become more international in scope because participants have become more sophisticated, technological improvements have made information more readily available, and many countries have reduced or removed capital controls. As a result, a greater degree of substitution between domestic and foreign financial assets and the development of new financial instruments could affect the demand for money by offering money stockholders a broader array of financial assets for managing money balances. At the same time, the new instruments and greater substitutability among domestic and foreign instruments could make capital more mobile among countries. This might strengthen the link between interest rates and capital movements, making the demand for money more sensitive to capital flows.

In addition, capital flows and international financial transactions probably play a more important role in determining exchange rate movements. Changes in exchange rates, in turn, by affecting prices and the demand for domestically produced goods, could have significant effects on the growth rate of gross national product (GNP) as well as on the rate of inflation in the United States. Moreover, changes in exchange rates, by driving a wedge between domestic spending and production or income, could distort GNP as a measure of transactions in money demand equations. In addition, GNP might be made a less accurate measure of total transactions if active trading in a broader array of financial instruments is increasing the volume of transactions. Finally, such dramatic changes in international financial flows as have occurred in recent years as a result of the large swings in current account balances might also be viewed in some sense as shock variables that would shift the traditional reduced-form relationships incorporating money growth.

In general, the potential scope for international factors to affect traditional relationships between money and the economy—relationships that had focused only on domestic variables in the past—appears quite large. The more difficult task is to try to quantify some of these international influences. Beyond the already complex problem of measuring these international factors in a meaningful way is the consideration that these relationships have been affected at the same time by other factors, such as domestic financial innovation, deregulation of consumer deposits, and dramatic swings in energy and food prices.

As a result, the channels through which international factors might affect the standard relationships between money and output or prices cannot all be quantified in

this article. The issue is analyzed from several different perspectives, however, and the effects of some of these international factors are identified for relationships incorporating the narrow definition of money (M1). While it is difficult to identify the influence of foreign rates of return or interest-rate differentials on the demand for M1, there is some empirical evidence that international considerations have contributed to making GNP a less appropriate measure of transactions. In conventional reduced-form equations, which relate GNP growth to current and lagged M1 growth, the effects of the large capital flows into the United States in recent years (as proxied by foreign investment as a percent of domestic savings) and of energy and food price shocks appear to have been important sources of instability. A somewhat less conventional reduced-form equation that relates M1 growth to the federal funds rate and GNP also seems to have been affected significantly by the large capital flows into the United States. This seems to be the case even after the possibility that M1 has become more responsive to changes in interest rates in recent years has been taken into account. In the money-inflation reduced-form equation, international factors (operating from capital inflows to exchange rates and import prices) seem to have influenced prices even after money growth, unemployment, and other shock variables have been taken into account.

The next section looks at empirical results using money-demand equations, while the second section incorporates alternative money-income reduced-form equations. The third section analyzes the potential influence of international factors on the money-inflation relationship.

Section I: money demand

In this section, we explore what effects capital movements might be having on the demand for M1 by estimating standard money demand equations over various time periods. We first present standard equations that attempt to control for various domestic sources of instability in the money demand equation and then proceed to investigate the ways in which international capital movements might be affecting the demand for M1.

Corporations potentially could now be using a much wider range of foreign instruments for purposes of investing their excess domestically held money balances on a short-term basis. If so, the conventional money-demand equation may appear unstable because the opportunity cost of holding money might no longer be adequately captured by just the domestic short-term interest rate. Hence, it might be necessary to include some measure of the rate of return on possible foreign investments (or the differentials with respect to domestic assets) as well as the exchange rate. In addition, capital flows might affect the transactions variable in money-demand equations, making GNP an inadequate measure of total transactions in the economy. For example, large capital inflows and current account deficits would cause the demand for goods and services (as measured by GNP less net exports) to grow more rapidly than domestic production (as measured by GNP).

Unfortunately, very little economic literature addresses this question. For the most part, the money-demand literature focuses on domestic variables in explaining the demand for narrow money, M1.[1] The literature on currency substitution has taken a more international approach to money demand by examining how domestic residents adjust the relative amounts of their foreign and domestic money holdings. In more general international portfolio balance models, it is argued that interest rates on foreign assets and the expected exchange rate should theoretically at least be included in the demand for money, regardless of whether domestic residents hold foreign as well as domestic money balances.[2] In other words, even though domestic residents may not hold money balances in more than one currency, they may still economize on their domestic money holdings if the rate of return on foreign financial instruments becomes attractive or if they expect the exchange rate to change.

Before exploring the effects of capital movements on money demand, we first present some results using standard domestic variables. The first equation in Table 1, estimated over the 1959-73 period, provides a benchmark before various innovations and deregulation caused the demand for money to become unstable. When the sample period is extended through 1986, thereby incorporating the 1974 shift in money demand as well as the introduction of NOW accounts into the sample period, the income coefficient drops considerably, to less than half its original size. At the same time, the interest rate coefficient more than doubles in size, and the lagged dependent variable increases by one-third and approaches 1.0 in value (second equation). Now, however, with over ten years of data since the mid-1970s shift in money demand, it is possible to estimate money-demand equations that exclude the pre-shift

[1]See, for example, David Laidler, "The Demand for Money: Theories, Evidence and Problems" (Harper and Row, New York, 1985), and John Judd and John Scadding, "The Search for a Stable Money Demand Function: A Survey of the Post-1973 Literature," *Journal of Economic Literature*, September 1982.

