

# **Economic Review**

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A Generalized Uncovered Interest Parity Model  
of Exchange Rates

Elizabeth S. Laderman

Determinants of Bank Versus Nonbank  
Competitiveness in Short-term Business Lending

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What Caused the 1990–1991 Recession?

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# A Generalized Uncovered Interest Parity Model of Exchange Rates

Adrian W. Throop

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*Sticky price monetary models of exchange rates, while reasonable theoretically, have been disappointing empirically. Out-of-sample predictions have been little or no better than those from a naive model of no change. The most likely reason is that shocks to the market's expectation of the future equilibrium real exchange rate weaken the stability of the association between exchange rates and the real interest rate differentials. This study identifies three types of shocks that appear to be empirically important. These are productivity growth, which changes the relative price of traded goods at home versus abroad, government budget deficits, and the real price of oil.*

*These factors along with real interest rates are shown to explain at least 80 percent of the longer run variation in both the trade-weighted dollar and bilateral rates against the dollar. An error correction model that includes these factors is shown to have out-of-sample prediction errors for changes in the trade-weighted dollar that are 30 to 45 percent lower than those from a naive model of no change, at horizons of four to eight quarters. The prediction errors for bilateral rates against the dollar are almost as low.*

This paper reexamines the sources of fluctuations in exchange rates between the dollar and other major currencies in the post 1973 flexible rate experience. The real values of the major currencies have fluctuated quite widely in this period. As a result, flexible-price models, which assume constant real currency values (or purchasing power parity), have not been successful in explaining their movements.<sup>1</sup> Sticky price monetary models, which assume that prices in markets for goods adjust to disturbances more slowly than prices in markets for financial assets, have appeared to work more satisfactorily.<sup>2</sup> In these models, purchasing power parity holds in the long run when prices are able to adjust fully, but deviations from purchasing power parity occur in the short run. These deviations are associated with temporary differentials between real interest rates at home and abroad. Uncovered interest parity holds in the sense that the differences between real interest rates are offset by expected changes in the real exchange rate. As a result, movements in the real exchange rate can be explained by changes in the differential between home and foreign real interest rates.

The robustness of the sticky price monetary model has been challenged in an important series of papers by Meese and Rogoff, however.<sup>3</sup> They showed that, while variations in interest differentials can explain some of the movements in the major currencies within the period of estimation of the model, predictions outside that period are no better than those of a naive model of no change, even when actual values of the explanatory variables are used. Meese and Rogoff further suggested that the most likely hypothesis for explaining this result is the existence of shocks to the flexible-price equilibrium of the real exchange rate. The resulting variation in the expected value of the future real exchange rate would weaken the statistical association between real interest differentials and exchange rates. Yet, it has been difficult to identify which real factors have affected equilibrium real exchange rates over what periods.

1. Studies of the U.S. dollar using data for the period 1973 to 1978 have yielded findings consistent with the flexible price model, but those incorporating more recent data have been much less favorable to that approach. See Bilson (1978) and Hodrick (1978).

2. See, for example, Dornbusch (1976), Frankel (1979), Hooper and Morton (1982), and Shafer and Loopesko (1983).

3. See Meese and Rogoff (1983a, 1983b, 1988) and also Meese (1990).

This paper identifies several important factors in addition to real interest rate differentials that have altered real exchange rates between the major currencies. These factors include productivity in traded and nontraded goods, the real price of oil, and government budget balances. We call the resulting extension of the sticky price monetary model a generalized uncovered interest parity model of the exchange rate. It is shown that exchange rates are cointegrated with these factors over time. Because of this, real exchange rates can deviate from a simple purchasing power parity relationship even in the long run. Moreover, the adjustment of currencies to the equilibrium values determined by these factors is a major part of their short-run fluctuation. In particular, out-of-sample predictions (using actual values of the explanatory variables) of both the nominal and real trade-weighted dollar, as well as of three bilateral rates against the dollar, from an error-correction form of the generalized model are shown to be significantly better than those from a naive model of no change.

Section I reviews the basic elements of the conventional sticky price model of exchange rates and previous tests of its out-of-sample predictive power. Section II develops the generalized uncovered interest parity model. In Section III it is shown that the exchange rate is cointegrated with productivity differentials, the real price of oil, government budget balances, and the long-term real interest rate differential. Then, an error correction model is estimated to capture the gradual adjustment of exchange rates to the longer-run equilibrium established by this larger combination of variables. Out-of-sample predictions from this generalized uncovered interest parity model are shown to be very much superior to those of a naive model of no change. Section IV provides a summary and some conclusions.

## I. CONVENTIONAL UNCOVERED INTEREST PARITY MODEL

Much of the recent work on exchange rates has been based upon the "monetary" or "asset" view. The market rate of exchange between two currencies is seen in the short run to equilibrate the international demand for stocks of assets, rather than the international demands for flows of goods, as the more traditional view posits. However, market adjustment ensures equilibrium in the goods markets as well in the longer run. The most widely used approach has been the uncovered interest parity model.

### *Uncovered Interest Parity*

The conventional uncovered interest parity model of exchange rates uses two basic building blocks: (1) uncovered interest parity and (2) purchasing power parity. The condi-

tion of uncovered interest parity says that market arbitrage will move the exchange rate to the point at which the expected rate of return on investments denominated in either the home or foreign currency is the same, except for a possible risk premium. Thus,

$$(1) \quad e_t - E_t(e_{t+k}) = k(i_t - i_t^*) + pr_t,$$

where

$e_t$  = log of nominal value of home currency

$E_t(e_{t+k})$  = market expectation at time  $t$  of exchange rate at time  $t+k$

$i_t$  = home country interest rate on security with  $k$  periods to maturity

$i_t^*$  = foreign country interest rate on security with  $k$  periods to maturity

$pr_t$  = risk premium

If the interest rate differential times the periods to maturity,  $k$ , exceeds the expected rate of depreciation of the home currency (allowing for any risk premium,  $pr_t$ ), then arbitrageurs would bid the value of the home currency up until the equality holds, thus equalizing expected returns at home and abroad.

A problem with using this form of the theory for predicting exchange rates is that it is difficult to model the expected value of the nominal exchange rate  $k$  periods ahead. One way around this problem is to state the uncovered interest parity condition in real terms. Given nominal uncovered interest parity, it is also true that the expected depreciation in the *real* value of the home currency equals the excess in the *real* rate of return on investments in the home country over those in the foreign country (times  $k$ ):<sup>4</sup>

$$(2) \quad q_t - E_t(q_{t+k}) = k((i_t - k\pi_t) - (i_t^* - k\pi_t^*)) + pr_t$$

or

$$(3) \quad q_t = E_t(q_{t+k}) + k((i_t - k\pi_t) - (i_t^* - k\pi_t^*)) + pr_t,$$

where

$q_t$  = log of real value of home currency

$k\pi_t$  = market expectation at time  $t$  of inflation rate at home over  $k$  periods

$k\pi_t^*$  = market expectation at time  $t$  of inflation rate abroad over  $k$  periods

4. The uncovered interest parity condition in nominal terms is:  $e_t - E_t(e_{t+k}) = k(i_t - i_t^*)$ . But by definition  $e_t = q_t + p_t^* - p_t$  and  $E_t(e_{t+k}) = E_t(q_{t+k}) + p_t^* + k_k\pi_t^* - p_t - k_k\pi_t$ . Substituting these relationships into the first equation then gives  $q_t - E_t(q_{t+k}) = k[(i_t - k\pi_t) - (i_t^* - k\pi_t^*)]$ .

