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Eurodollars and the U.S. Money Supply

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INTRODUCTION

IT is frequently asserted that the Eurodollar market has contributed substantially to worldwide inflation and general economic instability. Eurodollars allegedly move with ease from country to country, disrupting national credit and money markets and creating fears about the inflationary consequences for the U.S. economy if all these "dollars" pour back into the U.S. banking system.

Inflation results when spending grows faster than real output. If excess spending occurs because the quantity of money grows faster than people's desire to hold money, then Eurodollar transactions can increase inflation only if they reduce the growth of output, reduce people's desire to hold money, or increase the amount of money in existence. There is no theoretical or empirical evidence that Eurodollar transactions have reduced output growth. The extent to which the Eurodollar market has reduced the demand for domestic currencies remains uncertain. Consequently, if the Eurodollar market contributes to inflation, it does so either by increasing the amount of money in existence or impeding control of domestic money stocks. The extent to which the Eurodollar market has independently contributed to an expansion of the world money supply has been the focus of a num-

ber of studies.¹ Despite this research effort, serious questions remain about whether or not the volume of Eurodollar balances should be included in any aggregation of the world money stock.

This article, however, addresses a different but related question by focusing on the relationship between the Eurodollar market and monetary control. It assumes throughout that the Federal Reserve System does not engage in Eurodollar transactions or alter its monetary policy as a result of such transactions. The first section of the article describes the Eurodollar market. The second section illustrates, through the use of balance sheets, how Eurodollar transactions *may* affect the U.S. money supply. The third section investigates the effects of Eurodollar transactions on the U.S. money supply in the context of a money multiplier model.

¹For representative studies on this question that make use of a multiplier framework, see John H. Makin, "Identifying a Reserve Base for the Eurodollar System," *Journal of Finance* (June 1973), pp. 609-17; and Boyden E. Lee, "The Eurodollar Multiplier," *Journal of Finance* (September 1973), pp. 867-74. For an alternative portfolio balance approach that challenges the relevance of the multiplier framework as applied to the Eurodollar market, see John Hewson and Eisuke Sakakibara, *The Eurocurrency Markets and their Implications* (Lexington, Mass.: Lexington Books, 1975).

A Brief Descriptive History of the Eurodollar Market

A Eurocurrency market consists of banks that accept deposits and make loans in currencies other than those of their own country.² The modern Eurodollar market evolved from the special circumstances of the post-World War II international finance system.³ Early in this period, many foreigners found it convenient to deposit dollar balances with banks in Europe. As in the post-World War I period, these funds were generally repatriated to the U.S. as European banks acquired dollar assets directly through the U.S. money market.⁴ By the end of the 1950s, however, Eurobanks began lending dollar-denominated funds, and this activity spawned the modern Eurodollar market.

The primary reason for this market's development and subsequent expansion is that, like other financial market innovations, it reduces the costs of international trade by offering traders an efficient means of economizing on transaction balances in a world where most trade is denominated and transacted in dollars. Regulation Q ceilings and differential reserve requirements for various categories of U.S. bank liabilities also contribute to further Eurodollar intermediation. U.S. banks periodically encounter difficulty in attracting and retaining corporate deposit balances because of effective Regulation Q interest rate ceilings.⁵ Foreign branches of U.S. banks, however, do not face these restrictions. Consequently, as interest rates rise and the yield differential between Eurodollar and domestic deposits widens, corporate depositors channel funds into Eurodollar accounts. Foreign branches of U.S. banks then can re-lend the funds back to the parent institution. In this way, many U.S. banks are able to mitigate some of the consequences of the disintermediation that accompanies periods of

rising U.S. interest rates.⁶ Finally, differences in reserve requirements across bank liabilities often reinforce U.S. banks' incentive to secure funds from Eurodollar sources.

The Eurodollar Banking System

Because Eurobanks intermediate between lenders and borrowers, the Eurodollar market, like any other fractional reserve banking system, can expand the amount of Eurodollar liabilities. Since not all depositors will withdraw their funds simultaneously, Eurobanks can lend these deposits, and the transferral of these funds from one bank to another produces a multiple expansion of deposits and credit. In national banking systems, this multiple expansion is limited by the extent to which banks hold required or precautionary reserves. The potential expansion of dollar-denominated credit occurring through the Eurodollar system is limited only by the amount of precautionary reserves that Eurobanks hold in order to meet their short-term liquidity needs.

Eurobanks do not issue demand deposits, even though some deposits are of very short duration—frequently overnight—and can be transferred from one individual to another easily and conveniently. Despite this rapid transferability, Eurodollars are not *generally* acceptable as payment for goods and services in any country and therefore are excluded from current definitions of money.⁷ Borrowers of Eurodollars who wish to buy goods and services with the proceeds of a loan must first convert them into some national currency.⁸ Viewed in this light, Eurodollar deposits are similar to savings and time deposits that serve as a “temporary abode of purchasing power.”

In summary, the Eurodollar system can expand *credit* by some multiple of its reserves, but it cannot create *money* since its liabilities, unlike those of banks, are not generally acceptable as a means of payment. Although the Eurodollar market does not create money directly, it may generate some important *indirect* effects if Eurodollar transactions affect *domestic* money stocks.

²Although U.S. banks are prohibited from accepting deposits or making loans in currencies other than U.S. dollars, banks in other countries, including foreign branches of U.S. banks, are not.

³For a detailed discussion of the history of this market see Paul Einzig, *The Eurodollar System*, 5th ed. (New York: St. Martin's Press, 1973).

⁴Some authors have attributed a special role in the development of the Eurodollar market to Communist bloc countries. It is argued that these countries feared that their assets would be frozen by the U.S. government as part of Cold War political strategy.

⁵The emergence of the large denomination certificate of deposit (CD) market can be traced to the early 1960s, when corporate financial officers began managing cash positions more carefully to take advantage of the higher interest rates offered on short-term time deposits. (Banks have not been permitted to pay explicit interest on demand deposits.)

⁶Until these borrowings by U.S. banks were subjected to reserve requirements, banks had an additional incentive to acquire such funds.

⁷The Federal Reserve Board of Governors does include “overnight Eurodollars held by U.S. residents other than banks at Caribbean branches of member banks” in its current definition of M2. This article, however, focuses on the transaction-based definitions of money—old M1 and the newly defined M1A and M1B.

⁸This process is analogous to that which occurs when an individual borrows from a savings and loan institution. Before spending these funds, he too must first convert the loan into currency or demand deposits at a commercial bank.

Transaction 1. Conversion of Demand Deposits into Eurodollars					
Public		U.S. banks		Eurobanks	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
DDP—\$100		DDE+\$100		DDE+\$100	ED+\$100
ED+\$100		DDP—\$100			

Can Eurodollar Transactions Affect the U.S. Money Stock?

The Eurodollar market and the U.S. monetary system are linked by those transactions in which holders of U.S. dollar-denominated assets deposit dollars in Eurobanks, or in which holders of Eurodollars spend these funds in the United States. The majority of such transactions involves the exchange of short-term assets. For example, an individual or a corporation that owns demand deposits, certificates of deposit, repurchase agreements, Treasury bills, or commercial paper may convert these assets into Eurodollars. Similarly, holders of Eurodollars, or borrowers in the Eurodollar market, may convert these funds into domestic financial instruments or buy goods and services outright.

In the following discussion, four transactions are used to typify the relationship between the Eurodollar and U.S. money markets.⁹ Transactions 1 and 3 involve the conversion of demand deposits into Eurodollars. Transaction 1 assumes that Eurodollar institutions hold their reserve assets in the form of demand deposits at U.S. banks; transaction 3 assumes that these reserve assets are held in the form of balances "due from" U.S. banks. Transactions 2 and 4 involve conversion of other U.S. bank liabilities such as certificates of deposit into Eurodollars. Transactions 2 and 4 maintain the same assumptions as transactions 1 and 3, respectively, about the form in which Eurodollar institutions maintain their reserves.

For convenience, two additional assumptions are made. First, the Federal Reserve System continues to supply the monetary base at some predetermined constant rate. This assumption is necessary to distinguish the effect of Eurodollar transactions from policy-induced changes in money stock. Second, the required reserve ratio is assumed to be 10 percent on demand deposits and 5 percent on other bank liabilities.

⁹Although they do not exhaust all possible asset substitutions, these four transactions are representative of the way in which Eurodollar-related transactions affect the U.S. money stock.

In transaction 1, a holder of demand deposits at a U.S. bank transfers \$100 million into Eurodollar deposits at a Eurobank.¹⁰ On the public's balance sheet, demand deposits (DDP) decline and Eurodollar deposits (ED) rise by the same amount. At the Eurobank, the individual's account is credited and the bank's Eurodollar liabilities rise by \$100 million. When the check clears, the U.S. bank's demand deposit liability to the public (DDP) declines and the demand deposit liability to the Eurobank (DDE) increases. The Eurobank's balance sheet will record this transaction as an increase in assets.

The impact of this transaction on the U.S. money stock depends on how money is measured. Using the old definition of money (M1), which includes foreign commercial bank demand deposits at U.S. banks, the money supply is unaffected since DDP declined and DDE rose by the same amount. Because DDP and DDE have the same reserve requirements, excess reserves are not affected and no further contraction or expansion of loans and deposits in the U.S. is possible.

On the other hand, if money is measured either by M1A or M1B (which *exclude* foreign bank demand deposits at U.S. banks), then the money supply decreases by the amount of the transaction since DDP declines while the increase in DDE is not counted. Because excess reserves are still unaffected, there will be no further change in the money stock. Thus, the initial effect of deposit outflows into the Eurodollar market lowers the money stock, as currently measured, by an amount equivalent to the size of the transaction.

It is important to note that in this transaction Eurobanks collectively are assumed to hold total reserves (in the form of demand deposit balances at U.S. banks) equal to the initial dollar outflow from U.S. banks. If, in the extreme, Eurobanks hold *no* reserves at all, the U.S. money stock, however defined, will be

¹⁰This Eurobank may be a foreign branch of some U.S. bank or an unaffiliated foreign bank.

Transaction 2. Conversion of Certificates of Deposit into Eurodollars

Public		U.S. banks		Eurobanks	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
CD-\$100		CD-\$100		DDE+\$100	ED+\$100
ED+\$100		DDE+\$100			

unaffected.¹¹ However, to the extent that Eurobanks hold some precautionary reserves in the form of demand deposits at U.S. banks, the qualitative effect of the Eurodollar transactions is the same as outlined above.

In transaction 2, the owner of a certificate of deposit (CD) at a U.S. bank fails to renew a maturing CD and deposits the funds as a Eurodollar deposit at some foreign bank. On the public's balance sheet, CDs fall and Eurodollar deposits rise. At the Eurobank, Eurodollar liabilities increase and, when the transaction clears, the foreign bank's deposits at the U.S. bank rise. At the U.S. bank, domestic CDs fall while liabilities to foreign banks rise. If money is measured as M1, then the increase in DDE implies an immediate increase in the money supply. On the other hand, if M1B (or M1A) is used, the money stock does not change since neither CDs nor DDEs are included in the definition of money. In both cases, however, bank excess reserves decline. Because the DDE reserve requirement is 10 percent and the CD reserve requirement is 5 percent, an increase in DDE, offset by an equivalent decrease in CDs, raises banks' required reserves by 5 percent of the transaction. Since banks must contract loans and deposits, the money stock will decline. Thus, in the case of M1, the net effect is an expansion (an immediate increase in M1 plus a subsequent, less than fully offsetting, contraction caused by a decrease in excess reserves). In the case of M1B, there is a net contraction (no immediate change in M1B—only the subsequent contraction).

These results are derived from the assumption that the Eurodollar banking system maintains precaution-

ary reserves in the form of demand deposit balances at U.S. commercial banks.¹² The effect of Eurodollar-related transactions on the U.S. money stock will be somewhat different if Eurobanks hold their precautionary reserves in a different form. For instance, the Eurobank receiving the initial deposit transfer from a U.S. bank will, on the day of the transaction, actually receive a credit referred to as balances "due from" the U.S. bank. The U.S. bank initially carries the transaction as balances "due to" a foreign bank. This part of the transaction is analogous to the initial book entries made by domestic banks when funds transferred between them are in the process of collection. Transactions 1 and 2 assume that these "collection balances" are cleared quickly with offsetting changes to U.S. demand deposit balances of the Eurobanks. This assumption is appropriate if the Eurobank wishes to lend to non-bank borrowers.

On the other hand, if the Eurobank continues to carry the "due from" item on its balance sheet, the U.S. bank will record a corresponding liability item "due to" a foreign branch or commercial bank instead of recording a demand deposit.¹³ The Federal Reserve defines the *net* amount of these "due tos" (gross "due tos," less the U.S. bank's "due froms") as Eurodollar borrowings.¹⁴ In this case, Eurodollar borrowings increase and, because these borrowings are subject to different reserve requirements than demand

¹¹The Eurobank would create a new loan equal to the full amount of DDE, thereby drawing down such balances. The borrower would have to acquire a U.S. demand deposit before he could spend the proceeds of this loan. This transaction then restores the balance sheet of the U.S. bank to its original position. Note that this intermediation through the Eurodollar market generates a greater extension of credit than would have occurred if generated through the U.S. banking system only.

¹²In the event that the Eurodollar banking system held no reserves, the final effect of this second transaction would be to increase the money stock under any definition of money.

¹³The Eurobank may consider these funds to be either precautionary reserve balances or an earning asset like any other loan, depending on the nature of its relationship with the U.S. bank and on whether the "due from" credit explicitly earns interest and is of some specific duration. Whether these funds are regarded as reserves or an earning asset, their impact on the U.S. money stock is the same as described in the text.

¹⁴For foreign commercial banks that are not branches of U.S. banks, only those gross "due to" balances *not* designated as demand deposits are treated as Eurodollar borrowings. For branches of U.S. banks, all gross balances "due to" the branch enter into the calculation of Eurodollar borrowings.

Transaction 3. Conversion of Demand Deposits into Eurodollars					
Public		U.S. banks		Eurobanks	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
DDP-\$100			DT+\$100	DF+\$100	ED+\$100
ED+\$100			DDP-\$100		

deposits, the money stock is affected differently. The two transactions outlined above are now re-examined under the assumption that the Eurobank chooses to carry an asset in the form of a "due from."