[2]John Cuddington, "Currency Substitution, Capital Mobility and Money Demand," *Journal of International Money and Finance*, August 1983. Also see Jaime Marquez, "Currency Substitution and the New Divisia Monetary Aggregates: The U.S. Case," *International Finance Discussion Papers*, No. 257, Board of Governors of the Federal Reserve System, July 1985.

observations (1959 to 1973). The third equation, estimated from 1974 to 1986, shows coefficients for both the real income and interest rate variables that are considerably larger than those reported for the 1959-73 period, suggesting that the demand for M1 has become much more sensitive to these variables than was the case prior to 1974.[3] The coefficient on the lagged dependent variable in the 1974-86 period is also quite large compared to the coefficient estimated for the 1959-73 period, suggesting a slower speed of adjustment.

The fourth equation shows the results when the dollar volume of NOW accounts as a percent of M1 is added to the regression equation (to allow for the possibility that the introduction of NOW accounts caused nontransactions balances to be shifted into M1). It is statistically significant, and its inclusion causes the coefficient on real income to decline in value by about one-half, while the coefficient on the interest rate variable retains its larger value. The fourth equation in a sense represents a benchmark equation that attempts to control for many of the domestic sources of instability in money demand in recent years, namely, the mid-1970s shift in money demand, the introduction of NOW accounts, and the possibility that the demand for M1 has become more interest-sensitive than in the past.

Capital flows, by affecting exchange rates and trade balances to a larger degree than in the past, could be an important additional source of instability for money demand by making GNP (a measure of domestic production) an inaccurate measure of total transactions in the economy. An indirect way of exploring this possibility would be to incorporate in the money demand equation some alternative measures of transactions such as domestic demand (GNP less net exports) or debits (a measure of total transactions, both financial and nonfinancial). Earlier work has suggested that debits would be the more comprehensive measure of transactions.[4]

[3]For theoretical reasons why this might happen, see J. Wenninger, "Financial Innovation, a Complex Problem Even in a Simple Framework," this *Quarterly Review*, Summer 1984. For some econometric results that suggest that the deregulation of consumer deposits might be making the demand for M1 more sensitive to movement in interest rates, see J. Wenninger, "Responsiveness of Interest Rate Spreads and Deposit Flows to Changes in Market Rates," this *Quarterly Review*, Autumn 1986.

[4]Debits are the total volume of withdrawals from checking accounts. Hence, except for those transactions done with currency, debits capture the total amount of transactions done with M1, whether or not these transactions are GNP-related. For more detail, see J. Wenninger and L.J. Radecki, "Financial Transactions and the Demand for M1," this *Quarterly Review*, Summer 1986. In that article it was shown that debits seem to work somewhat better in explaining the rapid growth of M1 in 1985 than did either GNP or

Table 1

Standard Money-Demand Equations*

Equation	Sample Period	Real Income	Real Debits	Three-Month Treasury Bill Rate	Debits as a Percent of GNP	NOWs as a Percent of M1	Lagged Dependent Variable	R^2	RHO
1	1959 to 1973	0.117 (3.7)		−0.012 (2.0)			0.642 (5.3)	0.95	0.49
2	1959 to 1986	0.054 (5.1)		−0.026 (5.3)			0.990 (36.0)	0.95	0.32
3	1974 to 1986	0.152 (6.6)		−0.032 (5.1)			0.935 (25.5)	0.98	0.03
4	1974 to 1986	0.082 (2.9)		−0.030 (5.7)		0.0006 (3.0)	0.938 (30.9)	0.98	0.00
5	1974 to 1986		0.032 (8.8)	−0.029 (6.1)			0.938 (32.8)	0.99	0.00
6	1974 to 1986	0.023 (0.6)	0.028 (3.3)	−0.030 (6.0)			0.934 (31.7)	0.98	0.00
7	1974 to 1986	0.051 (1.5)		−0.030 (6.0)	0.028 (3.3)		0.934 (31.7)	0.98	0.00
8	1974 to 1986		0.038 (3.2)	−0.030 (6.0)		−0.0002 (0.6)	0.934 (31.5)	0.98	0.00

*The equations are estimated in log level form and adjusted for autocorrelation when necessary. The dependent variable is real M1.

Specifically, debits may capture both domestic and international influences that are not reflected in the domestic demand variable. The results incorporating debits are shown in equation 5. This change in specification improves the R^2. Again in this case, the coefficient on the interest rate variable has a value larger than that of the coefficient estimated for the 1959-73 period.

Equations 6 and 7 attempt to use both debits and GNP together in the money-demand equation, either directly in equation 6 or as a ratio in equation 7. In both cases, real GNP is not significant when debits are included. This suggests that debits are capturing not only the transactions associated with GNP but additional transactions as well. In equation 8 we investigate whether NOW accounts still are important in explaining money demand when debits rather than GNP are used to measure transactions. In this case, the NOW-account variable is not significant, suggesting that the rapid growth in NOW accounts might not be an independent source of M1 growth in recent years once the more rapid growth of transactions as measured by debits has been taken into account.