The advantage of equation (3) is that, particularly if a long-term real rate of interest is used, the expected value of the real exchange rate  $k$  periods ahead may be assumed to be a constant, corresponding to a flexible price equilibrium of purchasing power parity. Although equation (3) as it stands predicts the real exchange rate, it can be modified to explain the nominal exchange rate. This is done by breaking the real exchange rate into its real and nominal components:

$$(4) \quad e_t = E_t(q_{t+k}) + p_t^* - p_t \\ + k(({}_k i_t - {}_k \pi_t) - ({}_k i_t^* - {}_k \pi_t^*)) + pr_t,$$

where

$p_t^*$  = log of overall price level abroad

$p_t$  = log of overall price level at home

The monetary theory of exchange rates explains  $p^*$  and  $p$  in terms of the demand for money at home and abroad. Given a stable standard demand function for money, the price level in each country would vary positively with the money supply and the nominal interest rate and negatively with real income.

Making these substitutions, Meese and Rogoff (1983a) estimated equation (4) for bilateral values of the dollar against the mark, pound, and yen. They then made predictions of these exchange rates outside of the period over which the model coefficients were estimated, *using actual realized values of all the explanatory variables*. The resulting prediction errors were no lower than those from a naive model that simply assumes no change in the exchange rate. As a result, it appeared that current structural models of the nominal exchange rate do not describe stable economic relationships.

However, these results may simply have been due to instability in the demand for money functions, resulting in poor predictions of  $p$  and  $p^*$ , rather than to instability in the basic uncovered interest parity relationship. Therefore, Meese and Rogoff (1988) followed up their earlier study by making similar out-of-sample predictions from an estimate of equation (3) making the real exchange rate the dependent variable. In this version of uncovered interest parity, current price levels are subsumed in the definition of the real exchange rate, which then simply becomes a function of the real interest rate differential and the market's expectation of the flexible-price equilibrium value of the real exchange rate. The latter is assumed to be a constant given by purchasing power parity. Once again, however, out-of-sample predictions were no more accurate than those from a naive model of no change.

Note that since what is at issue is the stability of the exchange rate model as indicated by its ability to make *ex post* forecasts, rather than *ex ante* forecasts, there is a straightforward way of testing the predictive ability of the nominal version of the model that is independent of the complications introduced by money demand. This is simply to use equation (4) with the actual realized values of the price levels,  $p^*$  and  $p$ , on the right hand side to predict the nominal exchange rate. This equation relies upon the same basic building blocks of uncovered interest parity and purchasing power parity as equation (3) for the real exchange rate. Moreover, the prediction errors from the two equations will be exactly the same because  $p^*$  and  $p$  are known.<sup>5</sup> Obviously, however, the prediction errors for the naive model of no change would differ for real and nominal exchange rates.

Meese and Rogoff (1988) suggest that the most likely hypothesis for explaining the poor out-of-sample predictions of the conventional model of exchange rates, whether nominal or real, is the existence of shocks to the flexible price equilibrium of the real exchange rate. The resulting variation in the expected value of the future real exchange rate would weaken the statistical association between the real interest rate differential and either the nominal or real exchange rate. To assess the empirical importance of these effects, this paper expands the conventional model to include factors that alter the flexible-price equilibrium of the real exchange rate. This generalized uncovered interest parity model is then used to generate out-of-sample predictions of both nominal and real exchange rates.

## II. GENERALIZED UNCOVERED INTEREST PARITY MODEL

The expected value of the flexible-price equilibrium of the real exchange rate, which serves as an anchor for the conventional uncovered interest parity model, is likely to change significantly over time in response to a number of factors. This section expands the model to include some of these factors.

### *Productivity Growth*

The real exchange rate relevant for uncovered interest parity is measured in terms of overall price levels. But, when measured this way, the flexible-price equilibrium will tend to change over time as a result of differential rates

5. The error in predicting the log of the real exchange rate is:  $q_t - \hat{q}_t$  or  $e_t - p_t^* + p_t^* - (\hat{e}_t - \hat{p}_t^* + \hat{p}_t)$ . But since the price levels are known,  $\hat{p}_t^* = p_t^*$  and  $\hat{p}_t = p_t$ . Therefore,  $q_t - \hat{q}_t = e_t - \hat{e}_t$ .

of productivity growth between traded and nontraded goods. This can be seen by examining the relationship between the real exchange rate when measured in terms of overall price levels and when measured in terms of the prices of tradable goods.

The log of the real value of the home currency in terms of overall price levels is:

$$(5) \quad q_t = e_t - p_t^* + p_t,$$

where

$e_t$  = log of nominal value of home currency

$p_t$  = log of overall price level at home

$p_t^*$  = log of overall price level abroad

Next, the log of the real value of the home currency in terms of the prices of traded goods is:

$$(6) \quad qd_t = e_t - pd_t^* + pd_t,$$

where

$pd_t$  = log of price of traded goods at home

$pd_t^*$  = log of price of traded goods abroad

Substituting (6) into (5), the relationship between the real exchange rates measured in these two different ways is therefore:

$$(7) \quad q_t = qd_t + (pd_t^* - p_t^*) - (pd_t - p_t).$$

Thus, even if the real exchange rate in terms of the prices of traded goods remains constant according to purchasing power parity, the real exchange rate in terms of overall price levels varies according to whether the relative price of traded goods is changing by more or less than abroad.

Since productivity typically grows faster in the traded goods sector than in the non-traded goods sector, the relative price of traded goods typically falls over time. Should the relative price of traded goods fall faster at home than abroad, then the real value of the home currency in terms of overall prices would rise even though the real exchange rate in terms of traded goods prices remains constant. The theory of purchasing power parity suggests that the exchange rate should adjust to equalize the prices of traded goods at home and abroad in terms of the same currency. But even if purchasing power parity holds in this sense, the flexible price equilibrium of the real exchange rate in the uncovered interest parity model would vary over time according to differential productivity growth.<sup>6</sup>

6. This aspect of the purchasing power parity hypothesis was explored in a well-known article by Belassa (1964). A more recent treatment is Koedijk and Schotman (1990).

In empirical analysis, the wholesale price index is frequently used as a proxy for the prices of traded goods.<sup>7</sup> That approach is also followed here. Returning to equation (3) for uncovered interest parity with the real exchange rate, equation (7) can be substituted for the expected value of the real exchange rate, giving:

$$(8) \quad q_t = B_0 + E_t(qd_{t+k}) \\ + E_t((pd_{t+k}^* - p_{t+k}^*) - (pd_{t+k} - p_{t+k})) \\ + B_3({}_kR_t - {}_kR_t^*)$$

where

$${}_kR_t - {}_kR_t^* = ({}_k i_t - {}_k \pi_t) - ({}_k i_t^* - {}_k \pi_t^*).$$

Next, the expected difference between relative prices at home and abroad is assumed to be a linear function of the current difference, so that:

$$(9) \quad q_t = B_0 + E_t(qd_{t+k}) \\ + B_2((pd_t^* - p_t^*) - (pd_t - p_t)) \\ + B_3({}_kR_t - {}_kR_t^*).$$

If purchasing power parity holds in traded goods, then  $E(qd_{t+k})$  is simply a constant. But home and foreign-traded goods by and large are imperfect substitutes, so that purchasing power parity does not hold even for traded goods. International adjustment requires changes in the prices of home-traded goods relative to foreign-traded goods, and therefore in the real exchange rate measured in terms of the prices of traded goods.

### Budget Balances

An important factor requiring such adjustment is changes in the balance between saving and investment at home relative to that abroad. A country with a high rate of investment relative to saving will tend to absorb more output than it produces, which will tend to put upward pressure on the prices of home-traded goods relative to those of foreign-traded goods. Historically, private saving has been quite stable.<sup>8</sup> In the last two decades, however,

7. See, for example, Koedijk and Schotman (1990), Clements and Frenkel (1980), and Wolff (1987).

8. See David and Scadding (1974). As pointed out by Feldstein (1992), private saving in the U.S. has trended down in the 1980s. However, foreign private saving rates also have declined in this period. See, for example, Bosworth (1993, ch. 3). So effects on the dollar have tended to be offsetting.