In transaction 3, as in transaction 1 above, \$100 million in demand deposits at a U.S. bank are converted into Eurodollars. Balance sheet entries in the public's account are identical to those in transaction 1. Unlike that example, however, the Eurobank records its assets from the transaction as balances "due from" (DF) U.S. banks. At the U.S. bank, DDP declines and funds "due to" (DT) its own branch or other foreign banks rise by \$100 million. This transfer has two immediate effects. First, M1, M1A, and M1B decline by \$100 million since DDP falls by \$100 million and DT is not included in either measure of the money stock. Second, since banks are assumed to hold reserves equal to 10 percent on demand deposits and 5 percent on all other liabilities, including Eurodollar borrowings, the U.S. bank's excess reserves rise by \$5 million. These excess reserves permit an expansion of loans and deposits, partially offsetting the initial decline in the money supply.

In transaction 4, the U.S. public converts \$100 mil-

lion in CDs into a Eurodollar deposit at a foreign bank. The change in the public's balance sheet is identical to transaction 2. Eurobank liabilities rise by \$100 million, as do balances "due from" the U.S. bank. Upon clearing the transaction, U.S. bank liabilities in the form of CDs fall, while funds "due to" its foreign branch rise by \$100 million. Since neither CDs nor DTs are included in the definitions of money and since both, by assumption, have the same reserve requirement, the money stock is unaffected.

As this discussion illustrates, Eurodollar transactions can affect the U.S. money supply even when the monetary base remains constant. The extent to which Eurodollar transactions affect the money stock depends partially on how money is measured.¹⁵ Differential reserve requirements combine with Eurodollar flows to produce an additional effect on the money stock. The transactions outlined here, however, have essentially the same impact on the money stock as do transfers from demand deposits into domestic time deposits or other near-money assets. Consequently, the problems that such transfers might create for monetary control are not unique to Eurodollar transactions.

Transaction 4. Conversion of Certificates of Deposit into Eurodollars					
Public		U.S. banks		Eurobanks	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
CD-\$100			CD-\$100	DF+\$100	ED+\$100
ED+\$100			DT+\$100		

¹⁵Additional transactions would have to be examined if the U.S. money supply is measured by broader aggregates, such as M2. For instance, if the demand deposit transfer outlined in transaction 1 were channeled to a Caribbean branch of a U.S. bank, M1A and M1B would decline as before, but M2 would not change. An increase in the magnitude of such transfers might suggest the desirability of redefining trans-

action balances. On the other hand, to the extent that such transfers occur *because* differential reserve requirements encourage banks to raise funds in this way, the differential effects on the various monetary aggregates could be eliminated by uniformly applying reserve requirements to branch Eurodollar deposits of non-bank institutions.

EFFECTS OF EURODOLLAR TRANSACTIONS

Although the foregoing analysis of balance sheets can illustrate the effects of a single transaction, it overlooks other portfolio changes that often accompany the transaction. The transactions described above involved a change in preferences for Eurodollar deposits relative to domestic bank deposits. By holding other asset balances constant, however, these transactions also implicitly altered preferences for all other assets relative to demand deposits (or Eurodollars).

An alternative analytical model provides a more convenient framework for investigating the effect of relative shifts in preferences between *only* two assets. A money multiplier model can analyze directly the effect on the U.S. money stock of a change in portfolio preferences between any two assets while holding constant the relative preferences for all other assets. The next section develops such a model and provides some quantitative estimates of the impact of Eurodollar transactions on the U.S. money stock.

A Multiplier Model

The money multiplier framework can be used to analyze how changes in the portfolio decisions of commercial banks and the public affect the domestic money supply. Such changes are typically described by changes in the various ratios that comprise the money multiplier. For instance, a shift in the public's preferences for time deposits relative to demand deposits is characterized by a change in the desired *t*-ratio.¹⁶ Money multipliers for three definitions of money — M1, M1A, and M1B — are derived in the appendix and reproduced here.

$$(1) m_1 = \frac{1 + f + k}{\Delta},$$

$$(2) m_{1a} = \frac{1 + k}{\Delta},$$

$$(3) m_{1b} = \frac{1 + k + n}{\Delta},$$

where $\Delta = r_d [(1+f+d) + n] + r_t t + r_c c + r_h h + e + k$.¹⁷ These multipliers provide the framework for

¹⁶When the initial substitution results in a reduction in demand deposits, all other actual ratios will rise momentarily. Because its *desired* ratios for other assets have not changed, the public will reduce its holdings of other liabilities to restore these ratios to their desired levels. An increase in the *t*-ratio, for example, will be accompanied by an increase in time deposits and a reduction in demand deposits, currency, etc.

¹⁷The denominator (Δ) of each multiplier includes four different required reserve ratios, in contrast to the simplifying assumption of two reserve requirements made in the preceding section. This approach makes the analysis more realis-

Table 1

Definitions of Ratios Used in the Money Multipliers

Ratio symbol	Ratio of the following items to demand deposits of the non-bank public (the demand deposit component of M1A)
c	Large denomination certificates of deposit
d	Demand deposits of the U.S. Treasury at commercial banks
e	Excess reserves
f	Demand deposits of foreign commercial banks and official institutions at U.S. commercial banks
h	Net Eurodollar borrowings
k	Currency held by the non-bank public
n	Interest-bearing checkable deposits (ATS and NOW accounts, and share drafts at credit unions)
t	Time and savings deposit component of the money stock
r _j	Reserve ratios against various bank liabilities (j = c, d, h, and t)

examining the implications of various Eurodollar transactions. For convenience, table 1 defines the ratios that comprise the multipliers.

Eurodollar transactions may affect the multiplier either through domestic banks' net balances "due to" its own branches and to other Eurobanks (i.e., through Eurodollar borrowing) or through foreign commercial banks' deposits with U.S. banks. Shifts in preferences toward Eurodollars similar to those described by transactions 1 and 3 are represented in the multiplier model either by changes in the ratio of foreign commercial bank deposits to domestic demand deposits (the *f*-ratio) or by changes in the ratio of Eurodollar borrowing to domestic demand deposits (the *h*-ratio). Asset shifts like those detailed in transactions 2 and 4 entail a shift in preferences from certificates of deposit to Eurodollars. Thus both the ratio of CDs to domestic demand deposits (the *c*-ratio) and either the *f*- or *h*-ratio change simultaneously.

Changes in the portfolio decisions of the public and commercial banks affect the money stock. These effects can be analyzed by differentiating these multipliers with respect to changes in the relevant preference ratios. These partial differentials can be translated easily into elasticities.

tic. Nevertheless, the present model retains the assumption that all checkable deposits are subject to a single, uniform reserve requirement. Under current regulations, checkable deposits are subject to different reserve requirements, depending on bank size and the type of deposit.

Table 2
Elasticities of Money Multipliers with Respect to Changes in Selected Preference Ratios

Multiplier	f-ratio	h-ratio	c-ratio
m_1	$\frac{f}{\Delta} \left[\frac{1}{m_1} - r_d \right]$	$-r_h \frac{h}{\Delta}$	$-r_c \frac{c}{\Delta}$
m_{1a}	$-r_d \frac{f}{\Delta}$	$-r_h \frac{h}{\Delta}$	$-r_c \frac{c}{\Delta}$
m_{1b}	$-r_d \frac{f}{\Delta}$	$-r_h \frac{h}{\Delta}$	$-r_c \frac{c}{\Delta}$

Elasticities were determined for each multiplier with respect to changes in the f-, h-, and c-ratios and are presented in table 2. Because the elasticities for M1A and M1B are identical, only the analysis for M1B—the broader measure of transactions balances—is discussed below.

In transaction 1, the public's shift from U.S. demand deposits toward Eurodollars was associated initially with an increase in foreign commercial banks' demand deposits at U.S. banks. In the multiplier framework this transaction would be characterized by an increase in the f-ratio. This change assumes that Eurobanks hold precautionary reserve balances in the form of demand deposits at U.S. banks and that these reserves are proportional to the total volume of Eurodollar deposits.¹⁸ The initial deposit shift toward Eurodollars increases Eurodollar reserves, thereby allowing an expansion of Eurodollar loans and deposits. Although Eurobanks have not changed their desired ratio of Eurodollar reserves as a share of total *Eurodollar deposits*, Eurodollar reserves as a percent of *U.S. demand deposits* have risen.

Table 2 indicates that the sign of the elasticity of the M1 multiplier (m_1) with respect to changes in the f-ratio depends upon the relationship between m_1 and the average reserve ratio against demand deposits (r_d). Over the past two decades, m_1 has rarely fallen below 2.5, and the highest marginal reserve requirement has never exceeded .17. Clearly then, for even these extreme values of r_d and m_1 , the elasticity of

¹⁸This simplifying assumption probably overstates the extent to which such deposits serve as reserves for the Eurodollar system and consequently *overstates* the effect that Eurodollars have on the U.S. money stock.

m_1 with respect to the f-ratio is positive. That is, an increase in f is associated with an increase in the U.S. money stock as measured by M1. In contrast, the elasticity of the M1B multiplier (m_{1b}) with respect to changes in the f-ratio is negative. The difference between the m_1 and m_{1b} elasticities results from excluding foreign commercial bank deposits from the new measures of the U.S. money stock. Further, for plausible values of m_1 and r_d , the absolute value of the elasticity of m_1 with respect to f exceeds that of m_{1b} .

Changes in the h-ratio reflect a preferential shift in the composition of U.S. bank liabilities toward Eurodollar borrowing. As shown in table 2, elasticities for each multiplier with respect to the ratio of Eurodollar borrowing to domestic demand deposits (h) are identical. Thus, changes in Eurodollar borrowing by U.S. banks have a similar effect on the money stock regardless of how money is defined. (Note that if r_h is zero, as is currently the case, these elasticities are zero.)

A shift in the preferences of the U.S. non-bank public away from domestically issued CDs is represented by a change in the ratio of CDs to domestic demand deposits (c). If this shift is accompanied by an offsetting change in either the f- or h-ratio, then the impact on the U.S. money stock will be the result of the combined elasticities of the multipliers with respect to the c- and f- (or c- and h-) ratios. This is the multiplier counterpart to transactions 2 and 4 above. As shown in table 2, all multipliers have the same negative elasticity with respect to the c-ratio.

Table 3 reports numerical values for these elasticities, calculated from monthly data over the period

Table 3
Calculated Elasticities of Money Multipliers with Respect to Changes in Selected Preference Ratios (1973-1979)

Multiplier	f-ratio	h-ratio ¹	c-ratio
m_1	.021	-.004	-.044
m_{1a}	-.006	-.004	-.044
m_{1b}	-.006	-.004	-.044

¹Based on the period from 1973 through September 1978, during which Eurodollar borrowings were subject to reserve requirements. Federal Reserve action announced in August 1978 lowered reserve requirements against such borrowings to zero, beginning in October 1978.

from January 1973 through December 1979.¹⁹ These elasticities indicate that a 1 percent increase in the f-ratio would cause a .021 percent increase in m_1 and a .006 percent decline in both m_{1a} and m_{1b} . Further, these calculations reveal that, although the multipliers are more sensitive to fluctuations in the c-ratio, even those elasticities are small. Therefore, unless changes in the ratios are large, they would have little impact on the money stock. For instance, suppose that m_{1b} is 2.5, that the monetary base is \$160 billion, and that M1B is \$400 billion. Holding the base constant, a 1 percent increase in the c-ratio would lower M1B by approximately \$176 million, while a 1 percent increase in the f-ratio would lower M1B by only \$24 million.

Interest Rate Effects

Since these ratios are intended to reflect the portfolio behavior of the public and the commercial banking system, they should vary with interest rates. Thus, if the ratios reflecting Eurodollar activity are sufficiently interest-sensitive, changes in interest rates will change the money stock.²⁰

The interest-sensitivity of Eurodollar flows depends upon the extent to which Eurodollars are substitutes for domestic deposits. Term Eurodollars are Eurodollar liabilities of a specified maturity, usually 90 days or less. The relative attractiveness of these deposits should vary with their interest rate differential against domestic CDs. If both assets were perfect substitutes, they would require the same yield. On the other hand, if depositors considered domestically issued CDs to be safer or more convenient, Eurodollar deposits would yield a higher interest rate, implying that a positive interest rate spread would prevail even in equilibrium. Any momentary widening of this spread would attract funds to the Eurodollar market. Thus, Eurodollar flows should vary directly with changes in the equilibrium interest rate spread.

The equilibrium spread itself will vary with changes in market interest rates if U.S. bank liabilities are subject to different reserve requirements. For example, as U.S. banks bid competitively for funds, the mar-

ginal effective cost of funds from various sources tends toward equality. (For convenience, this discussion focuses on only two bank liabilities — U.S. CDs and borrowings from Eurobanks.) Under current regulations, CDs are subject to a higher marginal reserve requirement than are Eurodollar borrowings.²¹ Assuming no reserve requirement against Eurodollar borrowing, the cost of these liabilities to U.S. banks is equalized when the following condition is satisfied:

$$(4) \quad i_E = \frac{i_{U.S.}}{1 - r_c},$$

where $i_{U.S.}$, i_E , and r_c are, respectively, the domestic CD rate, the Eurodollar interbank lending rate, and the marginal reserve requirement against CDs.²²

The spread, S , between Eurodollar and U.S. interest rates is defined as:

$$(5) \quad S = i_E - i_{U.S.},$$

which upon substitution from equation (4) produces $(\frac{r_c}{1 - r_c}) i_{U.S.}$. If U.S. interest rates rise, the spread between Eurodollars and domestic CDs will widen. Differentiating equation (5) with respect to $i_{U.S.}$ yields

$$(6) \quad \frac{dS}{d i_{U.S.}} = \frac{r_c}{1 - r_c}.$$

Since $\frac{r_c}{1 - r_c}$ is positive, an increase in U.S. market interest rates will be associated with an increase in the Eurodollar/U.S. interest rate *differential* which, in turn, will stimulate a flow of funds from domestic CDs to the Eurodollar market.