If we consider the accuracy of the equations in predicting M1 growth in 1986, we find that equation 5, which uses debits, underestimates M1 growth by 3.3 percentage points, while equations 3 and 4 underestimate it by 5.3 and 4.6 percentage points, respectively. These results suggest that additional transactions associated with capital flows and foreign exchange may be having an effect on the demand for money by operating through the transactions variable. But since the variable captures many other influences as well, it is not possible to know how important international variables might be.

As noted above, capital movements and changes in exchange rates could also have a more direct effect on the domestic demand for money by affecting expected rates of return. To explore whether foreign rates of return are influencing the demand for money, we included two alternative interest rate differentials in equations 4 and 5. The results are shown in Table 2. The first was the three-month Treasury bill rate less the trade-weighted, short-term, foreign interest rate that we adjusted for expected movements in exchange rates by using the actual change in the trade-weighted exchange rate (these latter two variables are from the Board staff's multicountry model). The other variable was the U.S. long-term interest rate less the German long-term rate that we adjusted for expected changes in exchange rates by using the actual exchange rate. These variables were not significant in either equation, nor were the other measures of foreign rates of return variables we experimented with, such as those constructed with forward rates and ARIMA (autoregressive, integrated, moving average) model predictions of exchange rates. This, of course, does not mean that capital flows are not affecting the demand for M1. It only means that severe econometric problems appear to preclude a method of measurement that relies upon the use of foreign rates of return in money-demand equations.

These econometric problems stem from three sources. First, there is the rather obvious problem of multicollinearity between domestic and foreign interest rates. If capital has become sufficiently mobile that large amounts of funds (not just transactions balances) will be shifted quickly to take advantage of any favorable rate spreads, then domestic and foreign interest rates are likely to move so closely together over time that their individual effects on M1 holdings cannot be estimated.

Second, the demand for money, as noted earlier, has not been stable in recent years. There was a downward shift in the mid-1970s associated with increased emphasis on cash management, and perhaps an upward shift in the early 1980s associated with the introduction of NOW accounts. Such pronounced changes in money demand make it difficult, of course, to detect more subtle changes that might result over time from the increasing internationalization of financial markets, partly because it is not possible to measure very precisely the effects of these other factors.

Third, there is the problem of identifying those exchange rates and foreign interest rates that are rel-

Table 2

Including Foreign Rates of Return in Money-Demand Equations

	Short-Term Differential*	Long-Term Differential*
Equation 4 (From Table 1)	−0.00009 (0.9)	−0.0008 (1.0)
Equation 5 (From Table 1)	−0.00007 (0.7)	−0.0007 (1.0)

*The short-term differential is defined as the three-month Treasury bill rate less the trade-weighted foreign short-term interest rate plus the change in the trade-weighted exchange rate. The long-term differential was defined as the U.S. government bond rate less the German long-term government rate plus the change in the exchange rate. These variables were included separately in each equation. These variables could not be included in log form because large fluctuations in exchange rates often produced negative numbers.

Footnote 4 continued
domestic demand. For some further results using domestic final demand, see J. Wenninger and L.J. Radecki, "Recent Instability in Velocity," this *Quarterly Review*, Autumn 1985.

evant to the study of domestic money demand. Clearly, several exchange rates and rates of interest cannot be included in the money-demand equation because of multicollinearity. Hence, it might be necessary to use some sort of international indexes of exchange rates and foreign interest rates, or to shift the focus to another dominant currency such as the German mark. But even if an appropriate exchange rate could be selected, there is the additional problem of measuring expected changes in that exchange rate.[5] Moreover, if interest rate parity holds, then the expected change in the exchange rate in the forward market is simply the difference between the domestic and foreign interest rates. If money holders basically accept the forward market's expectation of exchange rates, there would be no reason to invest in foreign assets. The same expected rate of return would be realized in either case. Whether or not interest rate parity holds, it does suggest that one commonly accepted measure of exchange rate expectations (those implicit in forward contracts), when combined with domestic and foreign interest rates in a money-demand equation, could cause severe multicollinearity problems by introducing an identity among the independent variables.[6]

In general, it appears that econometric problems probably preclude any effort to identify the effects of capital flows on money demand that involves the direct inclusion of exchange rates and foreign rates of return in money-demand equations. There does, however, appear to be some evidence that capital flows might have affected the demand for money indirectly by making GNP a somewhat less accurate indicator of the volume of transactions that matter for money demand.