U.S. government saving has fluctuated a lot. Consequently, this paper focuses on the effects of changes in government saving.

The effects of changes in government saving on the flexible-price equilibrium of the real exchange rate can be illustrated with the aid of a simple model.<sup>9</sup> This assumes that traded goods produced in different countries are imperfect substitutes, so that the equilibrium price of traded goods in one country relative to that in another changes in response to shifts in supply and demand. In contrast and consistent with the notion of uncovered interest parity, financial assets as a first approximation are assumed to be perfect substitutes (this assumption will be relaxed later). Real aggregate spending at home and abroad varies inversely with the country's real interest rate; and the real trade balance moves inversely with the real value of the country's currency measured in terms of prices of tradable goods. In algebraic terms, the conditions for full employment at home and abroad are therefore:

$$(10) \quad y_0 = A(R) + nx(qd)$$

$$(11) \quad y_0^* = A^*(R^*) + nx^*(qd)$$

where

$y_0, y_0^*$  = full employment output

$A(A^*)$  = real aggregate spending, or absorption

$nx(nx^*)$  = real net exports

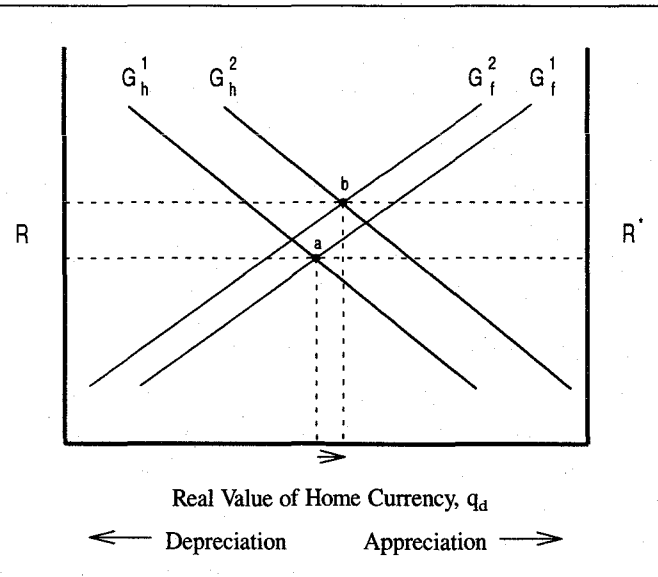
$(R, R^*)$  = real interest rate

$qd$  = real value of home currency measured in prices of tradables

Assuming a complete adjustment to full employment equilibrium, there are three unknowns ( $R$ ,  $R^*$ , and  $qd$ ) but only two equations. However,  $R$  can be solved as equal to  $R^*$  in the case where home and foreign assets are perfect substitutes (or equal to  $R^*$  plus or minus a risk premium in the case of imperfect substitutes).

Figure 1 provides a graphical representation of this system. The goods market equilibrium in the home country is represented by  $G_h$ . It is downward sloping because a reduction in the domestic real interest rate (left scale) must be offset by an appreciation in the real value of the home currency ( $qd$ ) in order to maintain real aggregate spending equal to potential output. Conversely, the locus of the foreign goods market equilibrium,  $G_f$ , is upward sloping. A reduction in the foreign real interest rate (right scale) has

FIGURE 1  
EFFECT OF FISCAL EXPANSION IN HOME COUNTRY:  
SHORTER RUN



to be offset by a depreciation in the real value of the home currency in order to restore a goods market equilibrium abroad. General equilibrium in the case of perfect substitutability between assets lies at point  $a$ , where the two schedules for goods market equilibrium intersect and the interest rates are equalized.

Consider now the comparative statics of a fiscal expansion in the home country. A fiscal expansion in the form of a larger budget deficit or smaller surplus at home increases the demand for home goods, shifting the  $G_h$  schedule up and to the right.<sup>10</sup> Either a higher real interest rate or higher real value of the domestic currency, or some combination of the two, is necessary to maintain the same level of aggregate spending on home goods as before.

To the extent that higher domestic spending falls on foreign goods, the  $G_f$  schedule shifts up also. But one would expect more of the increased spending to fall on home goods than foreign goods. So the  $G_h$  schedule would shift up by more than the  $G_f$  schedule, leading to a new general equilibrium at a point like  $b$ . At this point the world level of real interest rates will have risen, and the real value of the home currency ( $qd$ ) will have *appreciated* in response to the fiscal expansion at home.

9. For earlier treatments, see Dornbusch (1983), Blanchard and Dornbusch (1984), Hutchison and Throop (1985) and Throop (1989).

10. This assumes that households do not increase their saving in order to fund the extra future tax liabilities caused by the increase in the government's larger deficit. If they did increase their saving by the full amount of the increase in these liabilities, then the  $G_h$  and  $G_f$  schedules would not change at all. On this so-called "Ricardo effect," see Barro (1974), Bernheim (1987), Brunner (1986), and Tobin (1980, ch. 3).



Even if the fiscal deficit were to persist, however, the value of the home currency could begin to depreciate and eventually end up lower than it was before. This would happen if there were a limit to the amount of home currency assets that foreigners were willing to absorb. Associated with the net import surplus resulting from the home currency's appreciation is a net capital inflow into the home country. As a result, as foreigners increase their holding of home country assets, the risk premium on them is likely to increase, driving a growing wedge between home and foreign country interest rates.

This process is illustrated in Figure 2. Assume for simplicity that there is no risk premium to begin with. Then the fiscal expansion shifts the  $G_h$  and  $G_f$  schedules up as before. This makes the dollar appreciate from point  $a$  to point  $b$ , as before. But now the risk premium grows with the accumulation of home country debt by foreigners. The risk premium, given by  $cd$  in the diagram, drives a growing wedge between foreign and home country interest rates. The risk premium will continue to grow until the exchange rate has depreciated by enough to prevent net indebtedness to foreigners from growing any further. If the budget deficit persists, this would occur when the home currency has depreciated by enough not only to eliminate the original import surplus but also to generate an export surplus sufficient to pay for servicing the debt without further capital inflows. Thus, given a persistent fiscal deficit, a stable equilibrium requires that the home currency depreciate by more than the original appreciation.

The movements in the real exchange rate that are pro-

duced by changes in budgetary positions in this comparative statics exercise correspond to changes in the long-run flexible-price equilibrium of the real exchange rate in the uncovered interest parity model. The actual effect of budgetary changes on the exchange rate in the short run will depend upon the character of market expectations. In particular, what matters is whether the market views changes in budgetary positions as temporary or permanent, the effective time horizon over which its expectations are formed, and the degree to which the risk premium can be expected to change as indebtedness changes. Although the very long-run effect of a persistent fiscal expansion would appear to be one of depreciation in the real value of the home currency, the market may well expect an appreciation to result over its relevant time horizon.

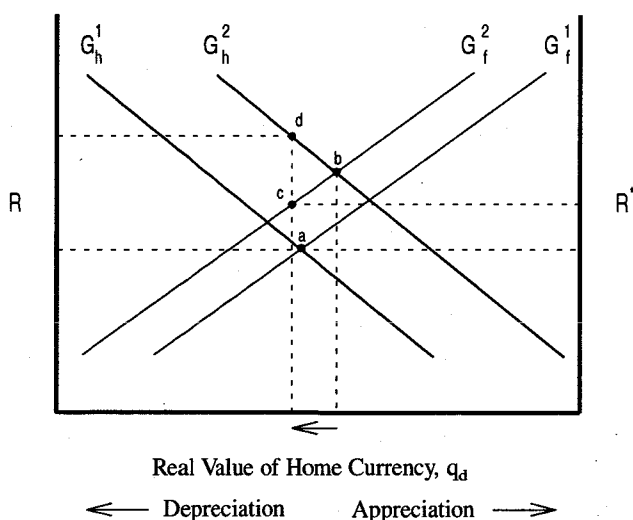
### Real Price of Oil

The final factor that appears to have been important in affecting the flexible-price equilibrium value of real exchange rates is the real price of oil. The real price of oil rose 65 percent in the early 1970s, and then another 70 percent in the late 1970s and early 1980s as the result of the actions of the OPEC cartel. Then in the mid-1980s it dropped by 50 percent as the cartel's power started to erode.