Equation (6) implies that the elasticity of the interest rate spread with respect to the level of U.S. interest rates should be $(\frac{r_c}{1 - r_c}) \frac{i_{U.S.}}{S}$. Using the U.S. certificate of deposit rate as the representative U.S. interest rate, this elasticity was estimated to be 1.08 over the period from 1973 through 1979.²³ This value did not differ significantly from unity, indicating that a 1 percent rise in the level of U.S. interest rates is asso-

¹⁹The elasticity expressions from table 2 were calculated for each month in the sample and then averaged over the period. For the f-ratio elasticities, a 9 percent average reserve requirement against demand deposits was assumed. For the h- and c-ratios, actual marginal reserve requirements in effect during each month were used.

²⁰The positive (and larger) elasticity of the M1 multiplier, with respect to the f-ratio, suggests that M1 would fluctuate more than either M1A or M1B when the f-ratio changes. If the f-ratio is interest-sensitive, then M1 would show greater volatility due to interest rate changes than would either of the new definitions of money.

²¹Both domestic CDs and net Eurodollar borrowings, as part of a bank's "managed liabilities," were subject to a marginal reserve requirement on the total amount of managed liabilities above some base. This reserve requirement was imposed, in addition to any other reserve requirements, against the liability. At present, this separate reserve requirement is zero against net Eurodollar borrowings and is 6 percent against domestic CDs.

²²If there are reserve requirements against Eurodollar borrowing, the equal cost condition becomes $\frac{i_e}{1 - r_h} = \frac{i_{U.S.}}{1 - r_c}$.

²³This elasticity was also estimated using the U.S. Treasury bill rate by regressing the logs of the spread against a constant and the logs of the interest rate. Results were similar.

ciated with a 1 percent increase in the spread. In other words, the spread was some constant fraction of the level of U.S. interest rates.

Over much of this period, reserve requirements against CDs and Eurodollars were identical, implying that any observed spread would correspond to some risk or preference premium on Eurodollar deposits. Thus, the estimated unitary elasticity of this premium, with respect to the level of U.S. interest rates, suggests that the risk premium varies directly with interest rate levels. Interestingly, for the subperiod from September 1978 through December 1979, after reserve requirements against Eurodollar borrowings were lowered to zero, the estimated interest rate spread elasticity of 1.57 differed significantly from unity at the 10 percent confidence level. This result is consistent with the *effective* risk spread remaining a constant ratio to the level of U.S. interest rates.

If the money multipliers are more interest-sensitive due to Eurodollar activity, the Fed's ability to restrain money and credit expansion could be affected, as some critics of the Eurodollar market have asserted. For example, if Federal Reserve policy temporarily raises domestic interest rates, the volume of CDs could be expected to decline relative to Eurodollar borrowings by U.S. banks. Such Eurodollar-related flows would affect both the c- and h-ratios and, consequently, the multipliers. The net impact on the U.S. money stock depends on both the interest elasticities of these ratios and the elasticities of the multipliers with respect to changes in the ratios.

POTENTIAL IMPACT OF EURODOLLAR TRANSACTIONS ON THE U.S. MONEY STOCK

Two critically important results are evident in the foregoing discussion. First, Eurodollar transactions affect the behavior of the U.S. money supply primarily through their impact on the money multipliers.²⁴ Second, Eurodollar transactions respond to changes in interest rate differentials that are related to interest rate levels. The behavior of the three relevant ratios is examined to assess the importance of these Eurodollar-related effects for the 1973-79 period.

Table 4 reports the annual averages (of monthly data) for the f-, h-, and c-ratios from 1973-79. The

²⁴Even if these Eurodollar transactions have a sizeable impact on the money stock, they would not pose an insurmountable barrier to *controlling* the money stock. To the extent that such effects are predictable, the monetary authority could offset them in its conduct of monetary policy.

Table 4

Values of Selected Preference Ratios (Annual Averages of Monthly Data)

Year	f-ratio	h-ratio	c-ratio
1973	.029	.038	.299
1974	.037	.045	.386
1975	.036	.026	.402
1976	.038	.019	.313
1977	.042	.004	.278
1978	.043	.008	.347
1979	.039	.096	.359

f-ratio, ranging from .029 to .043, shows the least amount of year-to-year variation, while the c- and h-ratios are more volatile. Using annual averages of the c- and h-ratios, however, masks much of their intra-year variability. For instance, despite an apparent increase in 1979 over its 1978 value, the c-ratio actually declined substantially during most of the year and, by year end, was 11 percent lower than it had been at the beginning of the year. The h-ratio, on the other hand, began to rise sharply after Federal Reserve Board action in August 1978 lowered the reserve requirement on net Eurodollar borrowing to zero in August 1978.²⁵

Table 5 reports the estimated interest elasticities of these ratios and provides another perspective on their behavior over the past eight years.²⁶ All interest elasticities are positive and differ significantly from zero at least at the 10 percent confidence level. The estimated interest elasticities for both the f- and h-ratios exceed that of the c-ratio, reinforcing the view that the presence of differential reserve requirements induces more

²⁵For a discussion of the extent to which Eurodollar borrowings are substituted for domestic CDs, see David H. Resler, "Does Eurodollar Borrowing Improve the Dollar's Foreign Exchange Value?" this *Review* (August 1979), pp. 10-16.

²⁶Data reported in table 5 were computed by estimating equations of the general form $\ln x = a_0 + a_1 \ln i + u$, where x designates the ratio, i the market yield on three-month Treasury bills, and u a random error term. This equation was estimated by a Cochrane-Orcutt iterative regression technique to correct for the presence of serially correlated residuals in the ordinary least squares regression. For the cross elasticities, $\ln c$ was substituted for $\ln i$ in this general expression. Although it would be desirable to estimate the elasticities of these ratios with respect to the interest rate spread, such estimates would require the specification of a full structural model. Consequently, the estimates provided here should be considered to be crude approximations of the interest elasticities that are useful for a rough determination of the importance of Eurodollar activity in the U.S. money supply process.

Table 5
Elasticities of Selected Preference Ratios (1973-79)¹

Ratio	With respect to:	
	Interest rates	c-ratio
f	.196 (2.017)	-.081 (-.448)
h	.715 (1.966)	-.441 (-.649)
c	.147 (2.534)	

¹t-statistics appear in parentheses.

substantial Eurodollar flows during periods of rising interest rates.²⁷

Table 5 also reports estimates of the cross elasticities of the h- and f-ratios against the c-ratios. Although these elasticities were of the predicted sign, they did not differ significantly from zero, indicating that substitutions between Eurodollar transactions and domestic CDs have not had an important effect on these ratios during the period.

The potential effect of interest-induced Eurodollar transactions on the money stock can be evaluated by using estimates reported in tables 3 and 5. Assuming a constant monetary base of \$160 billion, the potential effect that Eurodollar transactions would have on M1 and M1B was calculated for a 1 percent change in the level of interest rates (10 basis points if interest rates are initially 10 percent).²⁸ These calculations indicate that if old M1 were used to measure money, the U.S. money stock would be about \$68 million higher than it would have been otherwise. On the other hand, if measured by M1B, the money stock would have been only about \$44 million higher. In each case, these changes are less than two *one-hundredths* of 1 percent of the money stock. Even a 10 percent monthly increase (100 basis points) in domestic interest rates would result in an average monthly money stock

²⁷Elasticity estimates for the h-ratio were derived indirectly. Since calculations of the elasticities were based on logarithmic transformations of the actual ratios and since the h-ratio was negative during some months of the sample period, it was necessary to first transform the h-ratio by adding one to all values for h. The estimated elasticity of $1 + h$ was then converted into an elasticity for h by multiplying the estimated coefficient of $(1 + h)$ by $(1 + h)/h$, evaluated at the mean values of h over the sample period.

²⁸These calculations were based on average values of the multipliers and the estimated elasticities of the three ratios, even though the t-statistics for some coefficients did not differ significantly from zero.

(M1) that would be less than 0.2 of 1 percent higher. Because the assumptions used in this analysis exaggerate the effect that Eurodollar transactions have on the money stock, it is apparent that Eurodollar transactions have only a small effect on the U.S. money supply. Further, the Federal Reserve could easily offset this effect with appropriate open-market transactions.

Summary and Conclusions

This article has examined the extent to which Eurodollar transactions can affect the U.S. money supply, as measured by current and past Federal Reserve Board versions of narrowly defined money. Using both T-accounts and a money multiplier framework, Eurodollar transactions were shown to affect the U.S. money stock in two ways. First, regardless of the chosen definition of money, Eurodollar flows may affect the U.S. money stock indirectly through their impact on the portfolio composition of U.S. banks' liabilities. Changes in this portfolio composition, whether due to Eurodollar flows or simply domestic asset shifts, may affect the money supply through differential reserve requirements. Second, Eurodollar flows may affect foreign commercial bank demand deposits at U.S. banks. To the extent that these deposits serve as reserves for the Eurodollar system, they will vary directly with flows between the U.S. Eurodollar and the U.S. money markets. Because these deposits are excluded from the new definitions of money, but not from the old M1 definition, Eurodollar flows will affect the various transactions-based definitions differently. Analysis based on the multiplier model indicated that old M1 would be slightly more sensitive to Eurodollar flows than either M1A or M1B.

Since Eurodollar transactions have some impact on narrowly defined money, the question of whether such transactions impair the monetary authorities' control of monetary aggregates merits investigation. The multiplier framework presented in this paper was used to examine systematically Eurodollar-induced effects on the money stock. Based on estimates over the period for 1973-79 — a period of rapid growth in the Eurodollar market — Eurodollar flows were shown to have only minor effects on the U.S. money stock. This evidence warrants the conclusion that the Eurodollar market does not pose a serious threat to the ability of the Federal Reserve to control the money supply.

APPENDIX: Derivation of Money Multipliers

A. Definitions of Symbols

Description	Variables	Ratio as to DP	Relevant reserve ratios
Bank Liabilities			
Time Deposits	T	t	r_t
Demand Deposits	—	—	—
Government	D_g	d	r_d
Non-bank public	D_p	l	r_d
Foreign Commercial bank	D_f	f	r_d
Large CDs	CD	c	r_c
Net Eurodollar borrowings	H	h	r_h
Interest-bearing checking deposits	ICD	n	r_d
NOW accounts	NOW		
Credit union drafts	DCU		
ATS accounts	ATS		
Excess reserves	E	e	—
Currency held by public	C	k	—
Source base	B	—	—
Money Stock Measures	M1 M1A M1B		

B. Derivations

- (1) $B = R + C$
- (2) $M1 = m_1 B = D_p + D_f + C$
 $M1A = m_{1a} B = D_p + C$
 $M1B = m_{1b} B = D_p + C + NOW + DCU + ATS$
 $= D_p + C + ICD$
- (3) $T = t D_p$
- (4) $D_g = d D_p$
- (5) $D_f = f D_p$
- (6) $CD = c D_p$
- (7) $H = h D_p$

$$(8) ICD = n D_p$$

$$(9) E = e F_p$$

$$(10) C = k D_p$$

$$(11) R = r_d (D_p + D_f + D_g + [ICD]) + r_t T + r_c CD + r_h H + E$$

Substituting into equation (11) from equations (3) through (10) produces:

$$(12) R = [r_d (1 + f + d + n) + r_t t + r_c c + r_h h + e] D_p$$

Thus (1) can be rewritten as:

$$(13) B = [r_d (1 + f + d + n) + r_t t + r_c c + r_h h + e + k] D_p = \Delta D_p$$

where Δ equals the bracketed term on the right hand side of (13).

Similarly, the three money definitions can be written as ratios to D_p :

$$(14) M1 = (1 + f + k) D_p$$

$$M1A = (1 + k) D_p$$

$$M1B = (1 + k + n) D_p$$

The three multipliers are derived by dividing all expressions in (14) by (13) producing:

$$(15) m_1 = \frac{1 + f + k}{\Delta},$$

$$m_{1a} = \frac{1 + k}{\Delta},$$

and $m_{1b} = \frac{1 + k + n}{\Delta}$, as in the text.



Dynamic Forecasting and the Demand for Money

SCOTT E. HEIN

MUCH of the statistical evidence on the breakdown in the short-run demand for money relationship in the United States results from poor *dynamic* out-of-sample simulations over the post-1974 period.¹ However, this evidence must be regarded cautiously because the dynamic forecasting procedure lacks a firm econometric foundation.

This paper reexamines the conclusions that have emerged from these inadequate dynamic money demand forecasts. First, it presents a conventional money demand relationship and its post-1974 dynamic forecasts, along with a restatement of the conclusions

¹Since only *ex post* forecasting is discussed in this paper, the terms "forecasts" and "out-of-sample simulations" are used interchangeably. In addition, this paper discusses the stability of a relationship in the statistical sense: a relationship is said to be stable if the regression coefficients are statistically invariant with time.

The following studies rely heavily on dynamic forecasting performance in their analysis of the stability of the demand for money relationship: Stephen M. Goldfeld, "The Case of the Missing Money," *Brookings Papers on Economic Activity* (3:1976), pp. 683-730; Jared Enzler, Lewis Johnson, and John Paulus, "Some Problems of Money Demand," *Brookings Papers on Economic Activity* (1:1976), pp. 261-79; Michael J. Hamburger, "Behavior of the Money Stock: Is There a Puzzle?" *Journal of Monetary Economics* (No. 3, 1977), pp. 265-88; Gillian Garcia and Simon Pak, "Some Clues in the Case of the Missing Money," *American Economic Review, Papers and Proceedings* (May 1979), pp. 330-34; and Richard D. Porter, Thomas D. Simpson, and Eileen Mauskopf, "Financial Innovation and the Monetary Aggregates," *Brookings Papers on Economic Activity* (1:1979), pp. 213-29.

ERRATA: Change \tilde{Y} to \hat{Y} in eq. 4 & 11; p. 16, col. 1, line 9; p. 16, col. 2, line 20. Change $\tilde{Y}_{T+2} - Y_{T+2}$ to $Y_{T+2} - \tilde{Y}_{T+2}$, p. 17, col. 2, line 2.

drawn from such an investigation.² Next, the dynamic forecasting procedure is contrasted, in general terms, with the more widely understood *static* forecasting technique. This analysis provides a framework for reevaluating conclusions about the breakdown in the money demand relationship.