Section II: reduced-form results (money and GNP)

The M1-GNP reduced-form equation provides an alternative framework for examining whether the money-GNP relationship has been affected by international variables. Earlier work in this area has concentrated primarily on whether international variables (import prices and exchange rates) have influenced the relationship between money and inflation in a reduced-form context.[7] Clearly, changes in international variables such as an appreciation of the dollar can affect the real side of the U.S. economy as well. That is, not only would a strong dollar help contain inflation by reducing the ability of domestic producers to increase prices, but it would also tend to slow the growth in output if domestic demand is shifted toward foreign-made goods. In the next section of this article we will work with the M1-GNP reduced-form equations in assessing what role capital flows as well as other shock variables might play. In the final section we will use the M1-inflation relationship. The box on the next page contains a brief discussion of the theory behind the two alternative money-GNP reduced-form approaches that are estimated and discussed in this section. The box also includes comments on the use of capital flows as a shock variable in these reduced-form equations.[8]

Table 3 shows the empirical results for the conventional reduced-form equation that relates nominal income growth to current and lagged M1 growth and other variables. Equation 1 is the basic equation, which includes only the money growth and business cycle dummy variables. In subsequent equations, additional shock variables (mid-1970s money-demand shift, energy prices, GNP growth due to inventories, and the proxy for capital inflows into the United States) are added one at a time to the basic equation. The table contains the technical definitions of the variables.

Equation 1 suggests that the part of M1 growth that is due to growth of MA (currency and demand deposits) has a significant effect on GNP growth, while the part of M1 growth attributable to increases in NOW accounts does not have a significant effect. In addition, there appears to have been a rather marked cyclical pattern in the error term during recessions and first years of recoveries. The second equation also includes a dummy variable for the period from mid-1974 through 1978—the period of a widely recognized downward shift in money demand (see references in footnote 1). It is significant and of the expected sign and also has the effect of reducing the size of the coefficient on MA somewhat.

In equation 3, an energy-food-price-shock variable is added, and it also is significant and of the expected

[5]And in the case of the exchange rate, even the interpretation of the variable in the estimated equations would not be clear. On the one hand, the expected movement in the exchange rate is part of the expected rate of return on a foreign investment; on the other hand, unpredictable volatility in exchange rates might affect the basic decision of whether to consider foreign assets at all in managing money balances. For more detail on this in a somewhat different context, see M.A. Akhtar and B.H. Putman, "Money Demand and Foreign Exchange Risk: The German Case, 1972-1976," *Journal of Finance*, June 1980.

[6]See Cuddington, "Currency Substitution."

[7]See Dallas S. Batten and R.W. Hafer, "The Impact of International Factors on U.S. Inflation," *Southern Economic Journal*, October

Footnote 7 continued
1986, pp. 400-412. Also see P. Hooper and B. Lowrey, "Impact of the Dollar Depreciation on the U.S. Price Level: An Analytical Survey of Empirical Estimates," Board of Governors of the Federal Reserve System, Staff Study 103, April 1979; and Charles Pigott and Vincent Reinhart, "The Strong Dollar and U.S. Inflation," this *Quarterly Review*, Autumn 1985.

[8]For earlier work along these lines, see Robert J. Gordon, "Supply Shocks and Monetary Policy Revisited," *American Economic Review*, May 1984; and "The Short-Run Demand for Money: A Reconsideration," *Journal of Money, Credit and Banking*, November 1984.

The theory behind the conventional money-GNP reduced-form approach is quite straightforward. A simple IS-LM model can be used to illustrate this.

$$(1)\ Y = -cr + X$$
$$(2)\ M1 = -ar + bY + Z$$

where: M1 = narrow money stock
r = interest rate
Y = income
Z = money demand shifts or shocks to money demand
X = autonomous expenditures or real side shocks
a, b, c = structural parameters

If equations 1 and 2 are combined to derive the reduced-form for income, the following equation results:

$$(3)\ Y = \frac{c}{a + bc} M + \frac{a}{a + bc} X - \frac{c}{a + bc} Z$$

Clearly, the money-GNP relationship can be affected not only by any international or domestic variables that would be included as shocks in the X or Z vectors but also by any developments that would affect the key elasticities in the model (a, b, or c). In the first section of this paper, rather clear evidence was presented that the interest elasticity of money demand (a) had increased substantially in absolute value in recent years; hence the multipliers in equation 3 may not have been stable in recent years. In particular, a given M1 growth rate or a shock from the financial side (Z) probably will not result in as large an impact on GNP as in the past, while shocks from the real side (X) would be expected to have larger impacts on GNP.

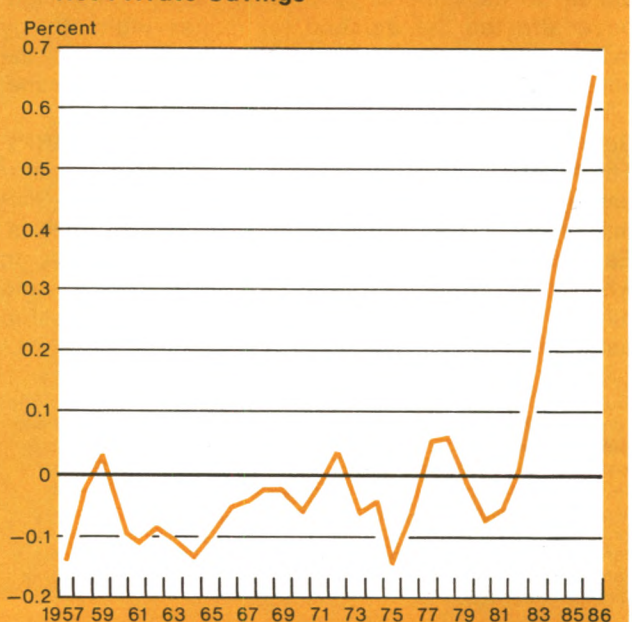
Earlier work has suggested several variables that might be included as shock variables to the money-income relationship.* These include the impact on prices of changes in food and energy prices, the 1974-78 money-demand shift, dummy variables for cyclical variations in velocity (recessions and first years of recoveries), the introduction of nationwide NOW accounts, and the inventory cycle. In addition, if the large capital flows into the United States in recent years caused instability in the money-income relationship, a shock variable that accounts for this general phenomenon should also be included. In this article, net foreign investment as a percentage of net private savings is used as a proxy for the capital flows. It is, of course, difficult to know in some longer-run context what sign to expect on this shock variable because the relationship between capital flows and exchange rates is not a simple one. Over the 1982-85 period, however, large deficits in the U.S. fiscal budget apparently caused U.S. interest rates to be relatively high. The higher interest rates, together with other factors such as safe-haven considerations, attracted capital into the United States and caused the dollar to rise. The strong dollar helped to contain inflation and tended to slow the growth in output as demand was shifted abroad.