Like the effects of budget deficits, the effects of oil price changes on the flexible-price equilibrium value of real exchange rates between currencies of the oil-importing countries depend upon the effects on the goods markets of those countries. Following oil price increases, the less developed oil-exporting countries typically have temporarily invested the proceeds of higher oil export revenues in the capital markets of the developed oil-importing countries, which in turn have lent much of these funds to other less developed countries. In this "recycling" process international capital mobility has been fairly high, so that it can be assumed real interest rates in different countries would continue to be roughly equalized in flexible-price equilibrium. As a result and similar to the effects of budget deficits, the effect of an oil price change on equilibrium exchange rates of the oil-importing countries depends upon the relative effects on aggregate demand in those countries. These effects may change over time to some degree, as the oil-exporting countries gradually increased their expenditures on the exports of oil-importing countries. However, the most important factor is the degree of dependence of the importing countries on imported oil. This can be illustrated with the aid of the model used in the previous section.

Industrialized countries differ widely in their dependence on imported oil. For instance, the U.S. imports about 40 percent of its oil, but Japan is totally dependent on

FIGURE 2  
EFFECT OF FISCAL EXPANSION IN HOME COUNTRY:  
LONGER RUN



imports to satisfy its oil needs. Let the home country in the model be like the U.S., which is less dependent upon oil imports than its major industrialized trading partners. The other country in the model represents those trading partners.<sup>11</sup>

Following a price increase by OPEC, in the first stage assume that all of OPEC's oil revenues are invested abroad. If the home country is less dependent upon imported oil than its industrialized trading partners, its import bill will increase but by less than theirs. The increase in the import bill reduces aggregate demand, and so requires a reduction in the real interest rate to maintain full employment equilibrium. As shown in Figure 3, the  $G_h$  schedule for the home country therefore shifts down, but by less than the  $G_f$  schedule for the other oil importers. The result is a decrease in the world real interest rate because of the increase in OPEC's saving and a real appreciation of the home currency (in terms of tradable goods prices). The currency of the foreign country, which is more dependent on imported oil than the home country, depreciates so as to allow it to export more to the home country in order to pay for its oil imports more cheaply.

Over a longer run, OPEC will gradually increase the proportion of oil revenues that are spent on foreign goods and services. This increases the demand for exports of both the home country and the foreign country in the model. But so long as OPEC does not have a much stronger preference

for the goods of the foreign country compared with those of the home country, the real appreciation of the home country's currency will not be undone. Thus, following an oil price increase it is likely that the market will expect an appreciation in the flexible-price value of the real equilibrium exchange rates of those countries that are less dependent on imported oil.<sup>12</sup> Notice also that over the longer run the upward shifts of  $G_h$  and  $G_f$  will tend to restore the world rate of interest to its previous level.

### Generalized Uncovered Interest Parity

The log of the flexible-price equilibrium value of the real exchange rate, measured in terms of the prices of traded goods, thus can be assumed to be a function of budget balances both at home ( $USBB$ ) and abroad ( $FBB$ ) and the log of the real price of oil ( $LPOIL$ ). This gives:

$$(12) \quad E_t(qd_{t+k}) = \gamma_0 + \gamma_1 USBB_t + \gamma_2 FBB_t + \gamma_3 LPOIL_t.$$

Next, substituting (12) into (9) gives the generalized open interest parity condition for the *real* exchange rate as:

$$(13) \quad q_t = B_0 + B_1 USBB_t + B_2 FBB_t + B_3 LPOIL_t + B_4((pd_t^* - p_t^*) - (pd_t - p_t)) + B_5({}_kR_t - {}_kR_t^*).$$

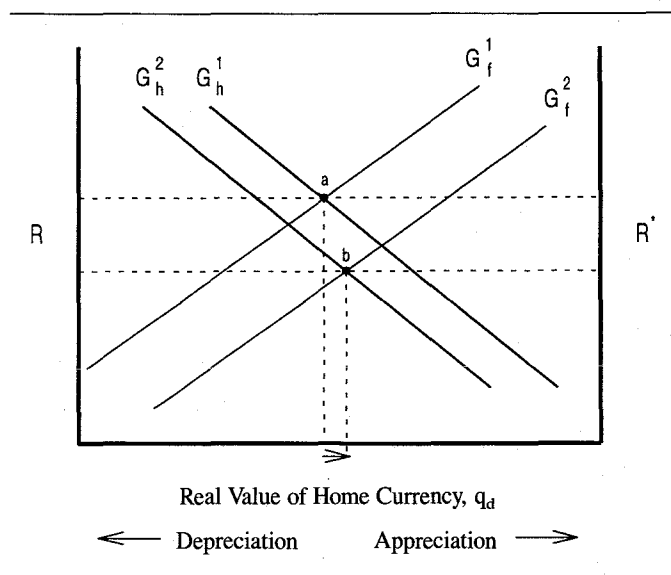
The presence of  $p_t^*$  and  $p$  on both the left hand side (in  $q_t$ ) and right hand side of (13) produces an automatic correlation between the left and right side variables. To avoid this statistical problem when estimating the coefficients of the model, the dependent variable is redefined to be the *nominal* value of the home currency by substituting (5) for  $q_t$ . Collecting terms, this gives the generalized uncovered interest parity condition for the *nominal* exchange rate as:

$$(14) \quad e = B_0 + B_1 USBB_t + B_2 FBB_t + B_3 LPOIL_t + B_4(pd_t^* - pd_t) + (1 - B_4)(p_t^* - p_t) + B_5({}_kR_t - {}_kR_t^*).$$

The estimate of this equation is then used to make out-of-sample predictions of the nominal exchange rate, assuming the values of all explanatory variables are known. To make out-of-sample predictions of the *real* exchange, known values of  $p_t$  and  $p_t^*$  are simply added and subtracted,

11. The exchange values of the currencies of the oil exporting countries do not enter into this analysis because oil is priced in dollars, and these "petrodollars" are either invested or spent on goods and services abroad.

FIGURE 3  
EFFECT OF OIL PRICE INCREASE



12. Trehan (1986) detects a positive influence of the price of oil on the trade-weighted value of the U.S. dollar. Also see Krugman (1983) and Dunn (1979).

respectively, to the value of  $e$  predicted by the estimated form of equation (14). But as pointed out earlier, since  $p_t$  and  $p_t^*$  are known, the prediction errors for real and nominal exchange rates are the same.

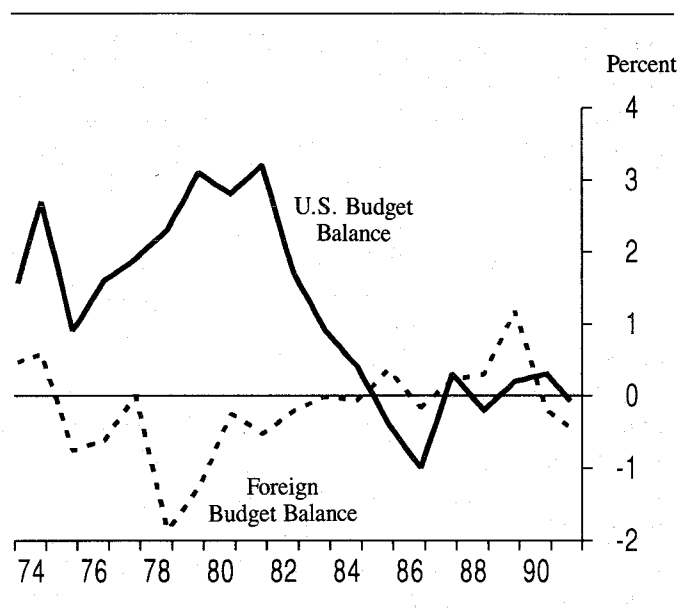
For the case of the trade-weighted dollar,  $e_t$  is measured by the multilateral trade-weighted value against 10 major industrial countries constructed by the staff of the Board of Governors of the Federal Reserve System. The interest rates,  ${}_kR_t$  and  ${}_kR_t^*$ , are yields on 10-year government bonds less a centered 12-quarter moving average of inflation in consumer prices. The real price of oil is calculated as the ratio of the seasonally adjusted producers' price of crude petroleum to the seasonally adjusted producers' price of finished goods.