The review demonstrates that certain inferences drawn from dynamic forecasts of money demand over the post-1974 period are incorrect and misleading. In general, the pattern and the degree of breakdown in the money demand relationship has been obscured by reliance on this forecasting procedure. The shifts are neither as large nor as frequent as suggested by the dynamic forecast errors.

A Conventional Demand for Money Relationship and Its Dynamic Forecasts

The money demand relationship considered here is given by:

$$(1) \quad \ln(M_t/P_t) = \alpha_0 + \alpha_1 \ln TBR_t + \alpha_2 \ln RCB_t + \alpha_3 \ln GNPR_t + \alpha_4 \ln(M_{t-1}/P_{t-1}) + \varepsilon_t$$

where M is measured by old M1 balances, P is the

²With the exception of Michael J. Hamburger and Gillian Garcia and Simon Pak, all of the above studies obtained poor out-of-sample money demand simulations for the post-1974 period. For an alternative view on the stability suggested by Hamburger and Garcia-Pak, see R. W. Hafer and Scott E. Hein, "Evidence on the Temporal Stability of the Demand for Money Relationship in the United States," this *Review* (December 1979), pp. 3-14.

implicit GNP deflator (1972 = 100), TBR is the treasury bill rate, RCB is the commercial bank pass-book rate, GNPR is real GNP (1972 dollars), and ε_t is a random error term.³ This relationship was estimated for the sample period IV/1960 — II/1974 with ordinary least squares, after correcting for serial correlation in the error terms.⁴ The estimated coefficients and summary statistics are as follows:⁵

$$(2) \ln(M_t/P_t) = -0.978 - 0.012 \ln TBR_t - 0.044 \ln RCB_t + \\ (4.01) \quad (1.95) \quad (2.33) \\ 0.208 \ln GNPR_t + 0.542 \ln(M_{t-1}/P_{t-1}). \\ (4.00) \quad (4.06)$$

$$\bar{R}^2 = 0.964$$

$$SEE = 4.68E-03$$

$$DW = 1.63; \text{ Durbin-h} = 9.79$$

$$RHO = 0.57$$

All estimated coefficients have the anticipated sign, are significantly different from zero, and are similar in magnitude to those found by others. The coefficient of determination corrected for degrees of freedom, \bar{R}^2 , shows that a substantial portion of the variation in real money balances is explained by the independent variables on the right-hand side of the equation.

This estimated equation was used to *dynamically* forecast the dependent variable, $\ln(M_t/P_t)$, for the post-sample period III/1974 — IV/1979. With the exception of the lagged dependent variable, actual values of the independent variables were used to perform this dynamic simulation. For the first forecast, III/1974, the actual value of the lagged dependent variable was used; thereafter, the previous period's forecast for this variable was utilized. The dynamic money

³This relationship and sample period were chosen for comparison purposes. The relationship is similar to money demand specifications estimated by Goldfeld and Porter, et. al. Both studies, however, deflate the lagged money term on the right-hand side of the equation by the *contemporaneous* price level. In this study, the lagged money term is deflated by the lagged price level so that the relationship has a true lagged dependent variable. This simplifies the procedure used to obtain dynamic forecasts. The sample period used in the study coincides with that investigated by Porter, et. al.

⁴This author, in a paper co-authored with R. W. Hafer, "The Dynamics and Estimation of Short-Run Money Demand," this *Review* (March 1980), pp. 26-35, argues that directly estimating the relationship described in equation (1) will yield inconsistent estimates; the relationship should be first-differenced before estimation. When this estimation procedure is employed, the supposed breakdown in the relationship is no longer evident. This present paper, however, follows the more widely accepted practice of estimating equation (1) directly, with the Cochrane-Orcutt technique.

⁵The Durbin-h statistic, which is appropriate to test for serial correlation in the disturbances when a lagged dependent variable is present, indicates the existence of first-order autocorrelation, even after the Cochrane-Orcutt technique is used. This is a serious problem, indicating that more attention should be devoted to the actual estimation technique employed. However, since this specification and estimation technique is widely used in money demand studies, no attempt to correct this problem is made here. It should be noted that the estimation results reported by Porter, et. al., are subject to the same criticism.

demand forecasts and resulting forecast errors presented in table 1 (columns 3 and 4, respectively) are in general agreement with those found by others.

Real money balances are consistently overpredicted and by increasing proportions (table 1, column 6). For example, by the second quarter of 1978, prior to the introduction of nationwide ATS accounts and New York NOW accounts, real money balances were forecasted to be approximately \$27 billion above the actual level for that period.⁶

The inability to accurately simulate the movement of real money balances over this period led to the general conclusion that the money demand relationship shifted. In reviewing the evidence, Kimball states: "As these overpredictions continued and increased in size through 1975 and 1976, many economists concluded that the money demand function had shifted during 1974 by a substantial amount and that this shift placed in doubt the usefulness of (old) M1 as either an indicator of GNP or as a policy instrument."⁷

This summary statement pinpoints three separate conclusions drawn from the errors associated with dynamic out-of-sample simulations of money demand. First, there is the contention that the relationship was subject to some sort of shift in or around 1974. The forecast errors suggest that this shift was quite sizable. Second, the dynamic forecasting errors suggest that the relationship has been shifting ever since late 1974 (column 3, table 1). This view is consistent with the notion of a negative drift in money demand over the period.⁸ Finally, the evidence of a shift and subsequent drift has raised a question about the usefulness of this money measure as an indicator of monetary policy.

Static Versus Dynamic Forecasts: A General Comparison

Although the dynamic forecasting procedure has been a primary tool used to evaluate the statistical breakdown in the money demand relationship, it has received little, if any, attention in the econometric literature. This section attempts to partially fill the

⁶It is felt that the introduction of these interest-bearing "checking deposits" has led to a shift out of conventional demand deposits. Evidence of this type of shift is provided subsequently.

⁷Ralph C. Kimball, "Wire Transfer and the Demand for Money," Federal Reserve Bank of Boston *New England Economic Review* (March/April 1980), p. 14.

⁸See for example, Porter, et. al., "Financial Innovations and the Monetary Aggregates," p. 214. In that article, table 1 indicates that quarterly real balances grew at an annualized rate of nearly 4 percent below that suggested by the estimation equation for the period III/1974-IV/1976. Also, see "Inflation and the Destruction of Monetarism," (New York: Goldman Sachs Economics, November 1979), pp. 5-12.

Table 1
Post-Sample Dynamic Forecasts of Money Demand (III/1974-IV/1979)

Date	Actual ln (M _t /P _t)	Dynamic forecast of ln (M _t /P _t)	Dynamic forecast error	Dynamic forecast error as percent of dependent variable	Dynamic forecast error in billions of real money balances ¹
III/1974	0.8645	0.8865	-0.0220	-2.54	\$ -5.28
IV/1974	0.8462	0.8872	-0.0410	-4.84	-9.75
I/1975	0.8260	0.8851	-0.0591	-7.16	-13.91
II/1975	0.8260	0.8880	-0.0620	-7.51	-14.61
III/1975	0.8264	0.8925	-0.0661	-8.00	-15.61
IV/1975	0.8187	0.8975	-0.0788	-9.63	-18.59
I/1976	0.8213	0.9071	-0.0858	-10.44	-20.37
II/1976	0.8258	0.9129	-0.0871	-10.55	-20.78
III/1976	0.8246	0.9178	-0.0932	-11.31	-22.28
IV/1976	0.8283	0.9233	-0.0950	-11.47	-22.82
I/1977	0.8320	0.9310	-0.0990	-11.90	-23.91
II/1977	0.8319	0.9371	-0.1052	-12.65	-25.49
III/1977	0.8415	0.9425	-0.1009	-11.99	-24.65
IV/1977	0.8442	0.9452	-0.1010	-11.96	-24.72
I/1978	0.8455	0.9470	-0.1015	-12.00	-24.88
II/1978	0.8429	0.9519	-0.1090	-12.93	-26.75
III/1978	0.8451	0.9549	-0.1098	-12.99	-27.02
IV/1978	0.8350	0.9574	-0.1224	-14.66	-30.01
I/1979	0.8092	0.9584	-0.1492	-18.44	-36.14
II/1979	0.8071	0.9619	-0.1548	-19.18	-37.52
III/1979	0.8107	0.9591	-0.1484	-18.31	-35.99
IV/1979	0.8032	0.9550	-0.1519	-18.91	-36.60

Summary Statistics

Mean error:	-0.097
Root-mean-squared-error:	0.103
Theil's inequality coefficient:	0.124
Fraction of error due to:	
(A) Bias:	0.890
(B) Variation:	0.015
(C) Co-variation:	0.095

¹Calculated as *actual* real money stock, less the exponential of the *predicted* logarithm of real money balances.

void by focusing on dynamic forecasting as a basis for evaluating the temporal stability (i.e., the constancy of the coefficients) of an economic relationship.

To facilitate understanding, the static forecasting procedure is discussed first. Consider a general relationship in which the lagged dependent variable, as well as an additional explanatory variable, X, are

hypothesized to influence the contemporaneous value of the dependent variable. Specifically, assume that

$$(3) Y_t = \alpha_0 + \alpha_1 X_t + \alpha_2 Y_{t-1} + \varepsilon_t$$

is the "true" model for $t = 1, 2, \dots, T$. In this equation, X is a non-stochastic independent variable, ε_t are independent and identically normally distributed random variables with mean zero and variance σ^2 , and

the parameters α_0 , α_1 , α_2 are non-stochastic and known with certainty.⁹

Under these conditions the traditional *static* forecast for Y_{T+1} , conditioned on knowledge of X_{T+1} and Y_T , is

$$(4) \tilde{Y}_{T+1} = \alpha_0 + \alpha_1 X_{T+1} + \alpha_2 Y_T.$$

According to the maintained hypothesis of structural stability, equation (3) is appropriate for period $T+1$. As a result, a forecast error ($Y_{T+1} - \tilde{Y}_{T+1}$) is expected and this error is equal to ε_{T+1} . The expected value of the forecast error, $E(\varepsilon_{T+1})$, is zero by assumption. It is important to recognize that this result can be generalized for any time period for which equation (3) is valid and a static forecast is developed. Specifically, for any time period for which equation (3) is true, a forecast error can be expected and this error will be a random variable with a zero *expected value* and a constant variance, σ^2 (table 2).

Provided the variance of the disturbances (σ^2) is known, the static forecast errors can be used to determine whether the relationship is temporally stable (i.e., whether equation (3) holds after T). The static forecast error should, by hypothesis, behave as a normally distributed random variable with mean zero and variance σ^2 . Contradictory evidence, such as static forecast errors that are large relative to σ^2 , would suggest that equation (3) does not characterize the post-sample period. Consistently one-sided static forecast errors (e.g., under- or overpredictions) would also support such a conclusion. Using similar reasoning, Brown, Durbin, and Evans have developed formal tests to ascertain whether a relationship such as that described by equation (3) remains valid over an extended time period.¹⁰

The difference between these static forecasts and the dynamic forecasts used in money demand studies is

⁹The assumption that the parameters are known with certainty makes the analysis simpler and, more importantly, doesn't effect the central conclusions drawn in this section. The reader is referred to Henri Theil, *Applied Economic Forecasting*, (Chicago, North-Holland, 1966), pp. 5-8, for a discussion of the case where the parameters in (3) are ordinary least square estimates. The analysis in this paper, based on the assumption that the parameters are known with certainty, will *underestimate* the variance of the forecast error if the forecasts are actually based on parameters that are obtained from ordinary least squares.

¹⁰R. L. Brown, J. Durbin, and J. M. Evans, "Techniques for Testing the Constancy of Regression Relationships Over Time," *Journal of the Royal Statistical Society* (Vol. 37 1975), pp. 149-92. In one sense, the test the authors describe is more general than that discussed here. Specifically, they investigate the stability of a relationship when the right-hand side parameters are actually random variables, and when σ^2 is unknown. However, they do not consider the specific case in which a lagged dependent variable is included as an additional explanatory variable.

simple and relatively straightforward; dynamic forecasts use previously *forecasted* values of the lagged dependent variable instead of *actual* values. In other words, the forecaster is assumed to know the actual value of all the explanatory variables on the right-hand side of the equation, except for the lagged dependent variable.¹¹ Consequently, in dynamic forecasting, an estimate of the lagged dependent variable — specifically, the value forecasted for the previous period — must replace the actual value of the variable that would be used in static forecasting. In this respect, the dynamic forecasts are developed as part of a recursive system.

To better understand the dynamic forecasting procedure, assume equation (3) holds for $t=1, \dots, T$, and dynamic forecasts for periods beyond T are desired.¹² The actual value of Y_T is used to form the initial dynamic forecast of Y_{T+1} . Thus, the dynamic forecast for $T+1$, \tilde{Y}_{T+1} , is equal to the static forecast, \tilde{Y}_{T+1} :

$$(5) \tilde{Y}_{T+1} = \alpha_0 + \alpha_1 X_{T+1} + \alpha_2 Y_T.$$

The resulting dynamic forecast error ($Y_{T+1} - \tilde{Y}_{T+1}$) is ε_{T+1} — identical to the forecast error that occurred in the static forecasting procedure. Consequently, everything said about the first static forecast error holds for the dynamic forecast error as well.