Almost all of the variation in this capital-flow shock variable is concentrated in the post-1982 period (see chart); hence any regression results would be dominated by this period, and a negative coefficient would be expected. Moreover, the extremely large change in this variable outside its normal range (from about zero in 1981 to 47 percent in 1985) probably did constitute a major shock to the U.S. economy.† In any case, changes in capital flows at other times could well be associated with different movements in exchange rates, and therefore have a different effect on GNP. For example, if expectations of higher domestic inflation lead to persistent downward pressure on the dollar, the same volume of capital inflows might be associated with a declining dollar. Under those circumstances, foreign exchange market intervention and higher U.S. interest rates might be necessary to sustain the capital inflows. Hence, using this shock variable in the reduced-form equation primarily measures its effect in the post-1982 period. The results do suggest, however, that capital movements could be quite important at times, although the sign on the direction of the effect is specific to this particular episode and should not be viewed as indicating

*For more detail, see J. Wenninger, "The M1-GNP Relationship: A Component Approach," this *Quarterly Review*, Autumn 1984, and J. Wenninger and L.J. Radecki, "Recent Instability in Velocity," this *Quarterly Review*, Autumn 1985. Also see the references cited in footnote 8 as well as John A. Tatom, "Alternative Explanations of the 1982-1983 Decline in Velocity," in *Monetary Targeting and Velocity*, Conference Proceedings, Federal Reserve Bank of San Francisco, December 1983.

†The recent study by the Bank for International Settlements took the position that one of the basic shocks to the financial system that spurred extensive financial innovation was the capital flows created by the large redistribution of current account deficits and surpluses in recent years. For more detail, see "Recent Innovations in International Banking," Bank for International Settlements, April 1986.

Net Foreign Investment as a Percent of Net Private Savings



what might happen in the future.

We also looked at the possible effects of capital flows from the perspective of an alternative reduced-form approach that relates M1 growth to current and lagged changes in the federal funds rate and a measure of transactions (GNP). This equation, developed during the 1970s, was of considerable interest from the perspective of controlling M1.‡ It was not, however, a reduced-form equation in the same sense as the one just derived from the IS-LM model. That equation was formulated in terms of an ultimate objective variable (GNP) being related to an intermediate policy variable (M1). This other equation, in contrast, was viewed as a reduced-form equation that related an intermediate variable (M1) to a policy instrument variable (the federal funds rate), with GNP taken as exogenous in the short run. In a sense, this equation might be viewed as a money-demand equation rather than a reduced-form; the question of interpretation depends on whether the supply of reserves or the federal funds rate is taken to be the variable the Federal Reserve attempts to set "exogenously." At the time this equation was formulated in the early 1970s, the federal funds rate frequently was taken as exogenous and the equation was viewed as a reduced-form equation. In this case, the interpretation of the capital flow variable would be similar to the interpretation given in the money demand section. That is, the strong dollar associated with large capital flows produced a trade deficit that slowed GNP relative to total transactions and consequently caused GNP to understate the demand for M1. Hence, in this reduced-form equation, we would expect the sign on the capital flow variable to be positive because the results are likely to be dominated by the 1982-85 period.

‡For more detail, see R.G. Davis and F.C. Schadrack, "Forecasting the Monetary Aggregates with Reduced Form Equations," in *Monetary Aggregates and Monetary Policy*, Federal Reserve Bank of New York, October 1974. This reduced-form equation was derived from a money-demand equation and a demand-for-reserves equation, with the federal funds rate taken as exogenous.