To measure anticipated budget balances, a moving average of inflation-adjusted high employment budget balances as a percent of GDP for the most recent four quarters was used.<sup>13</sup> The alternative of budget balances over four quarters ahead did not perform as well. Neither did flexible distributed lags on current and past budget balances. For the trade-weighted dollar, trade weights clearly should be used in aggregating the rest of the world's relative prices and real interest rates. But the effect of a foreign structural budget deficit depends upon the relative size of the foreign country as well, and the weights should reflect this. The smaller the foreign country, the larger will trade generally be as a proportion of GDP, the steeper will be its  $G$  schedule, and the less the  $G$  schedule of the home country will be changed by a movement of the foreign country's budget deficit. As a result, the smaller will be the size of the effect of its own budgetary changes on its exchange rate with the home country. Therefore, in the case of the trade-weighted dollar, foreign budget balances were weighted by GDP weights times trade weights.

Theoretically, both foreign and U.S. budget balances should be included in the model. However, while the U.S. budget balance had the expected estimated effects in all cases, the estimated effects of foreign budget balances were close to zero and sometimes of unanticipated sign. In the case of the trade-weighted dollar, the explanation appears to be that during the sample period there was relatively little variation in the weighted foreign budget balance, as shown in Figure 4. For the bilateral rates the explanation appears to be different. As discussed, the size of the effect of a foreign budget deficit on the respective dollar bilateral rate depends upon the relative size of

FIGURE 4

## U.S. AND FOREIGN INFLATION-ADJUSTED STRUCTURAL BUDGET BALANCES



the foreign country. In the sample period, the largest of the three foreign economies (Japan) was only one-third of the size of the U.S. economy. So the effect of its budget deficit on the dollar bilateral rate would be much smaller than the effect of the U.S. budget deficit. The crudeness of the budget data and sharper perceptions of U.S. as opposed to foreign budget deficits also may have been contributing factors. In any case, because of a lack of significant effects, foreign budget balances were dropped from the model.

A further point with respect to equation (14) is that the coefficients on the wholesale price differential ( $B_4$ ) and the consumer price differential ( $1 - B_4$ ) should sum to 1.0. Unrestricted estimates of these coefficients came close to meeting this condition, and this constraint was imposed both in the cointegrating vectors and subsequent error correction models of the exchange rate.

### III. STABILITY OF THE GENERALIZED UNCOVERED INTEREST PARITY MODEL

The generalized open interest parity condition of equation (14) does not hold instantaneously. This is because perceptions of the flexible-price equilibrium of the real exchange rate evolve gradually in response to changes in the current values of their determinants. However, the variables in equation (14) are cointegrated in the long run and can be described by an error correction system in the short run.

13. These budget balances are for state and local, as well as the federal, government. The recent data was constructed from various issues of the *OECD Economic Outlook*. Back data are from Price and Muller (1984).

### Cointegration

Having found that short-term movements in real long-term interest rate differentials are no better than a naive model of no change for making out-of-sample predictions of real bilateral exchange rates, Meese and Rogoff (1988) went on to examine the possibility that real exchange rates adjust slowly to real interest rate differentials. They rejected this possibility, however, because they found that real bilateral long-term interest rate differentials were *not* cointegrated with real bilateral exchange rates. Cointegration of these variables would mean that there is a long-run relationship between them.<sup>14</sup>

Meese and Rogoff used the Engle-Granger two-step procedure to test for cointegration. In the first step one variable is regressed against other variables that are potentially cointegrated with it. The residuals from the regression are then tested for stationarity by means of the Dickey-Fuller test. If nonstationarity of the residuals is rejected, then the combination of variables can be regarded as cointegrated.<sup>15</sup> Table 1 substantiates a lack of cointegration between the real exchange rate and the real long-term interest rate differential for the four exchange rates in this study using the Dickey-Fuller test.<sup>16</sup>

A more powerful test for cointegration is available, however. As proved by Engle and Granger (1987), any variables that are cointegrated have an error correction representation. This means, for example, that if the real exchange rate is cointegrated with the real interest rate differential, then the errors in this relationship are part of a larger error correction system. Such a two variable system would be written as:

$$(15) \Delta q_t = -\rho_1 EC_{-1} + \text{lagged} [\Delta q_t, \Delta ({}_k R_t - {}_k R_t^*)]$$

$$(16) \Delta ({}_k R_t - {}_k R_t^*) = \rho_2 EC_{-1}$$

$$+ \text{lagged} [\Delta q_t, \Delta ({}_k R_t - {}_k R_t^*)]$$

14. A necessary condition for cointegration is that the variables be nonstationary and also integrated of the same order. See Charemza and Deadman (1992), ch. 5. Meese and Rogoff (1988) rejected stationarity for levels of the three real bilateral exchange rates as well as the corresponding real long-term interest differentials, but not for first differences. Stationarity can also be rejected for levels of the nominal and real trade-weighted dollar and the corresponding long-term real interest rate differential.

15. See Engle and Granger (1987) and Engle and Yoo (1987), and Charemza and Deadman (1992), Ch. 5.

16. Coughlin and Koedijk (1990) and Edison and Pauls (1991) report similar results with respect to the cointegration of exchange rates and real interest rates using the Dickey-Fuller test.

where  $EC_t = q_t - B_0 - B_1 ({}_k R_t - {}_k R_t^*)$ .

In this error correction model, the short-run and long-run responses of the variables are allowed to differ, and all variables are treated as endogenous. In contrast, the Dickey-Fuller test assumes that short- and long-run responses are the same. It also ignores possible endogeneity of the explanatory variables. As a result, the Dickey-Fuller test is inefficient. A more powerful test for cointegration is obtained by maximum likelihood estimation of the complete error correction system, as developed by Johansen (1988) and Johansen and Juselius (1990).<sup>17</sup> Table 1 shows that, on the basis of this more powerful test, cointegration between the real exchange rate and the real long-term interest rate differential is accepted for the trade-weighted dollar and bilateral rates against the mark and pound, but is rejected for the bilateral rate against the yen.<sup>18</sup>

The Johansen procedure also was used to test for cointegration of all variables in (14).<sup>19</sup> Since the power of this

TABLE 1

TESTS FOR COINTEGRATION OF REAL EXCHANGE RATE AND REAL LONG-TERM INTEREST RATE DIFFERENTIAL, 1974.Q1 TO 1991.Q3

	AUGMENTED DICKEY-FULLER TEST	JOHANSEN PROCEDURE	
		Maximum Eigenvalue	Trace
Trade-weighted US\$	-2.41	16.3**	19.4**
Yen/US\$	-2.39	4.0	7.2
Mark/US\$	-1.68	12.94*	17.4*
Pound/US\$	-1.78	15.5**	18.7**

\*\*Significant at 5 percent.

\*Significant at 10 percent.

17. In the case of two variables there can be only one unique cointegrating vector. In the more general case of a model with  $n$  variables, however, there can be up to  $n-1$  unique cointegrating vectors. See Johansen and Juselius (1990) or Charemza and Deadman (1992, Ch. 6.4).