However, in forecasting Y for the subsequent period ($T+2$), the forecasted value of Y_{T+1} , rather than the actual value, is used to develop the dynamic forecast. Thus, the $T+2$ dynamic forecast is represented by:

$$(6) \tilde{Y}_{T+2} = \alpha_0 + \alpha_1 X_{T+2} + \alpha_2 \tilde{Y}_{T+1}.$$

Using the equation for the previous period's dynamic forecast error,

$$(7) Y_{T+1} - \tilde{Y}_{T+1} = \varepsilon_{T+1} \quad (\Rightarrow \tilde{Y}_{T+1} = Y_{T+1} - \varepsilon_{T+1}).$$

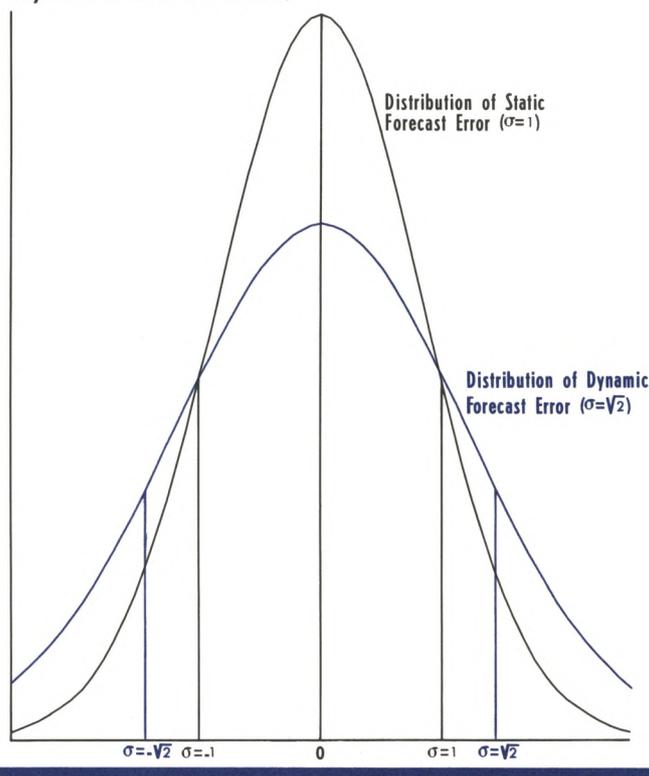
equation (6) can be rewritten as:

$$(8) \tilde{Y}_{T+2} = \alpha_0 + \alpha_1 X_{T+2} + \alpha_2 (Y_{T+1} - \varepsilon_{T+1}).$$

¹¹Dynamic forecasting appears to be particularly appropriate for studying an equation that has a lagged dependent variable *and* that is part of a larger model. If the right-hand side variables, other than the lagged dependent variable, were all exogenous, dynamic forecasting would give a valid indication of the "sturdiness" of that relationship. However, in the case of money demand, *all* of the right-hand side variables would be endogenous in a fuller model and thus should be forecasted as well. In this respect, it is strange that dynamic forecasting has become so popular in money demand studies, while true *ex ante* forecasting (in which *all* of the right-hand side variables are forecasted) would provide better insight into the problems associated with actually forecasting money demand. *Ex ante* forecast errors would provide a better understanding of the actual problems facing policymakers in forecasting the demand for money.

¹²Recall the assumption that the parameters α_0 , α_1 , and α_2 are assumed to be known with certainty.

Figure 1
Alternative Distributions of Static and Dynamic Forecast Errors



If equation (3) continues to hold for $T+2$, the actual value of the dependent variable will be given by

$$(9) Y_{T+2} = \alpha_0 + \alpha_1 X_{T+2} + \alpha_2 Y_{T+1} + \varepsilon_{T+2}.$$

Subtracting equation (8) from equation (9) yields the following dynamic forecast error for $T+2$:

$$(10) Y_{T+2} - \tilde{Y}_{T+2} = \varepsilon_{T+2} + \alpha_2 \varepsilon_{T+1},$$

which can be compared with the static forecast error for the same period:

$$(11) Y_{T+2} - \tilde{Y}_{T+2} = \varepsilon_{T+2}.$$

These alternative forecast errors are statistically similar in one sense, but quite different in another. Since, according to the null hypothesis of stability, the expected value of each disturbance, ε_t ($t = 1, \dots$), is zero, the expected value of both the static forecast error and the dynamic forecast error will be zero. In this respect, there would be no reason to prefer one forecasting procedure over the other, since both will yield *unbiased* forecasts.

The *variance* of these two forecast errors, however, is quite different. The variance of the static forecast error is the variance of the error, ε_{T+2} , which is simply σ^2 . Equation (10) shows that the variance of the dynamic forecast error will be larger than this for all cases in which α_2 is non-zero. If the errors are

independent, as has been assumed, the variance of the dynamic forecast error, $\text{var}(\tilde{Y}_{T+2} - Y_{T+2})$, is $\sigma^2 [1 + \alpha_2^2]$.¹³

Figure 1 compares the two alternative distributions under the assumption that both α_2 and σ_2 equal unity. The distribution associated with the static forecast error is clearly more concentrated about the mean of the distribution than the dynamic forecast error. Since the standard deviation of the static forecast error is equal to one, it is smaller than the dynamic forecast error, which is equal to $\sqrt{2}$ (≈ 1.414). In the statistical sense, the dynamic forecasting procedure can be considered *inefficient* relative to the static forecasting framework. This means that there is a higher probability of observing a *dynamic* forecasting error on the far tail ends of the distribution than there is with a *static* forecast. As a result, the investigator should be less confident in the former type of forecast.

In terms of evaluating the temporal stability of a relationship such as that presented in equation (3), the relatively larger variance associated with the dy-

¹³The variance of the dynamic forecast error, $\text{Var}(Y_{T+2} - \tilde{Y}_{T+2})$, equals $\text{Var}(\varepsilon_{T+2} + \alpha_2 \varepsilon_{T+1})$ according to equation (10). This latter term, by assumption of independence in the disturbances, equals $\text{Var}(\varepsilon_{T+2}) + \text{Var}(\alpha_2 \varepsilon_{T+1})$, which finally equals $\sigma^2 + \alpha_2^2 \sigma^2$.

Table 2
Static and Dynamic Forecasts Errors

Time	Static forecast error	Variance of static forecast error	Dynamic forecast error	Variance of dynamic forecast error
T+1	ϵ_{T+1}	σ^2	ϵ_{T+1}	σ^2
T+2	ϵ_{T+2}	σ^2	$\epsilon_{T+2} + \alpha_2 \epsilon_{T+1}$	$\sigma^2 (1 + \alpha_2^2)$
T+3	ϵ_{T+3}	σ^2	$\epsilon_{T+3} + \alpha_2 \epsilon_{T+2} + \alpha_2^2 \epsilon_{T+1}$	$\sigma^2 (1 + \alpha_2^2 + \alpha_2^4)$
T+K	ϵ_{T+K}	σ^2	$\sum_{i=1}^K \alpha_2^{(i-1)} \epsilon_{T+K-(i-1)}$	$\sigma^2 \left[\sum_{i=0}^{K-1} \alpha_2^{(i)^2} \right]$

dynamic forecasting procedure indicates that, for any given confidence interval, a larger dynamic forecasting error (than that associated with the static forecasting procedure) is required before the null hypothesis of temporal stability can be rejected.

Table 2 presents static and dynamic forecast errors and the variance of these respective errors for periods T+1 through T+3. In addition, these particulars are generalized for the K_{th} period beyond the end of the sample period, T. The generalization shows that the dynamic forecasting procedure becomes increasingly inefficient relative to the static forecasting procedure, the further the forecast is from the end of the sample period. As long as α_2 is less than unity, however, *increments* in the variance of the dynamic forecast error will diminish with time.

The table also shows the interesting fact that the dynamic forecast error for any given period can be calculated based on the knowledge of the parameter, α_2 , and on the static forecast errors for that same period and prior periods; that is, the dynamic forecast error for T+K is simply a weighted average of the static forecast errors, $\epsilon_T, \epsilon_{T+1}, \dots, \epsilon_{T+K}$, with the weights determined by α_2 . The essential contribution of the dynamic forecasting procedure is its unique weighting scheme for current and past static forecast errors. If the investigator is interested in determining the *long-run* forecasting accuracy of his model, the weighting scheme of the dynamic forecasting methodology is uniquely appropriate.

It is further evident from table 2 that the weighting scheme depends crucially on the parameter α_2 (the coefficient on the lagged dependent variable). Other things being equal, the researcher developing dynamic forecasts will prefer a smaller value for this parameter, because it is the mechanism by which past

forecast errors are fed through the system. The smaller the coefficient on the lagged dependent variable, the less impact its value will have on subsequent forecasts. The table also shows that, if α_2 exceeds unity, the dynamic forecasting framework becomes explosive: Past static forecast errors are given increasing weight as the forecast period is extended.

Finally, in terms of the question of the temporal stability of a relationship, table 2 indicates that the static and dynamic forecast errors will yield different patterns as a result of a shift in the relationship. For example, suppose a once-and-for-all intercept shift in equation (3) occurs at T+1, such that

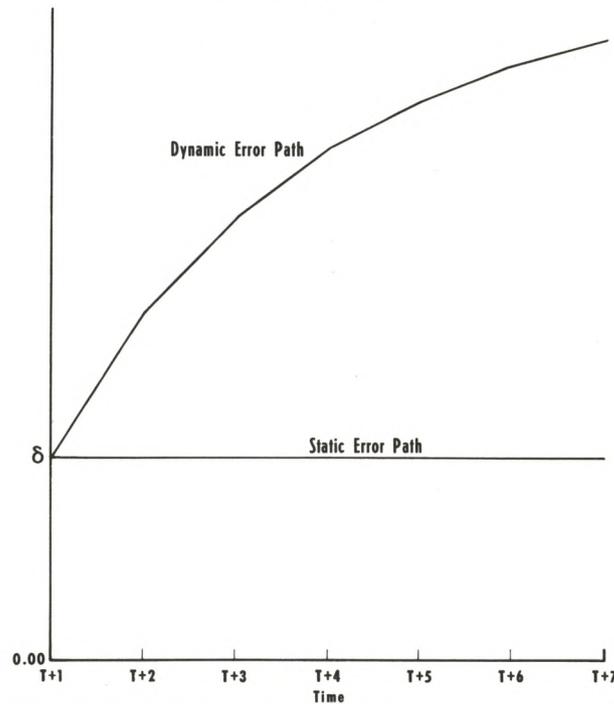
$$(12) Y_t = (\alpha_0 + \delta) + \alpha_1 X_t + \alpha_2 Y_{t-1} + \epsilon_t$$

holds for all $t > T+1$. If static forecasts are developed under the erroneous assumption that equation (3) presents the correct relationship, the resulting forecast error will be $\epsilon_t + \delta$ (for all $t > T+1$). As a result, there will be a bias in the forecast of the size, δ , that will persist irrespective of the time for which the forecast is made (table 3).

In the case of *dynamic* forecasting, the path of the forecasts errors that occurs in the face of this same intercept shift is considerably different. With dynamic forecasting, the forecast will deviate from the actual level not only because the intercept shift is not built into the forecast, but also because the lagged dependent variable is inaccurately forecast for intervening periods. Since the dynamic forecasting framework is a recursive system, these latter inaccuracies will cumulate over time.

Figure 2 compares the path (i.e., the expected value) of the static and dynamic forecast errors for a once-and-for-all, δ -sized intercept shift with a parameter value of $\alpha_2 = 0.7$. Although the hypothesized shift in the relationship is the same in both cases, the

Figure 2
Expected Value of Static and Dynamic Forecast
Errors Under Assumption of a δ -Sized
Once-And-For-All Intercept Shift



expected path of the two alternative forecast errors is quite different. Even an astute investigator could easily misjudge the once-and-for-all intercept shift in the relationship, if the only information provided is the pattern of the dynamic forecast errors. The researcher would probably perceive the shift as a *continuing* phenomenon, rather than a *once-and-for-all*

occurrence. In addition, if the researcher is provided only the dynamic forecast errors, the shift in the relationship is likely to be judged larger than it actually is. In the above example, the relationship was hypothesized to have shifted up by δ , but all the dynamic forecast errors after T+1 exceed this magnitude by ever-increasing amounts.

Table 3
Static and Dynamic Forecast Errors Under the
Assumption of an Intercept Shift (δ)

Time	Static forecast error	Bias in static forecast	Dynamic forecast error	Bias in dynamic forecast error
T+1	$\epsilon_{T+1} + \delta$	δ	$\epsilon_{T+1} + \delta$	δ
T+2	$\epsilon_{T+2} + \delta$	δ	$\epsilon_{T+2} + \delta + \alpha_2 (\epsilon_{T+1} + \delta)$	$\delta (1 + \alpha_2)$
T+3	$\epsilon_{T+3} + \delta$	δ	$\epsilon_{T+3} + \delta + \alpha_2 (\epsilon_{T+2} + \delta) + \alpha_2^2 (\epsilon_{T+1} + \delta)$	$\delta (1 + \alpha_2 + \alpha_2^2)$
T+K	$\epsilon_{T+K} + \delta$	δ	$\sum_{i=1}^K \alpha_2^{(i-1)} (\epsilon_{T+K-(i-1)} + \delta)$	$\delta \left(\sum_{i=0}^{K-1} \alpha_2^i \right)$

Table 4
Post-Sample Static Forecast of Money Demand (III/1974-IV/1979)

Date	Actual ln (M_t/P_t)	Static forecast of ln (M_t/P_t)	Static forecast error	Static forecast error as percent of dependent variable	Static forecast error in billions of real money balances ¹
III/1974	0.8645	0.8865	-0.0220	-2.54	\$ -5.28
IV/1974	0.8462	0.8753	-0.0291	-3.44	-6.88
I/1975	0.8260	0.8629	-0.0369	-4.47	-8.59
II/1975	0.8260	0.8560	-0.0300	-3.63	-6.96
III/1975	0.8264	0.8589	-0.0325	-3.93	-7.54
IV/1975	0.8187	0.8617	-0.0430	-5.26	-9.96
I/1976	0.8213	0.8644	-0.0431	-5.24	-10.01
II/1976	0.8258	0.8665	-0.0406	-4.92	-9.49
III/1976	0.8246	0.8706	-0.0461	-5.59	-10.74
IV/1976	0.8283	0.8728	-0.0445	-5.38	-10.42
I/1977	0.8320	0.8795	-0.0475	-5.71	-11.18
II/1977	0.8319	0.8835	-0.0516	-6.21	-12.17
III/1977	0.8415	0.8855	-0.0439	-5.22	-10.44
IV/1977	0.8442	0.8905	-0.0463	-5.49	-11.02
I/1978	0.8455	0.8923	-0.0468	-5.53	-11.16
II/1978	0.8429	0.8969	-0.0540	-6.41	-12.89
III/1978	0.8451	0.8959	-0.0508	-6.01	-12.13
IV/1978	0.8350	0.8979	-0.0629	-7.53	-14.96
I/1979	0.8092	0.8921	-0.0829	-10.25	-19.41
II/1979	0.8071	0.8811	-0.0740	-9.16	-17.22
III/1979	0.8107	0.8752	-0.0646	-7.97	-14.99
IV/1979	0.8032	0.8747	-0.0715	-8.90	-16.55

Summary Statistics

Mean error:	-0.048
Root-mean-squared-error:	0.051
Theil's inequality coefficient:	0.061
Fraction of error due to:	
(A) Bias:	0.914
(B) Variation:	0.002
(C) Co-variation:	0.084

¹Calculated as *actual* real money stock, less the exponential of the *predicted* logarithm of real money balances.