Table 3

Reduced-Form Results

(Dependent Variable = Quarterly Growth Rate of Nominal GNP)

Equation	MA	N	RY	RC	MD	P	IG	FD	SEE	DW	R^2
1	0.63	0.01	3.16	−2.40					3.6	1.8	0.33
	(3.3)	(0.1)	(3.2)	(2.2)							
2	0.48	0.05	2.73	−2.99	2.66				3.5	1.9	0.38
	(2.5)	(0.3)	(2.8)	(2.8)	(2.8)						
3	0.37	0.23	2.50	−3.45	3.29	0.95			3.3	2.1	0.47
	(2.1)	(1.6)	(2.7)	(3.4)	(3.6)	(4.0)					
4	0.37	0.26	0.91	−2.06	3.21	0.88	0.84		2.5	1.9	0.68
	(2.7)	(2.3)	(1.2)	(2.6)	(4.6)	(4.8)	(8.1)				
5	0.74	0.67	0.11	−2.38	2.76	0.63	0.84	−7.90	2.4	2.0	0.73
	(4.6)	(4.4)	(0.2)	(3.2)	(4.1)	(3.4)	(8.6)	(3.8)			
	M1-4										
6	0.71		0.08	−2.63	2.88	0.68	0.84	−7.97	2.4	2.0	0.72
	(5.0)		(0.1)	(3.9)	(4.7)	(3.9)	(8.7)	(3.9)			
			D								
7	0.87		−5.61						3.8	1.8	0.24
	(5.1)		(4.9)								

MA = sum of the coefficients (current and four lags) of M1 growth due to currency and demand deposits. N = sum of the coefficients (current and four lags) of M1 growth due to NOW accounts. IG = growth rate of GNP less the growth rate of total final demand (excluding commodity credit corporation purchases). P = growth rate of personal consumption deflator less growth of personal consumption deflator excluding food and energy. RY = dummy variable for first years of recoveries. RC = dummy variable for recessions. MD = dummy variable for shift in money demand during 1970s (mid-1974 to 1978). FD = net foreign investment as a percent of net private savings. M1-4 = sum of the coefficients (current and four lags) of M1 growth. D is a dummy variable that is 0 through 1981-IV and 1 thereafter. The sample period is 1960-III to 1986-IV.

sign. Including it results in a sizeable increase in the R^2. The introduction of this energy shock variable reduces the impact that the M1 growth attributable to MA has on GNP and causes the coefficient on the M1 growth due to NOW accounts to increase in size. In the fourth equation, GNP growth due to inventories is added to the equation. This variable is significant and has the expected sign. Including it also results in a sizeable

reduction in the standard error and a large increase in the R^2. Moreover, the introduction of this variable causes the dummy variable for first years of recoveries to become insignificant, suggesting that part of the error pattern in this relationship during recessions and first years of recoveries was due to the inventory cycle.

Finally, in equation 5 we add the ratio of net foreign investment to net private savings to see whether the large capital flows into the United States in recent years were affecting the money-GNP relationship even after the effects of all these other shock variables were taken into account. We find that this variable is significant, and its inclusion results in an improvement in the R^2 and a small further reduction in the standard error. The coefficient on this variable is negative (see box), suggesting that larger capital inflows have been associated with slower growth in nominal income. In other words, the strong dollar associated with the large capital inflows over the 1982-85 period appears to have kept nominal income growth lower than it otherwise would have been given M1 growth and the other shocks that occurred. But as we noted in the box, the relationship between capital flows and exchange rates is not a simple one, and consequently these results should be interpreted with caution.[9]

Including this capital-flow variable has some other effects on the equation. The coefficients on the money supply variables increase considerably, and the size of the coefficient on the energy-price-shock variable is reduced somewhat.[10] Moreover, both the M1 growth due to MA and the M1 growth attributable to NOW accounts are significant and estimated to have about the same impact on GNP growth, suggesting that it would not be necessary to make the distinction. (In other words, it appeared to be an important distinction to make before all the other shock variables were included but not after. Equation 6 confirms this conclusion by showing that there is little change when total M1 is used.)[11] This finding also tends to confirm the results from the money-demand section suggesting that NOW accounts did not appear to be an important explanation for the instability in that relationship in recent years once other factors (additional transactions captured by debits) were taken into account.

Equation 7 shows another version of this basic money-GNP reduced-form equation. This version uses a simpler approach to allow for the instability in this relationship since 1982.[12] It does not include any shock variables; besides M1 growth only a (zero-one) dummy variable for the post-1982 period is included. Hence, it serves as a useful benchmark for assessing the value of the more complex equations that incorporate several different sources of instability. Some striking differences emerge when equation 7 is compared to equation 6, which includes the various shock variables used in this study. Equation 7 has the standard result that the coefficient on M1 growth is close to 1.0 in value, whereas in equation 6 the coefficient is about 20 percent smaller. Overall, the fit of equation 6 appears much better than that of equation 7, with the R^2 about three times larger and the standard error 1.4 percentage points smaller. Hence, there appears to be some benefit in taking account of the individual effects of the various shock variables that have affected the money-income relationship in recent years.

Table 4 shows the recent in-sample errors in predicting GNP growth with the equations in Table 3. Equation 1 has not been very accurate in tracking GNP growth in 1985 and especially in 1986, with an average error of almost 4 percentage points over those two years. Equation 3 suggests that the shocks from energy and food prices are part of the explanation—without these developments, recent M1 growth would have been associated with considerably more nominal income growth than actually occurred (about 1.5 percentage points over 1985 and 1986). And equation 5 shows that the errors for 1985 and 1986, as well as for the entire period, can be reduced somewhat further if the proxy for large capital flows into the United States is included. Without that effect, recent M1 growth would probably have been associated with GNP growth over 1985 and 1986 that was about 1.1 percentage points greater.[13]

[9]It has been pointed out that exchange rate models could only account for at most one-half of the increase in the dollar over the 1982-85 period. For more detail, see Ralph C. Bryant and Gerald Holtman, "The External Deficit: Why? Where Next? What Remedy," *Brookings Review*, The Brookings Institution, Washington, D.C., Spring 1987. For a broader review of exchange rate models, see Peter Isard, "Lessons From Empirical Exchange Rate Models," *Staff Papers*, International Monetary Fund, March 1987.