18. Two lags on the differenced variables were used. Edison and Melick (1992) also found cointegration between the real trade-weighted dollar and the real long-term interest rate spread using the Johansen procedure.

19. A necessary condition for cointegration is that the variables be integrated of the same order. As discussed in footnote 14, exchange rates and real interest rate differentials were found to be stationary in first differences but not in levels, or integrated of order one. This is also true of the other variables in equation (14), with the exception of the Japanese price levels, which were stationary in levels. However, since the U.S. price level is nonstationary in levels, all of the relative price variables were nonstationary also, and thus also integrated of order one.

test is low for cointegration vectors that are close to being nonstationary, it is reasonable to follow a test procedure that allows rejection for probability values higher than the usual 5 or 1 percent. As shown in Table 2, the Johansen procedure rejects the null of no cointegrating vectors for the trade-weighted dollar at the 1 percent level; and at that same level of significance one cointegrating vector is accepted. Similarly, for the nominal bilateral rates against the dollar, the null of no cointegrating vector is rejected at from a 5 to 20 percent level of significance, and one cointegrating vector is accepted. Thus, the data for both the trade-weighted dollar and the three bilateral rates are consistent with cointegration of the variables in the generalized uncovered interest parity model.

Estimates of the cointegrating vectors for the variables in

TABLE 2

TESTS FOR COINTEGRATION OF THE EXCHANGE RATE WITH ALL VARIABLES IN GENERALIZED UNCOVERED INTEREST PARITY MODEL, 1974.Q1-1991.Q3

	JOHANSEN PROCEDURE		
	Number of Cointegrating Vectors	Maximum Eigenvalue	Trace
Trade-Weighted US\$	0	47.3****	96.8****
	1	25.6	49.6
Yen/US\$	0	35.6***	78.6****
	1	25.4	42.9
Mark/US\$	0	27.8*	65.1*
	1	14.1	37.3
Pound/US\$	0	30.5**	78.7****
	1	23.5	48.2

\*\*\*\*Reject at 1 percent  
 \*\*\*Reject at 5 percent  
 \*\*Reject at 10 percent  
 \*Reject at 20 percent

TABLE 3

COINTEGRATION VECTORS FOR NOMINAL EXCHANGE RATES, 1974.Q1-1991.Q3

	CONSTANT	USBB <sub>t</sub>	LPOIL <sub>t</sub>	(pd <sub>t</sub> * - pd <sub>t</sub> )	(p <sub>t</sub> * - p)	(R <sub>t</sub> - R <sub>t</sub> *)	$\bar{R}^2$	S.E.
Trade-Weighted US\$	4.56	-0.0625	0.281	0.985	0.015	0.0341	0.798	0.0678
Yen/US\$	5.41	-0.0447	0.278	2.03	-1.03	—	0.918	0.0813
Mark/US\$	0.987	-0.0469	0.165	2.89	-1.89	0.0179	0.866	0.0690
Pound/US\$	-0.218	-0.111	0.225	1.55	-0.55	—	0.861	0.0666

equation (14) are given in Table 3, and the resulting contributions to longer-run changes in the value of the nominal trade-weighted dollar are shown in Figures 5 and 6. The effect of the real interest rate differential was either very small or of the wrong sign for the yen and pound bilateral rates, most likely because of the difficulty of measuring long-term inflation expectations. So in these cases the variable was dropped. Otherwise, the overall effects on the exchange rate are about as anticipated. A 1 percentage point increase in the U.S. budget deficit as a percent of U.S. GDP is estimated to appreciate the value of the trade-weighted dollar by 6 percent, with the value in terms of the pound going up by more and in terms of the yen and the mark by less. A 10 percent higher real price of oil is estimated to appreciate the trade-weighted value of the U.S. dollar by about 3 percent, but less so against the mark than the other two currencies. Also, the value of the dollar moves positively with the relative price of traded goods abroad compared with the U.S., as anticipated.

The inclusion of factors besides interest rates substantially reduces the estimated long-run response of the dollar to interest rates. Without these additional factors, a 1 percentage point change in the real interest rate differential on 10-year bonds is estimated to move the trade-weighted dollar by about 7 percentage points. But with their inclusion the estimated effect drops to about 3½ percentage points. Evidently, risk in open interest arbitrage causes the response of the dollar to fall well short of the 10 percentage point response that would tend fully to equalize expected returns on 10-year bonds.

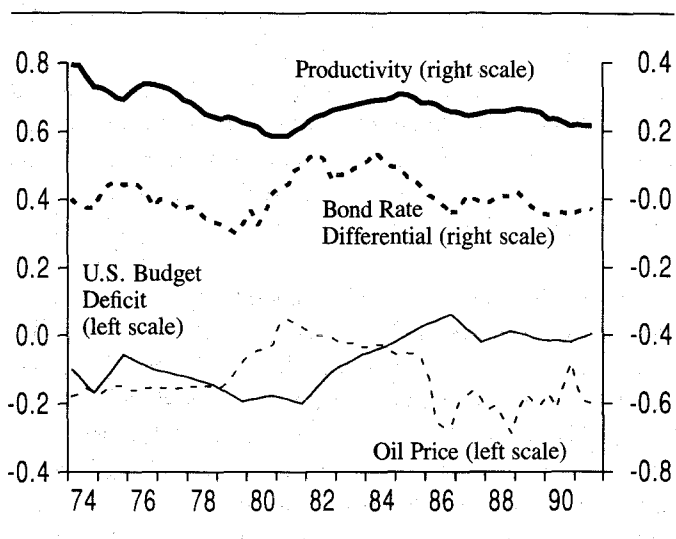
### PREDICTIONS WITH AN ERROR CORRECTION MODEL

Given cointegration of the variables, the short-run adjustment of the exchange rate to generalized open interest parity can be captured with an error correction model. Estimates of such a model for changes in nominal exchange rates are provided in Table 4. The model explains nearly

half of the in-sample variation of changes in the trade-weighted dollar (Figure 7) and somewhat lesser proportions of changes in the bilateral rates. A full response of the trade-weighted dollar to changes in the real interest rate differential takes only one quarter, consistent with a relatively quick exploitation of arbitrage opportunities. The

FIGURE 5

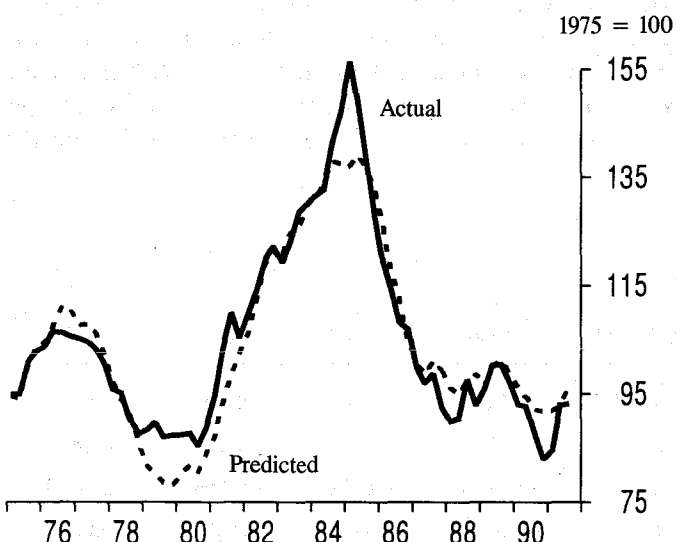
CONTRIBUTIONS OF ALL ECONOMIC FACTORS  
TO VALUE OF TRADE-WEIGHTED DOLLAR



NOTE: In logarithms.