**Static Versus Dynamic Forecasts
of Money Demand**

Given this analysis, it is useful to question whether the conclusions based on dynamic forecasts of the demand for money are valid. Of specific concern are the conclusions that the money demand relationship shifted down in 1974 and that this downshift has been progressively increasing ever since.

Static out-of-sample forecasts over the period, III/1974 — IV/1979, were developed for the same money demand relationship given in equation (2). These forecasts, along with summary statistics, are presented in table 4.

Like the dynamic forecasts, the static money demand forecasts differ by large amounts from the actual values observed. Real money balances are *consistently*

overpredicted and by fairly sizable amounts throughout the post-1974 period. The root-mean-squared-error for the static forecasts over the period III/1974 — IV/1979 is approximately ten times the sample period's standard error of the equation, suggesting that something in the relationship has indeed changed over the post-1974 period.¹⁴

While the static forecast results support the conclusion that the money demand relationship has shifted, they do not corroborate other inferences drawn from dynamic forecast errors. Reliance on the dynamic forecasting technique has seriously exaggerated the magnitude of the breakdown in the relationship. For example, the II/1978 dynamic forecast of money demand overestimates real money balance by almost \$27 billion. Many studies suggest that this forecast error is an estimate of the magnitude of the "downshift" in the money demand relationship.

When the same estimated relationship is statically rather than dynamically simulated, however, a much smaller estimate of the downshift emerges. In the case of static forecasts, real money balances are projected to be "only" \$13 billion above the actual level in II/1978. The reason for the significant difference in these forecast errors is that the dynamic forecast error is simply a weighted average of current and past static forecast errors. As table 4 shows, the static forecast errors in money demand have been consistently one-sided (*overpredicted*) since III/1974. Consequently, the dynamic forecast error for any period thereafter has *always* exceeded the static forecast error.

Although the dynamic forecasting procedure indicates how errors can cumulate over the long-run, it provides a poor basis for measuring the extent of the "shift" in the relationship. Again, consider the \$27 billion dynamic forecast error for II/1978. This error tells the policymaker the extent to which forecasts of real money balances would have been inaccurate if equation (2) had been used in II/1974 to project II/1978 money demand, assuming that he had full information about the actual course of interest rates and real income but no knowledge of the course of actual real money balances over the four-year intervening period. On the other hand, the \$13 billion static forecast error for II/1978 tells the policymaker how inaccurate his prediction of real money balances would have been if he had used the coefficients in equation (2) but had full knowledge of the I/1978 level of

real money balances. Thus, over one-half of the dynamic forecast error for II/1978 is due to the error in predicting real money balances in the previous period and should not be considered part of the "shift" in the relationship.

One example of improperly using dynamic forecast errors to measure the extent of the money demand shift is provided by the work of Tinsley and Garrett.¹⁵ These authors argue that the introduction of immediately available funds (IF) in the mid-1970's was largely responsible for the downshift in money demand. To support the argument that the introduction of these financial assets have displaced a portion of conventional demand deposits, they compare the size of IF with the dynamic forecast errors for a demand deposit equation: "There is, of course, a striking similarity between the *magnitude* of IF . . . and the size of the *dynamic* (emphasis added) forecast error of demand deposits . . ."¹⁶

If, as these authors argue, economic agents simply substituted IF for demand deposits in their portfolios, the dynamic forecast error should have increased at a faster rate than the growth of IF. This would occur because the dynamic forecast for periods beyond T+1 would differ from the actual observation by the magnitude of the shift in funds *plus* a weighted average of previous forecast errors for demand deposits. It is precisely this latter portion of the forecast error that many investigators ignore. Thus, rather than providing support, the similarity in magnitude between IF and the dynamic forecast errors actually casts doubt on the Tinsley-Garrett argument.

The use of the dynamic forecasting technique has also masked the pattern of the shift in the money demand relationship. As suggested at the outset, dynamic forecasts of money demand have led some researchers to conclude that there has been a continuous downshift in the relationship following II/1974, because the dynamic forecast errors have been increasing over time (figure 3).¹⁷ Obviously, the argument that this pattern of dynamic forecast errors implies a continuous shift in the relationship is invalid.

In contrast to the view of a continuous drift in the relationship, the static forecast errors suggest three

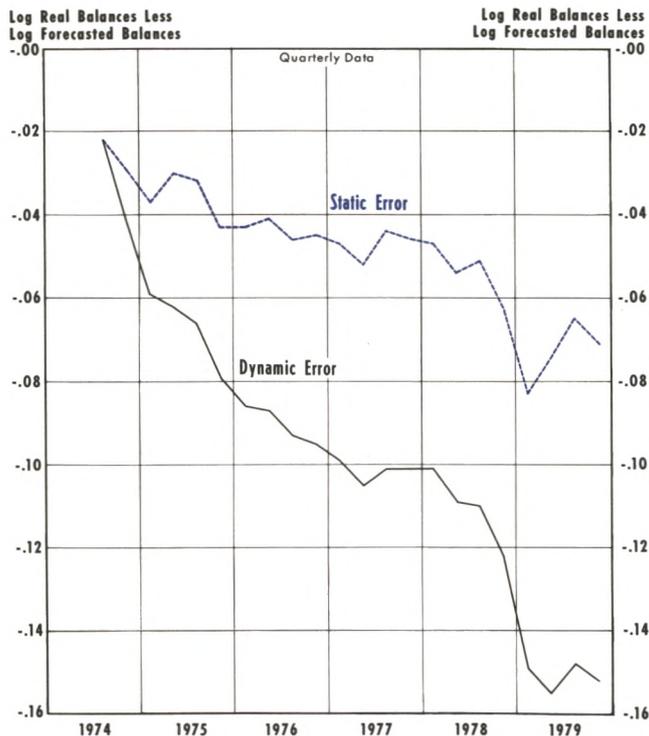
¹⁵P. A. Tinsley and Bonnie Garrett, with M. E. Friar, "The Measurement of Money Demand," Special Studies Paper, No. 133 (Board of Governors of the Federal Reserve System 1978).

¹⁶P. A. Tinsley, et. al., "The Measurement of Money Demand," p. 15.

¹⁷For this view see Porter, et. al. "Financial Innovations and the Monetary Aggregates." For a more elementary approach, see "Inflation and the Destruction of Monetarism," pp. 5-12.

¹⁴This conclusion is further supported by a Chow test, which leads to the rejection of the hypothesis of coefficient equality over the pre-III/1974 and post-III/1974 periods. The F-statistic for 5, 69 degrees of freedom, is 5.23. Thus, the null hypothesis can be rejected at the 1 percent level.

Figure 3
Static and Dynamic Forecast Errors of Money Demand Equations



separate intercept shifts.¹⁸ The first shift—equal to approximately -0.03 (table 4, column 4)—occurred in III/1974. There is, however, little evidence to support the notion that any further significant shifts occurred prior to IV/1975. All of the static forecast errors that occurred over the period IV/1974—III/1975 are within two standard errors of the estimated equation (SEE) on either side of -0.03 .

Another discrete shift in the relationship in IV/1975 is apparent from the jump in the static forecast error from III/1975 to IV/1975. Again, while there is a slight drift in the relationship, it does not appear to change significantly over the subsequent three-year period; from IV/1975 to III/1978, the static forecast error fluctuates around -0.05 . Static forecast errors over this period are within two standard errors of the estimated equation on either side of this point. Finally, in IV/1978, another downshift is indicated by the discrete jump in the static forecast error.¹⁹ But, again,

¹⁸For support of this notion of selected shifts in the money demand relationship, see Michael R. Darby, "The International Economy as a Source of and Restraint on United States Inflation," Working Paper No. 347 (Cambridge, Mass.: National Bureau of Economic Research, Inc., January 1980).

¹⁹Note that this latter point coincides with the introduction of nationwide ATS accounts and New York NOW accounts.

the forecast error subsequently stabilizes around this higher level.

The pattern of breakdown suggested by the static estimation procedure differs greatly from that deduced from the ever-increasing dynamic forecast errors shown in figure 3. The static forecasting procedure isolates the periods III/1974, IV/1975, and IV/1978 as the specific shift points that require further study. The analysis also suggests that, as far as short-run forecasting is concerned, the best the researcher can do in the future is to assume that any statistically significant shift in the relationship is a once-and-for-all occurrence.

CONCLUSION

This paper demonstrates that the magnitude of the recent downward shift in the money demand relationship has been exaggerated and the pattern of the precise shifts has been obscured by reliance on the dynamic forecasting procedure to evaluate the temporal stability of the money demand relationship.

The magnitude of the shift is much smaller (in fact, insignificant) if M1B is used in place of M1 as the monetary aggregate measure.

The pattern of ever-increasing dynamic forecast errors has led some investigators to conclude that money demand has been subject to a downward drift since III/1974, and, as a result, they argue that money is no longer a useful policy instrument or indicator. On the contrary, the evidence in this paper supports the notion of discrete once-and-for-all shifts in the relationship, and isolates the periods of late III/1974, IV/1975, and IV/1978 as specific periods of these shifts.

By rejecting the notion of a constantly shifting money demand relationship, this paper reaffirms the usefulness of money as a policy instrument. By using the conventional money demand equation considered here, a policymaker, unaware of the financial innovations occurring over the recent period, would have made only three significant errors in forecasting the growth rate of real money balances. Consequently, only on these three separate occasions would the linkage between money and prices have been other than expected.

Finally, although this paper has presented long-range (dynamic) forecasts of money demand which are in serious error, this evidence should *not* be interpreted as highly critical of a long-range policy of money control, such as Friedman's X-percent rule. The period considered in this paper, III/1974-IV/1979, was one of ever-accelerating monetary growth, which resulted in a higher rate of inflation, as well as higher interest rates. These high interest rates, in turn, have led to financial innovations (e.g., ATS accounts, NOW accounts, and money market mutual funds) designed to circumvent Federal Reserve regulations (primarily Regulation Q interest rate ceilings). To the extent that these financial innovations have been responsible for the shifts in money demand, the ultimate precursor of the shifts has been the excessive growth of money over this period. In other words, it is legitimate to question whether money demand would have been subject to the few shifts experienced had monetary growth not accelerated over the past decade.



Financing Constraints and the Short-Run Response to Fiscal Policy

LAURENCE H. MEYER

MONETARISTS have long emphasized that the impact of an increase in government expenditures depends on how the increase is financed. In particular, they have suggested that a bond-financed increase in government expenditures has only minimal effects on aggregate demand and income, because the government borrowing necessary to finance the additional public expenditures may “crowd out” a roughly equivalent amount of private spending and borrowing. This view is summarized as follows:

“Fiscal policy provides additional spending in a world of sparse spending opportunities. But it does not provide a new source of finance in a world where spending is constrained by sources of finance. The government expenditures are financed in debt markets in competition with private expenditures. The case least favorable to fiscal policy is that in which the additional government borrowing simply crowds out of the market an equal (or conceivably even greater) volume of borrowing that would have financed private expenditures.”¹

This paper presents a framework for analyzing fiscal policy that incorporates the interaction between government and the private sector in their spending and borrowing decisions. It shows that ambiguity surrounding the income-multiplier for increased government expenditures results from the failure to model correctly the stock repercussions of changes in government spending and private investment. Specifically, the ambiguity is caused by failure to allow for changes in the supply of capital (or private financial securities issued to finance the capital stock) that arise in

response to debt-financed fiscal policy. When the analysis is amended to correctly incorporate the financing of private and public expenditures and to develop the relationship among saving, the deficit, and crowding out, the *initial* impact of an increase in government expenditure on aggregate demand and income is unambiguously positive.

FOUR MODELS OF THE SHORT-RUN RESPONSE TO FISCAL POLICY

Four models of the response to fiscal policy are analyzed in detail. Each model includes the equilibrium conditions in the commodity and money markets (which correspond to the IS and LM curves in standard income-expenditure analysis) and the definition of disposable income, as shown in equations (1) through (3). The demand for output depends on income and the interest rate [equation (1)]; the money supply is exogenous, and the demand for money depends on the interest rate, income, and end-of-period value of household wealth [equation (2)].² Disposable income is simply national income minus taxes net of transfers [equation (3)].

²The model includes a wealth effect in the money demand function but not in the consumption function. This was done primarily to simplify the analysis, since the major concern involves the portfolio effects of fiscal policy. In addition, the relevant wealth variable in a consumption function is beginning-of-period wealth, and this is predetermined in the subsequent analysis. The only way a wealth effect in the consumption function could affect the conclusions is through an interest-induced wealth effect. Including an interest-induced wealth effect would be equivalent to making consumption (saving) depend on the interest rate. Such a modification is discussed later in the analysis.

¹John M. Culbertson, *Macroeconomic Theory and Stabilization Policy* (New York: McGraw-Hill, 1968), p. 463.