[10]We experimented with various lag structures for the various shock variables and obtained the best results using just the current quarter's value. Money growth, in contrast, affected GNP growth over about a one-year period.

[11]We also conducted several tests to see whether the larger interest elasticity of money demand noted in the first section had any effect on the stability of the coefficients. By and large, we could not find any evidence, possibly because other elasticities have changed as well, making the overall effect uncertain. In addition, the greater interest elasticity of money demand has been attributed to the

Footnote 11 continued
deregulation of consumer deposits. This has been a gradual process over the last nine years, making it difficult to identify a breaking point to test for structural shifts. For more detail, see J. Wenninger, "Financial Innovation—A Complex Problem Even in a Simple Framework," this *Quarterly Review*, Summer 1984.

[12]K.M. Carlson, "Recent Revisions and GNP Data," *Review*, Federal Reserve Bank of St. Louis, January 1986.

[13]The dollar, of course, has declined considerably since its peak in 1985. However, because of the long lags involved between changes in the dollar and the effects on economic activity, nominal income

The combined effect of energy and food prices and the large capital inflows probably accounted for almost 3.0 percentage points lower nominal GNP growth over 1985 and 1986, leaving about 1 percentage point of unusually weak GNP growth unexplained, with the error concentrated in 1986. By way of comparison, equation 7, which only includes a dummy variable for the post-1982 period, does about as well as equation 5 in tracking GNP growth in 1985, but considerably worse in 1986, with an average error for the two years of −2.6 percentage points.

Next, we will briefly review the results of adding these shock variables to the other reduced-form relationship described in the box. By and large, it appears that the capital flows into the United States in recent years were an important source of instability for this relationship as well. And confirming the results from the money-demand section, this relationship also suggests that M1 growth has become much more sensitive to movements in interest rates in recent years.

Equation 1 in Table 5 shows the results when M1 growth is regressed on GNP growth over the past year and on the percent change in the federal funds rate over the past year. Although these two variables appear significant in explaining M1 growth, the overall fit of the equation is quite poor. Adding a post-1982 dummy variable similar to the one used in equation 7 in Table 3 improves the overall fit of the equation and generally confirms the notion that since 1982 the growth in M1 has been more rapid than past relationships would predict for any given movements in GNP and interest rates—something on the order of 4.5 percentage points more. In equation 3, the shock variables used previously were added to equation 2. Only the shock variables that accounted for the inventory cycle and the inflow of capital into the United States were significant (as suggested in the box, the coefficient on the capital flow variable is positive in this reduced-form equation). At

Footnote 13 continued
growth appears to have been held below what it otherwise would have been well into 1986. By late 1986, however, the fall in the dollar was contributing to more rapid growth in GNP and adding to domestic inflation. As we noted in the box, these results primarily reflect the 1982-85 period when the capital inflows seemed to be associated with a strong dollar.

Table 4

Recent In-Sample Errors in Predicting GNP Growth*
(In Percentage Points)

	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 7
1983	−1.0	−0.7	0.0	0.0	−0.7	2.5
1984	1.2	1.2	1.7	1.5	3.0	3.7
1985	−2.3	−2.1	−1.1	−1.6	−0.3	0.2
1986	−5.4	−4.9	−3.4	−3.1	−1.9	−5.4
Entire Period	−1.9	−1.6	−0.7	−0.8	0.0	0.2

*Equations are from Table 3.

Table 5

Alternative Reduced-Form Results
(Dependent Variable = Quarterly Growth Rate of M1)

Equation	Y	R	D	IG	FD	R*D	SEE	DW	R^2
1	0.26	−3.74					3.8	1.1	0.08
	(1.7)	(2.9)							
2	0.36	−2.61	4.60				3.4	1.5	0.27
	(2.6)	(2.2)	(5.1)						
3	0.32	−2.96	0.51	−0.25	10.12		3.1	1.7	0.39
	(2.4)	(2.7)	(0.38)	(2.1)	(3.9)				
4	0.48	−2.51		−0.24	8.27	−15.72	2.9	2.0	0.49
	(3.9)	(2.6)		(2.2)	(5.2)	(4.4)			

Y = growth of GNP from four quarters earlier. R = percent change in the federal funds rate from four quarters earlier. D, IG, and FD are the same as in Table 3. Sample period is from 1960-III to 1986-IV.

the same time, the coefficient on the post-1982 dummy variable became insignificant, and the overall fit of the equation improved considerably. Finally, to see whether the responsiveness of M1 to changes in interest rates has increased since 1982, we included in equation 4 the post-1982 dummy variable multiplied by the interest rate variable. The coefficient on this variable is of the correct sign and statistically significant, and suggests that M1's response to changes in the federal funds rate is about six times greater than it was prior to 1982.