FIGURE 6

TRADE-WEIGHTED DOLLAR AND VALUE PREDICTED  
BY ALL ECONOMIC FACTORS

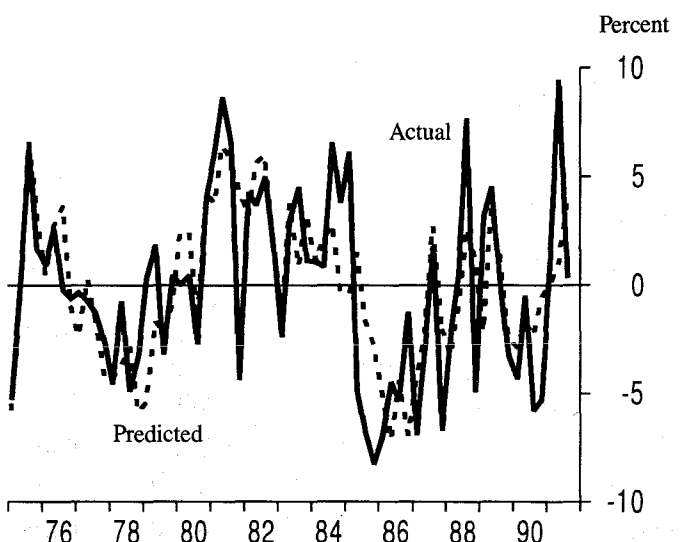


speed of response of the dollar to changes in the other variables is generally not as fast, suggesting a gradual formation of longer-term expectations with regard to the flexible-price equilibrium of the real exchange rate.

Out-of-sample predictions that use data other than those on which the model was estimated provide an important test of the stability of the economic relationships in the model. Therefore, the error correction model was first estimated for the period 1975:Q2 to 1981:Q4. Then predictions for one, four, and eight quarters ahead were made using the actual values of the explanatory variables. Predictions of the change in the nominal exchange rate were made with the estimated error correction equation, while the predictions of the change in the real exchange rate were obtained by subtracting off changes in logs of the price levels. The estimation was then updated to include successively more quarters, allowing additional out-of-sample predictions to be made. The root-mean-squared error (RMSE) for (non-overlapping) predictions of the error correction model was then calculated and compared with that of a naive model of no change. *F* tests indicated the lack of significance of lagged changes in the U.S. budget balance and the price of oil in most cases, suggesting that only the error correction part of the model is important for the short-run response to these variables. Consequently, two sets of predictions were examined, one including these variables and the other excluding them.

FIGURE 7

QUARTERLY CHANGE IN TRADE-WEIGHTED  
DOLLAR AND VALUE PREDICTED  
BY ALL ECONOMIC FACTORS



As discussed earlier, the RMSEs for predictions of the real and nominal exchange rates are the same in this exercise, and only the RMSEs for predictions from the naive model of no change differ. As shown in Table 5, the RMSEs for out-of-sample predictions of the nominal trade-weighted dollar from the full model are about 10 percent lower than those of the naive model of no change for one or two quarters ahead. Then, for four and eight quarters ahead the RMSE is about 30 and 45 percent less than for the naive model, respectively. Also, the partial model that drops lagged changes in the U.S. budget balance and the

price of oil reduces the RMSE by significantly more at horizons up to four quarters. Thus, not only does the generalized uncovered interest parity model fit the in-sample data for the nominal trade-weighted dollar better than the simple uncovered interest parity model does, but it also performs significantly better out of sample as well.

The results for the bilateral rates are almost as good. In the work of Meese and Rogoff, the RMSEs for the out-of-sample predictions of bilateral rates from the simple uncovered interest parity model were no lower than for those from the naive model. In contrast, the partial generalized

TABLE 4

ESTIMATED ERROR CORRECTION MODEL OF SHORT-RUN ADJUSTMENT FOR THE NOMINAL EXCHANGE RATE, 1975.Q2-1991.Q3

	VARIABLE			
	TRADE-WEIGHTED US\$	YEN/US\$	MARK/US\$	POUND/US\$
$\Delta USBB_{t-1}$	-0.00444 (-0.156)	-0.0421 (-0.934)	-0.0411 (-1.01)	-0.0156 (-0.333)
$\Delta USBB_{t-2}$	-0.0174 (-0.646)	0.0209 (0.486)	-0.0186 (-0.479)	-0.0401 (-0.904)
$\Delta LPOIL_{t-1}$	0.0237 (0.572)	0.0852 (1.32)	0.0306 (0.551)	-0.0165 (-0.239)
$\Delta LPOIL_{t-2}$	0.00768 (0.181)	-0.0474 (-0.723)	0.0874 (1.58)	0.000806 (0.0115)
$\Delta(pd_{t-1}^* - pd_{t-1})$	-0.297 (0.666)	0.149 (0.335)	0.553 (0.953)	0.354 (1.22)
$\Delta(pd_{t-2}^* - pd_{t-2})$	1.15 (2.56)	-0.0443 (0.460)	0.103 (0.180)	0.220 (0.763)
$\Delta(p_{t-1}^* - p_{t-1})$	1.29 (2.91)	0.851 (1.91)	0.447 (0.772)	0.646 (2.23)
$\Delta(p_{t-2}^* - p_{t-2})$	-0.150 (-0.333)	1.04 (2.27)	0.897 (1.57)	0.780 (2.71)
$\Delta(R_{t-1} - R_{t-1}^*)$	0.0190 (2.58)	—	0.0269 (3.03)	—
$\Delta(R_{t-2} - R_{t-2}^*)$	-0.00158 (-0.210)	—	-0.00143 (-0.143)	—
$\Delta e_{t-1}$	0.227 (1.90)	0.397 (2.57)	0.116 (0.923)	0.182 (1.10)
$\Delta e_{t-2}$	0.0228 (0.195)	-0.0901 (-0.561)	-0.109 (-0.860)	-0.0119 (-0.069)
$EC_{t-1}$	-0.234 (-2.87)	-0.166 (-0.166)	-0.188 (1.94)	-0.268 (-1.76)
S.E.	0.0330	0.0552	0.0468	0.0558

NOTE:  $t$  statistics are in parentheses.

TABLE 5  
 OUT-OF-SAMPLE RMSE FOR SHORT-RUN  
 ADJUSTMENT TO GENERALIZED UNCOVERED  
 INTEREST PARITY, 1982.Q1 TO 1991.Q3

	HORIZON	NAIVE MODEL		ERROR CORRECTION (Nominal and Real)	
		Nominal	Real	Full	Partial
Trade-Weighted US\$	1	0.048	0.050	0.045	0.041
	2	0.081	0.083	0.072	0.060
	4	0.135	0.138	0.093	0.082
	8	0.235	0.223	0.135	0.133
Yen/US\$	1	0.059	0.059	0.066	0.064
	2	0.100	0.097	0.084	0.080
	4	0.154	0.145	0.105	0.097
	8	0.263	0.236	0.190	0.189
Mark/US\$	1	0.057	0.055	0.058	0.051
	2	0.094	0.090	0.086	0.069
	4	0.156	0.144	0.117	0.097
	8	0.271	0.244	0.149	0.139
Pound/US\$	1	0.057	0.066	0.066	0.060
	2	0.089	0.111	0.111	0.085
	4	0.159	0.153	0.153	0.120
	8	0.205	0.125	0.125	0.150

model reduces the RMSE for bilateral rates by 5 to 30 percent for a horizon of two quarters and by 25 to 50 percent for horizons of four or eight quarters.

The RMSEs for the naive model of no change are approximately the same, whether predictions are made for nominal or real values of the dollar. Therefore, the marked superiority of the generalized uncovered interest parity model over the naive model holds up for the real exchange rates as well.

#### IV. SUMMARY AND CONCLUSIONS

Sticky price monetary models of the real exchange rate, while reasonable theoretically, have been disappointing empirically. These models imply that real exchange rates should vary significantly with real interest rate differentials, according to the principle of uncovered interest parity. But while some statistical association between exchange rates and interest rates has been found, predictions of real exchange rates using data other than those on which the model is estimated have not been satisfactory. The most likely reason is that shocks to the market's expectation of the future equilibrium real exchange rate

weaken the stability of the association between the real exchange rate and the real interest rate differential.