Models 1-4	
Model I: 1-3 with $L_a = 0$	$\begin{cases} (1) X = C_y Y + I_r r + \bar{C} + \bar{I} + \bar{C} \\ (2) \bar{m} = \bar{L} + L_x X + L_r r + L_a a \\ (3) Y = X - \bar{T} \end{cases}$
Model II: 1-3 + 4, 5	$\begin{cases} (4) a = \bar{m} + b + \bar{K} \\ (5) \Delta b = D_{-1} + \Delta \bar{C} - \Delta \bar{T} - \Delta \bar{m} \end{cases}$
Model III: 1-3, 5-7	$\begin{cases} (6) a = \bar{m} + b + d \\ (7) \Delta d = I_{-1} + \Delta I = I_{-1} + I_r \Delta r \end{cases}$
Model IV: 1-3, 8, 9	$\begin{cases} (8) a = \bar{a} + S \\ (9) S = Y - C = Y - (\bar{C} + C_y Y) \end{cases}$
Notation:	
X = output or national income	
Y = disposable income	
r = interest rate	
\bar{m} = money supply	
a = end-of-period wealth of households	
T = net taxes (taxes net of transfers)	
b = end-of-period supply of government bonds	
D_{-1} = deficit inherited from the previous period	
d = end-of-period supply of private securities	
I_{-1} = (net) investment in the previous period	
\bar{a} = beginning-of-period wealth of households	
S = saving	
\bar{C} = government expenditures on goods and services	
\bar{C}, \bar{I} = autonomous private expenditures on consumption and investment	
C_y, I_r, L_x, L_r, L_a = model parameters	
Parameter restrictions:	
$1 > C_y > 0$	
$-\infty < I_r < 0$	
$L_x > 0$	
$-\infty < L_r < 0$	
$1 > L_a > 0$	

that is critical to the analysis in this article. Two definitions of wealth can be used to complete the model: Both are equally correct and yield identical results when the definitions are specified properly. The *sum of the assets* measure defines wealth as the sum of the assets that are held in household portfolios. The *perpetual inventory* measure defines wealth as the sum of last period's wealth and saving, where saving is measured as the change in wealth between last period and this period.⁴ The sum of the assets approach links wealth to the rest of the model by using financing constraints that link the supply of money and bonds to spending decisions of the government and private sectors. The perpetual inventory approach links wealth to the rest of the model by adding a saving equation to the model.

Model 2 is an extension of Model 1 and incorporates both a wealth effect in the demand for money ($0 < L_a < 1$) and a government financing constraint [equation (5)]. The government financing constraint (GFC) requires that government expenditures (G) be financed by some combination of taxes net of transfers (T) and issue of money and government bonds (Δm and Δb , respectively).⁵ Equation (5) rewrites this restriction in terms of the inherited deficit (D_{-1}) and changes in government expenditures and taxes (ΔG and ΔT , respectively). The inherited deficit plus any increase in government spending in the present period relative to the previous period must be financed by increases in tax revenue net of transfers or by issue of money or government bonds.

Wealth is defined, according to equation (4), as the sum of money, government bonds, and the capital stock.⁶ Both money and the capital stock are assumed to be constant, and the supply of government bonds is determined via the GFC. Since all four models assume an exogenous money supply, increases in gov-

Model I, the traditional textbook model associated with the income-expenditure view, assumes $L_a = 0$ and includes *only* equations (1) through (3). It also corresponds, however, to Friedman's representation of a common framework that would be acceptable to both monetarists and nonmonetarists.³

Alternative Approaches to Modeling Wealth Determination

Models 2 through 4 include the determination of household wealth, and it is the modeling of wealth

³See, for example, Milton Friedman, "A Theoretical Framework for Monetary Analysis," *Journal of Political Economy* (March/April 1970), pp. 193-238.

⁴Peter E. Kennedy, "Direct Wealth Effects in Macroeconomics Models: The Saving vs. the Definitional Approach," *Journal of Money, Credit and Banking* (February 1978), pp. 94-8.

⁵The integration of the government financing constraint into macroeconomic models was advanced by the work of Carl Christ. See, for example, Carl F. Christ, "A Simple Macroeconomic Model with a Government Budget Constraint," *Journal of Political Economy* (January/February 1968), pp. 53-67.

⁶The author assumes throughout that government bonds are part of net wealth and this assumption presumes the absence of "tax discounting." The evidence on tax discounting is mixed. For a review of the theory and evidence on tax discounting, see Willem H. Buiter and James Tobin, "Debt Neutrality: A Brief Review of Doctrine and Evidence," Cowles Foundation Discussion Paper No. 497 (Yale University, September 15, 1978). For an empirical investigation which finds no evidence of tax discounting, see Jess B. Yavitz and Laurence H. Meyer, "An Empirical Investigation of the Extent of Tax Discounting," *Journal of Money, Credit and Banking* (May 1976), pp. 247-56.

ernment expenditures are financed by increasing the government debt. This common assumption allows us to focus on debt-financed fiscal policy.

The critical assumption in Model 2 is that the capital stock is also exogenous. Although this assumption is common in short-run models of income determination, it presents serious difficulties for modeling the portfolio repercussions of fiscal actions.⁷

Models 3 and 4 further refine the analysis of fiscal policy by relaxing the assumption that the capital stock is fixed. These models introduce properly specified but alternative definitions of wealth. Model 3 essentially retains the wealth definition used in Model 2 but endogenizes the capital stock by defining the end-of-period capital stock as the sum of the beginning-of-period capital stock and investment over the period. All capital is assumed to be held by firms and purchased with external funds acquired by selling securities to the household sector. Thus, households can be viewed as indirectly holding the capital stock via their holdings of private securities, and the net wealth of the household sector can be rewritten as the sum of money, government bonds, and private securities [equation (6)], where the supply of private securities is determined via the investment financing constraint [equation (7)].⁸ The simple structure of the model can be maintained by assuming that government debt and private securities are perfect substitutes in household portfolios.⁹ The supply of private securities is determined by the investment financing constraint (IFC), the private sector counterpart to the GFC. The IFC [equation (7)] links changes in the supply of private securities directly to (net) investment (expressed as last period's investment plus the change in investment from last period to the current period) and thus links private spending and financial decisions.

⁷Models embodying the assumption of a fixed capital stock have been used to investigate the portfolio repercussions of fiscal policy by Silber, Meyer, and B. Friedman. See William L. Silber, "Fiscal Policy in IS-LM Analysis: A Correction," *Journal of Money, Credit and Banking* (November 1970), pp. 461-72; Laurence H. Meyer, "The Balance Sheet Identity, the Government Financing Constraint, and the Crowding-Out Effect," *Journal of Monetary Economics* (January 1975), pp. 65-78; and Benjamin Friedman, "Crowding-Out or Crowding-In: Economic Consequences of Financing Government Deficits," *Brookings Papers on Economic Activity* (1978:3), pp. 593-641.

⁸Equations (4) and (6) correspond to two different ways of defining wealth: net private wealth and net wealth of households. Net private wealth equals the capital stock (the economy's tangible or real assets) plus outside financial assets of the private sector (outside money and government bonds). Net wealth of households includes only the outside financial assets of the household sector (assuming all capital assets are held by businesses). The two are identical, provided capital in net private wealth is valued at its market value as defined by the value of the financial claims to that capital stock held in household portfolios.

⁹Firms finance acquisition of capital via private bonds, equities,

Properties of the Framework

These four models have a common framework: They are fixed price/variable output, one-good, two-asset models of the short-run response to fiscal policy. Additionally, Models 3 and 4 employ an end-of-period specification of asset market equilibrium.

The fixed price/variable output framework is appropriate for studying the response of output to policy actions in a disequilibrium setting where price flexibility is insufficient to sustain continuous full equilibrium.¹⁰ Its suitability, however, is confined to developing insights about the *short-run* response to fiscal actions.

The framework described in this article extends the one-good, two-asset IS/LM model that is widely used in macroeconomics. The two assets included in the models are money and bonds. Both government and private debt are included in Models 3 and 4 and, in order to retain the two-asset framework, they are assumed to be perfect substitutes in household portfolios. To further simplify the analysis, households are assumed to hold all the financial assets and, in Models 3 and 4, firms are assumed to finance all investment externally.

The models are developed to yield one-period multipliers only. Models 2, 3, and 4 are intrinsically dynamic since the supply of bonds continues to increase as long as the government runs a deficit and, in Models 3 and 4, as long as saving and investment occur. The GFC, for example, requires that government expenditure increases be financed not only in the initial period but during all future periods as long as the deficit continues. The models, however, investigate the impact of the increase in government spending during the initial period only.

To model the financial repercussions of spending decisions in a one-period framework, an end-of-period (EOP) specification of asset market equilibrium is

and internal funds. To maintain the model's simple structure and allow every possibility for substantial portfolio effects associated with government deficits, all investment is assumed to be financed externally by emitting a single financial instrument which is a perfect substitute for government bonds in wealth owners' portfolios. In principle, the models employed in this article should distinguish between private debt, equity, and government debt. But the approach used here only makes the portfolio effect of deficit financing larger and the conclusion that there is an unambiguous one-period multiplier more noteworthy. For a three-asset version that is otherwise similar to the approach taken in this paper, see James Tobin and Willem Buiter, "Fiscal and Monetary Policies, Capital Formation, and Economic Activity," in George von Furstenberg, ed., *The Government and Capital Formation* (Cambridge: Ballinger Publishing Co., 1980), pp. 73-151.

¹⁰For a rationalization of this approach, see Robert J. Barro and Herschel I. Grossman, *Money, Employment, and Inflation* (Cambridge: Cambridge University Press, 1976).

used in Models 3 and 4.¹¹ In discrete time models, the concept of simultaneous equilibrium in stock and flow markets is subtle. Since flows are defined as rates over the unit interval and stocks are defined at a point during the interval, there is no natural way of defining simultaneous equilibrium.¹² For the following analysis, it is convenient to define simultaneous equilibrium as corresponding to flow equilibrium over the period and to stock equilibrium at the end of the period. By defining stocks at the end of the interval used to define the flow variables, the financing of expenditure flows over the period is allowed to affect the supplies of bonds outstanding, thereby allowing the model to include both the effect of the increase in expenditures and the effect of the associated increase in the supply of bonds.

MODEL 1: THE TEXTBOOK MULTIPLIER AND HICKSIAN CROWDING OUT

The textbook IS/LM multiplier identifies a single source of crowding out, labeled by Modigliani and Ando as "Hicksian crowding out."¹³ Model 1 includes neither a wealth effect in the demand for money ($L_a = 0$) nor any financing constraints. It is generally associated with the income-expenditure approach and has been widely criticized by monetarists. The multiplier for an increase in government expenditures in

this model is:

$$(1) \frac{\Delta X}{\Delta G} = \frac{1}{1 - C_y + \underbrace{(L_x/L_r)}_{\text{Hicksian crowding out}} I_r}$$

This multiplier has several properties: (1) In the absence of extreme values of the parameters, the multiplier is unambiguously positive, confirming the income expenditure view about the response to fiscal policy. (2) The multiplier does not allow for any effect of government borrowing on the response of output to the fiscal operation. Since money and taxes are held constant, the multiplier implicitly corresponds to a bond-financed fiscal action. Despite the absence of any effect associated with the increase in government borrowing, partial crowding out occurs via the income-induced rise in the interest rate. As income increases, the demand for money increases relative to the fixed supply of money. The resulting excess demand for money (and excess supply of bonds) exerts upward pressure on the interest rate which, in turn, restricts the interest responsive portion of aggregate demand (investment, in this model). However, as long as $L_r < 0$ and $I_r > -\infty$, $\Delta X/\Delta G$ remains positive and investment declines by less than the increase in government expenditures. The magnitude of Hicksian crowding out (or negative feedback) is controlled by the last set of terms in the denominator of equation (1).

Thus, although some investment is crowded out by government spending, the fiscal multiplier is nevertheless unambiguously positive. Of course, this does not guarantee that the multiplier is large. Monetarists have generally argued that, even in this framework, fiscal policy will have a minimal effect due to the actual magnitude of Hicksian crowding out resulting from the small absolute value of the L_r parameter and the large absolute value of the I_r parameter.¹⁴

MODEL 2: THE GFC AND THE WEALTH EFFECT: PORTFOLIO CROWDING OUT AND THE AMBIGUOUS FISCAL MULTIPLIER

To generate an ambiguous sign on the fiscal multiplier in this framework, the financing of government spending via the increase in the supply of government bonds must affect the interest rate and income. This requires that a wealth effect be added to the demand for money ($1 > L_a > 0$) and that both the definition of wealth given by equation (4) and the GFC [equation (5)] be included in the analysis.

¹⁴See, for example, Milton Friedman, "Comments on the Critics," *Journal of Political Economy* (September/October 1972), pp. 906-50.

¹¹For a discussion of the modeling of simultaneous stock and flow equilibria in period models, see Duncan K. Foley, "On Two Specifications of Asset Equilibrium in Macroeconomic Models," *The Journal of Political Economy* (April 1975), pp. 303-24.

¹²One way to eliminate the ambiguity is to reduce the unit interval of the period analysis until the beginning and the end of the period converge. This results in a continuous analysis in which flows at instantaneous rates and stocks can both be measured simultaneously. However, since this analysis focuses on capturing the stock repercussions of flow decisions, the end-of-period, discrete framework is particularly appropriate. Most continuous models are used to solve for either instantaneous or steady-state values of multipliers. Discrete models, on the other hand, are the most convenient approach when the analysis is to be carried out over a discrete interval, short of the time required to achieve full steady-state equilibrium. For example, Turnovsky notes: "While many macroeconomic models are formulated using discrete time, much of macroeconomic theory is formulated using continuous time. Both kinds of models have their place, and the choice between them is often dictated by convenience. If one is interested in analyzing short-run effects, discrete time models tend to be more useful. On the other hand, for steady-state and stability analyses, continuous models are usually more practical." Stephen J. Turnovsky, *Macroeconomic Analysis and Stabilization Policies* (Cambridge: Cambridge University Press, 1977), p. 43.

¹³Franco Modigliani and Albert Ando, "Impacts of Fiscal Actions on Aggregate Income and the Monetarist Controversy: Theory and Evidence," in Jerome Stein, ed., *Monetarism* (Amsterdam: North-Holland Publishing Company, 1976), pp. 17-42. The terminology, "Hicksian crowding-out," reflects the origins of the IS-LM framework in the writing of J. R. Hicks. See, for example, J. R. Hicks, "Mr. Keynes and the Classics: A Suggested Interpretation," *Econometrica* (April 1937), pp. 145-59.

The resulting fiscal multiplier is:

$$(2) \frac{\Delta X}{\Delta G} = \frac{1 - \overbrace{\left(\frac{L_a}{L_r}\right) I_r}^{\text{portfolio crowding out}}}{Q}$$

where the denominator, Q , is the same as in the first multiplier. The fiscal operation now has two direct impacts, indicated by the two terms in the numerator of equation (2): The increase in G directly increases aggregate demand (the *direct fiscal impact*, also operative in Model 1) and the accompanying increase in the supply of bonds exerts upward pressure on interest rates, thereby reducing aggregate demand (the *direct portfolio impact*). The net effect of these two direct impacts — and, hence, the multiplier — is ambiguous. Thus, while Hicksian crowding out can, at most, induce partial crowding out, “portfolio crowding out” can, at least in this model, induce complete or even more than complete crowding out, as suggested by the quote at the beginning of this article.