Because the Federal Reserve in 1979 reduced the emphasis it placed on the federal funds rate and increased the emphasis it placed on reserves, the results from this type of reduced-form equation should be regarded with caution. Nonetheless, it is encouraging that the results confirmed those of the earlier two sections: it appears that the coefficient on the interest variable has become larger in recent years and that capital inflows have been an important source of instability for this M1-GNP relationship. In addition, this equation is able to track recent M1 growth fairly well on an in-sample basis. For 1986, equation 4 underpredicted M1 growth by 1.5 percentage points. This error is not all that large, although it is still large enough to indicate that the rapid growth in M1 has not been fully explained, even if the effects of shock variables and the greater interest rate responsiveness of M1 are taken into account. Still, if this error is compared to the error of 8.2 percentage points when these other factors are not allowed for (equation 1), the approach used in equation 4 suggests that considerable progress can be made in explaining the recent instability in the money-income relationship.

Section III: reduced-form results (money and inflation)

In this section, we briefly consider whether capital flows have influenced the relationship between M1 growth and the inflation component of nominal GNP. In other words, after we have allowed for money growth, unemployment,[14] energy prices, and the money-demand shift variable used in the previous section, will it be possible to find that the large capital inflows into the United States in recent years have affected the inflation rate? The answer appears to be yes.

In the first equation in Table 6, the inflation rate (as measured by the GNP deflator) is related to M1 growth (over a four-year period as is common practice). M1 growth is significant, but the low R^2 and DW (Durbin-Watson) statistic and the large standard error suggest that variables other than M1 growth probably have played a role in determining inflation. Clearly, with M1 growth measured over a four-year period, there would be some room for shorter-run fluctuations in demand pressure to affect the inflation rate temporarily. To see if this is the case, we added the amount of unemployment in the U.S. economy measured as a four-quarter moving average of the unemployment rate for adult

[14]Here the unemployment rate is used as a proxy for shorter-run variation in demand pressure that could affect the inflation rate temporarily, even as the long-run trend in M1 growth established the more permanent trend in inflation.

Table 6

Reduced-Form Equations for Inflation

(Dependent Variable = Quarterly Growth Rate of GNP deflator)

Equation	M1-16	U	MD	P	FD	DW	SEE	R^2
1	0.74 (6.2)					0.7	2.6	0.31
2	0.88 (7.1)	−0.45 (3.1)				0.8	2.5	0.37
3	0.83 (7.6)	−0.51 (4.0)	3.03 (5.4)			1.0	2.2	0.51
4	0.84 (8.4)	−0.31 (2.5)	3.03 (6.0)	0.65 (4.9)		1.2	2.0	0.60
5	1.32 (12.0)	−0.22 (2.2)	2.28 (5.2)	0.36 (3.0)	−9.41 (6.7)	1.8	1.6	0.73

MD, P, and FD are the same as in Table 3. U is the unemployment rate for adult males (four-quarter moving average). M1-16 is the sum of the coefficients (current and 16 lags) of M1 growth. It is common practice to use longer lags on M1 growth in reduced-form equations for inflation than for nominal GNP. Sample period is from 1960-III to 1986-IV.

males. This variable is also significant and has the expected negative coefficient, and including it improves the overall fit of the equation somewhat. The third equation also includes the mid-1970s money-demand shift variable used in the previous section, and here too it has the correct sign and is significant. Including it results in a sizeable increase in the R^2. The fourth equation includes the energy and food price shock variable that was used in the previous section, and it is also significant and improves the overall fit of the equation. Finally, we incorporate the proxy variable for capital inflows used in the previous section (foreign investment as a percent of domestic savings). It is statistically significant and improves the R^2, DW statistic, and the standard error.

There are, of course, several channels through which capital inflows into the United States could have affected domestic inflation in recent years. The most obvious channel is through exchange rates and import prices. Not only do import prices affect the inflation rate directly, but they also help determine how much domestic producers can raise domestic prices. In addition, strong exchange rates can hold down inflation if domestic demand is shifted toward goods made outside of the United States, creating excess capacity and higher unemployment. Hence, international considerations may be operating through the unemployment rate variable (short-run demand pressure variable) in these equations as well as through the capital flow variable. Whatever the exact channel, the influence appears to have been sizeable in recent years. For example, equation 4 overpredicts inflation by 2.5 percentage points over the last three years, while equation 5 overpredicts it by only 0.4 percentage point (in-sample errors). As we noted earlier in evaluating the results of the other reduced-form equations, these results must be interpreted with caution because the relationship between capital flows and exchange rates (and hence inflation) is not simple, or necessarily stable.

Conclusions

In this article, we explored the possibility that capital movements have significantly affected conventional macroeconomic relationships incorporating narrowly defined money (M1) and other domestic variables. Our work suggests that capital movements might have been an important source of the instability in these relationships over the 1982-85 period when capital inflows were associated with a strong dollar. In the money-income and money-inflation reduced-form equations, these capital inflows appear to have had rather strong effects. In the money-demand equations, however, econometric problems made it difficult to determine whether capital movements have had a direct effect. Nevertheless, we did find some evidence that capital movements could be making GNP a less accurate measure of those transactions that influence money demand.

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