Note that if $L_a = 0$, the multiplier collapses to the multiplier derived for Model 1. Income-expenditure, macroeconomic models typically use a transactions-based model of the demand for money (where $L_a = 0$), while monetarists generally prefer portfolio models of the demand for money (where $L_a > 0$). If $L_a = 0$, wealth owners want to retain the entire increment in wealth in the form of bonds; in this case, the increase in the supply of bonds does not induce an excess supply of bonds and, therefore, does not exert upward pressure on the interest rate. On the other hand, if $L_a > 0$, wealth owners want to diversify their portfolios and, hence, to split any increase in wealth between increased holdings of money and bonds. In this case, an increase in the supply of bonds and wealth will increase the demand for bonds by less than the increase in the supply of bonds, resulting in an excess supply of bonds and upward pressure on the interest rate.

MODEL 3: ADDING THE INVESTMENT FINANCING CONSTRAINT: RETURNING TO AN UNAMBIGUOUS MULTIPLIER

Models 1 and 2 are useful as simple models which yield income-expenditure and monetarist results, respectively, but both are incomplete. Models 3 and 4 refine the analysis presented in Models 1 and 2 in different but equivalent ways. Although each combines portfolio crowding out with Hicksian crowding out as did Model 2, they yield unambiguously positive fiscal multipliers as did Model 1.

In order to allow for portfolio crowding out, it is necessary to continue assuming that $1 > L_a > 0$. The problem with Model 2 is that it accounts for the financing of government spending but ignores the financial repercussions of private spending. Model 3, therefore, respecifies the definition of wealth to include private securities along with government debt, and the IFC is added in order to link investment to the supply of private securities. Thus, Model 3 includes *dual* financing constraints: End-of-period wealth is now the sum of end-of-period supplies of money and bonds, and the GFC and IFC are used to determine end-of-period supplies of government and private securities, respectively.

By redefining wealth, Model 3 refines the definition given in Model 2, where the capital stock was treated as fixed even though net investment was occurring. Consequently, Model 2 failed to address the portfolio repercussions of investment. Increases in the capital stock associated with investment must be absorbed into private portfolios, just as increases in government debt associated with government deficits must be absorbed.

The multiplier for Model 3 is:

$$(3) \frac{\Delta X}{\Delta G} = \frac{1 - \overbrace{\left[\frac{L_a}{L_r + L_a I_r}\right] I_r}^{\text{direct portfolio impact}}}{Q'}$$

where $Q' = 1 - C_y + [L_x / (L_r + L_a I_r)] I_r$. The two terms in the numerator reflect the two direct impacts associated with the fiscal operation. The direct fiscal impact is the dollar-for-dollar increase in aggregate demand associated with the increased government expenditure. The direct portfolio impact is the effect on investment associated with the increase in the supply of government bonds. The multiplier has a form similar to that of Model 2: A positive direct fiscal impact and negative portfolio impact are contained in the numerator. However, in the case of Model 3, it can be demonstrated that the direct portfolio impact is unambiguously smaller than the direct fiscal impact so that the multiplier is unambiguously positive. The numerator is positive because the terms in the direct portfolio impact can be combined to form a ratio less than unity [$L_a I_r / (L_r + L_a I_r) < 1$].

The multiplier given by Model 3 implies that, although investment declines in response to an increase in government spending, the decline in investment induced by the increase in supply of government bonds is less than the increase in government expenditures. The increase in government debt raises the interest rate because it results in an increase in the supply

relative to the demand for bonds. If the decline in investment due to the rise in the interest rate were to exceed the increase in government spending, the decline in private bonds (associated with the decline in investment) would exceed the increase in the supply of government bonds so that the total supply of bonds would fall rather than rise.¹⁵ This situation, of course, would be contradictory since investment declines only if the interest rate rises. Because the decline in investment slows the rise in the interest rate, the resulting portfolio crowding out can be only partial. Although Hicksian crowding out occurs in response to the rise in income, it cannot alter the conclusion that the fiscal policy multiplier is unambiguously positive.

MODEL 4: A SIMPLIFIED SOLUTION WITH THE PERPETUAL INVENTORY DEFINITION OF WEALTH

Model 4 underlies Modigliani and Ando's conclusion that the short-run response to fiscal policy is positive: "Clearly r cannot rise unless $[a]$ rises; but $[a]$ cannot rise unless saving increases, which requires a rise in $X!$ "¹⁶ Model 4 uses a perpetual inventory definition of wealth [equation (8)] that is equivalent but alternative to that employed in Model 3. End-of-period wealth is defined in this case as beginning-of-period wealth plus saving over the period.¹⁷ The $\Delta X/\Delta G$ multiplier for this model is:

$$(4) \frac{\Delta X}{\Delta G} = \frac{1}{1 - C_y + \underbrace{[(L_x + L_a(1 - C_y))/L_r]}_{\text{both Hicksian and portfolio crowding out}} I_r}$$

This multiplier, like that for Models 2 and 3, includes both Hicksian and portfolio crowding out and it is identical to that in Model 3 even if it doesn't appear to be.¹⁸ As in Model 3, portfolio crowding out can be only partial.

¹⁵The statement that a decline in investment induces a decline in the supply of private bonds requires clarification. As long as net investment is positive, the supply of bonds will be increasing. The bond financing of government expenditures raises the interest rate, lowers investment, and lowers the supply of bonds relative to what it would have been in the absence of the policy action. The multiplier $\Delta X/\Delta G$, in turn, indicates how income differs from what it would have been in the absence of the policy action. The multiplier, therefore, has a different interpretation than the usual comparative static multipliers derived from IS/LM models without financing constraints. Such multipliers indicate the change in income between the old and the new equilibrium levels of income. One-period multipliers in models with financing constraints, in contrast, only indicate how income differs from what it would have been in the absence of the policy change.

¹⁶Modigliani and Ando, "Impacts of Fiscal Actions on Aggregate Income and the Monetarist Controversy," p. 17.

¹⁷Capital gains have been ignored in order to simplify the analysis.

¹⁸To show that Models 3 and 4 are identical, put the numerator of equation (3) in terms of a common denominator,

Multiplier 4 resembles multiplier 1 but it contains an additional term in the numerator of the fraction in the denominator of the multiplier. This term, $L_a(1 - C_y)$, represents the effect of the increase in wealth (via saving) on the demand for money. Since the money supply remains unchanged, all additional wealth is implicitly held in the form of bonds. To induce the private sector to increase its holdings of bonds relative to money, the Treasury must offer a higher interest rate. But, as Modigliani and Ando have noted, portfolio crowding out is activated by the increase in wealth that is associated with an increase in saving and, hence, income.¹⁹ Therefore, portfolio crowding out can restrain but not reverse the increase in income associated with the increase in government spending.

Model 4 highlights the role of saving in the analysis of crowding out. The increase in government bonds can be absorbed into private portfolios either by an increase in wealth (i.e., *induced saving generated by the fiscal action*) or by *displacing* (i.e., *crowding out*) *private debt*. Saving can be defined as the sum of the deficit and investment; the deficit can be defined as the difference between saving and investment. Any increase in the deficit must be offset, therefore, by a combination of increased saving (allowing absorption of increased government bonds) or decreased investment (replacing private securities with government bonds).

Model 4 analyzes the response to fiscal actions without directly including either the GFC or the IFC. Models 2 and 3 include the financing constraint in order to determine the end-of-period supplies of government and private bonds. The bond market is the redundant market in the analysis, and the perpetual inventory definition of wealth does not use end-of-period supplies of bonds. Consequently, Model 4 does not explicitly contain the supply of bonds or require the financing constraints in order to solve for the response to fiscal actions.

REFINEMENTS AND COMPLICATIONS

This section discusses the implications of relaxing

$L_r + L_a I_r$; then multiply the numerator and denominator by $L_r + L_a I_r$; then divide the numerator and denominator by L_r . The equivalence of Models 3 and 4 can also be seen by comparing the two definitions of wealth: Model 3 defines the change in wealth as the sum of the deficit and investment, and Model 4 defines the change in wealth as equal to saving. Since $S = I + D$ is an equilibrium condition, the multipliers for Models 3 and 4 will be identical.

¹⁹The "increase in wealth" in the above statement refers to the increase in wealth relative to what it would have been in the absence of the policy action. As long as saving is positive, wealth will increase. The policy action induces an increase in wealth only if it induces an increase in saving.

some of the assumptions employed in Models 1 through 4. First, some considerations relevant to an analysis of the longer-run response to fiscal actions are discussed. Second, two modifications that introduce the possibility that bond-financed fiscal policy may "pull in" rather than crowd out investment are considered. Finally, a modification that allows for an ambiguous short-run fiscal multiplier in Models 3 and 4 is discussed.

Longer-Run Considerations: Price Flexibility and Cumulative Stock Effects

Models 1 through 4 yielded only one-period multipliers. The longer-run response to fiscal actions is affected also by price flexibility and the cumulative effects of financing continuing deficits associated with once-and-for-all changes in government expenditures.

The models employed above assumed prices were fixed and were justified as simple disequilibrium models along lines developed by Barro and Grossman. However, they apply only to the analysis of the short-run response to fiscal actions. In the long run, price flexibility insures a unique equilibrium level of the unemployment rate via the Phillips Curve. Although fiscal policy may temporarily increase output and employment, most models yield zero long-run multipliers for the response of output and employment to policy actions.²⁰

Another factor that affects the longer-run response to fiscal actions is the continuing increase in the supply of bonds associated with a once-and-for-all increase in government expenditures. The implications of the continued financing of deficits associated with once-and-for-all increases in government expenditures for the long-run response of income have been investigated by Blinder and Solow.²¹

Pulling In: Income-Induced Investment and Multiple Assets

In each of the models developed above, an increase in government expenditures reduced investment. The question they addressed was whether investment fell by more or less than the increase in government expenditures. Two simple modifications introduce the

possibility that bond-financed increases in government expenditures may encourage rather than discourage investment. These modifications include adding income as an argument in the investment function and allowing government debt and private securities to be imperfect substitutes.

If investment depends on the level of income, investment may rise even though the fiscal operation raises the interest rate. Hendershott has referred to this phenomenon as pulling in rather than crowding out investment.²²

In the two-asset model employed above, increased supply of government debt restrains investment, in part, because government and private securities are assumed to be perfect substitutes. If the model is refined to allow for at least three assets — money, government debt, and, for example, equities — the portfolio response to the increase in the supply of government debt becomes ambiguous. Tobin and Tobin and Buiter have used three-asset models to study the response to policy actions.²³ In the two-asset model, an increase in government debt creates excess supply in the securities market and upward pressure on "the" interest rate. The three-asset model involves two rates: The rate on government bonds and the rate on equities. The models generally focus on the rate on government debt and the price of equities, and they designate investment as a positive function of the price of equities.

An increase in government debt increases the rate on government bonds thereby inducing substitution out of equities into government debt. This *substitution effect* reduces the demand for equities and depresses their price (thus raising their rate of return). Wealth is also increasing, and wealth owners may wish to diversify their portfolios and hold some of their increased wealth in equities. This *wealth effect* increases the demand for equities, as well as their price. The net impact of the substitution and wealth effects is ambiguous. Equity prices and, hence, investment may rise or fall. In this three-asset example, if $L_a = 0$, an increase in the supply of government debt unambiguously raises equity prices and stimulates investment.

²⁰See, for example, Modigliani and Ando's discussion of policy simulations with the MPS model in "Impacts of Fiscal Actions on Aggregate Income and the Monetarist Controversy."

²¹Alan S. Blinder and Robert M. Solow, "Does Fiscal Policy Matter?" *Journal of Public Economics* (November 1973), pp. 319-37.

²²Patric H. Hendershott, "A Tax Cut in a Multiple Security Model: Crowding-Out, Pulling-In and the Term Structure of Interest Rates," *Journal of Finance* (September 1976), pp. 1185-99.

²³James Tobin, "An Essay on Principles of Debt Management," in *Fiscal and Debt Management Policies*, Commission on Money and Credit (Englewood Cliffs, N.J.: Prentice-Hall, 1963), pp. 143-218; and Tobin and Buiter, "Fiscal and Monetary Policies, Capital Formation, and Economic Activity."

Interest-Responsive Saving

There is one modification of the models that permits a negative short-run response to fiscal policy — making saving a positive function of the interest rate (and consumption a negative function of the interest rate). This modification would not alter the qualitative results of Model 1, although it would, of course, increase Hicksian crowding out and reduce fiscal multipliers. In Models 3 and 4, however, it results in a theoretically ambiguous sign on the fiscal multiplier. The explanation of the effect of this modification will be most easily understood with respect to Model 4. In that model, the key to the unambiguous result is the positive relation between income and saving: The wealth effect in the demand for money is activated by an increase in wealth which in turn requires an increase in income. If saving depends on the interest rate as well as income, however, saving can increase even if income falls. Saving has generally been considered unresponsive to interest rates, but recent work by Boskin has revived the belief that saving may be significantly interest-responsive, although it remains

²⁴See, for example, Michael J. Boskin, "Taxation, Saving and

likely that this effect is quantitatively small.²⁴

CONCLUSION

Increased sales of government securities necessary to finance increased government expenditures can be purchased either from the increased saving that is generated by the fiscal action or by the crowding out of private security purchases. In order to fully model the response to fiscal policy, it is essential to capture the relationships among the deficit, saving, investment, government, and private debt. This paper has developed two alternative ways of analyzing these relationships, both of which utilize end-of-period specifications of asset market equilibrium. The first approach includes both government and private sector financing constraints in the model; the second approach relates changes in wealth to saving behavior in the model. Both approaches yield positive impacts of increased government expenditures on aggregate demand and income as the first-period fiscal effect. At least in the short-run, fiscal policy actions matter because complete crowding out does not occur.

the Rate of Interest," *Journal of Political Economy* (April 1978), pp. S3-S27.