This study has identified three types of factors that appear to be empirically important. These are productivity growth that causes changes in the relative prices of traded goods at home versus abroad, government budget deficits, and the real price of oil. These factors along with long-term real interest rate differentials account for at least 80 percent of the longer-run variation in both the trade-weighted dollar and bilateral rates against the dollar. However, taking these additional factors into account reduces the estimated effect of interest rates on the dollar. The estimated response of the trade-weighted dollar to a 1 percentage point change in the differential between 10-year real bond rates drops from about 7 percent to 3½ percent in the complete model.

An error correction model, based on this expanded form of uncovered interest parity explains nearly half of the in-sample variation in *changes* in the trade-weighted dollar and has out-of-sample prediction errors that are 30 to 45 percent lower than those from a naive model of no change over horizons of four or eight quarters. Moreover, prediction errors for bilateral rates are almost as low as for the trade-weighted dollar.

These results have important implications for monetary policy. Most macroeconomic models stress the role of real interest rate differentials between the U.S. and abroad in determining the real value of the dollar. However, this study has shown that productivity growth, the real price of oil, and budget deficits also play important roles. Moreover, taking these additional factors into account reduces the estimated effects of interest rates on the dollar. As a result, the influence of monetary policy on the international sector of the economy, operating through interest rates, probably is lower than generally thought.



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# Determinants of Bank Versus Nonbank Competitiveness in Short-term Business Lending

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*Since about 1974, banks' share of the market for short-term business lending has been steadily eroded through competition with nonbank creditors. This paper tries to identify some factors that may affect bank competitiveness in this category in the short run and discusses how these factors may have contributed to banks' loss of market share. Estimation of a simple linear model in first differences indicates that banks' market share responds negatively in the short run to above-average default risk and/or monetary tightness and to a decrease in banks' value of deposit insurance. Banks' market share responds positively to an increase in the level of interbank competition. Extrapolation from the short-run model to long-run effects demonstrates the plausibility that above average risk and/or monetary tightness and increases in the aggregate weighted capital-to-assets ratio, which contributes to decreases in the value of deposit insurance, may have played a small role in banks' loss of market share since the mid-1970s.*

Since about 1974, banks' share of the market for short-term business lending has been steadily eroded through competition with a variety of alternative creditors, including finance companies and the commercial paper market. This paper tries to identify some factors that may affect bank competitiveness in this market, at least in the short run, with competitiveness being measured by banks' market share of short-term business credit outstanding.

A reduced form model of bank market share is presented. In this model, market share over time depends on four factors that theoretically could affect the relative supply and demand for short-term bank business loans over time, specifically: (1) changes in the overall level of risk in the economy, (2) financial innovation, (3) bank regulatory costs and benefits, and (4) the level of interbank competition. On the basis of this model, a time series is estimated using linear regression techniques.

Because the data fail stationarity and cointegration tests, the model is estimated in first differences and only short-run influences are identified. I find some evidence that bank market share in short-term business lending responds negatively in the short run to an increase in banks' aggregate weighted capital-to-assets ratio (taken as a proxy for the value of deposit insurance) and positively to an increase in the percentage of total bank assets that is held by bank holding companies headquartered in states with interstate banking (taken as a proxy for the level of interbank competition). In addition, banks' market share appears to fall whenever the deviation is positive between the commercial paper—Treasury bill spread and that spread's mean (taken as a proxy for either the level of economy-wide default risk or the stance of monetary policy).

On the basis of the regression results, the paper then discusses the possible roles played by the various independent variables in explaining the decline in bank market share. However, because the lack of cointegration in the model means that the explanatory variables cannot fully account for the long-run influences on bank market share, the conclusions offered are treated as tentative.

The paper is organized as follows: Section I contains some background on banks' competitors in short-term business lending. Section II discusses the factors that in theory could affect bank competitiveness in short-term business lending. Section III presents a reduced form model of bank market share, defines variables, and discusses data and econometric issues. Section IV contains

regression results. Section V discusses the possible roles of the various independent variables in explaining the decline in bank competitiveness, and Section VI concludes.

## I. BANKS' COMPETITORS IN SHORT-TERM BUSINESS FINANCE

In this study, bank competitiveness in short-term business lending is measured by bank market share in this category, based on data from the Board of Governors' Flow of Funds Accounts. As of the third quarter of 1992, bank loans accounted for 52.6 percent of short-term credit to nonfinancial business, "other intermediated credit" for 39.3 percent, and commercial paper for 8.1 percent.<sup>1</sup>

The Flow of Funds Accounts include several sources of what is here called "other intermediated credit," and in the following discussion, I will focus on the two largest, namely, finance companies and offshore lenders.<sup>2</sup> Finance companies, like commercial banks, are financial intermediaries. They raise funds in the commercial paper market, often selling their paper to money market mutual funds, and they lend to both businesses and individuals. Because they do not take insured deposits, finance companies are not subject to regulations, such as reserve requirements and capital requirements, that apply to banks.

In this study, offshore credit may originate from foreign banks or other entities that are located outside the United States.<sup>3</sup> Domestic subsidiaries of foreign banks, as well as U.S. agencies and branches of foreign banks, are excluded from the definition of offshore lenders. Offshore lenders are for the most part not subject to the same regulations that face domestic banks.

The third source of short-term business credit, commercial paper, consists of unsecured short-term promissory notes that are offered to investors either through dealers or directly by the issuer. Original maturities of commercial paper range from one to 270 days, but average less than 60 days. The commercial paper market is a direct debt mar-

1. Trade credit also is a potentially important source of short-term business credit, but it is omitted from the total in this study. In addition, here short-term credit generally has a maturity that is less than one year.

2. Using the Flow of Funds breakdown of "other loans" (called here "other intermediated credit") for the nonfinancial corporate sector and applying it to the entire nonfinancial business sector, I estimate, that, as of year-end 1989, for example, finance company loans accounted for 54 percent of other intermediated credit to nonfinancial business. Other sources and their shares were: offshore (14.5), U.S. government (13.4), bankers' acceptances (7.4), savings and loans (6.7), and government-sponsored agencies (4).

3. A small proportion of this credit is from offshore bookings of U.S.-chartered banks.

ket, meaning that commercial paper credit is not intermediated. Most commercial paper is backed by bank lines of credit and is therefore issued by those able to obtain such lines of credit, that is, the most creditworthy borrowers.<sup>4</sup> Some commercial paper is sold indirectly through dealers.<sup>5</sup> Thus, the commercial paper market is regulated indirectly by the SEC, which has the authority to issue rules, such as capital requirements, that govern all securities dealers. The SEC also has regulatory authority over some commercial paper investors, such as money market mutual funds. However, any such regulations appear to have been relatively inconsequential to the commercial paper market during the period under study; they receive little or no attention in discussions of the commercial paper market and in studies of competition between banks and the commercial paper market.<sup>6</sup>

## II. DETERMINANTS OF BANK COMPETITIVENESS

In this section, I discuss variables which, in theory, could affect bank competitiveness in short-term business lending. These variables represent aspects of the ultimate determinants of bank competitiveness in short-term business lending: the supply and demand for short-term bank loans relative to the supply and demand for alternative short-term business financing. The variables relate to the level of risk in the economy, the relative benefits to banks versus other types of creditors of financial innovation, bank regulatory costs and benefits, and the level of inter-bank competition.<sup>7</sup>

Economists have several theories about the comparative advantage banks have in serving higher-risk customers. For

4. According to Moody's, about 84 percent of the total commercial paper issues worldwide are issued by companies with A-1 ratings from Standard and Poor's and P-1 from Moody's. See Fuerbringer (1991).

5. Dealers take only about 5-10 percent of the commercial paper they buy into their own inventories. They purchase the remainder for other investors and typically charge a commission of about 1/10 to 1/8 percent on an annual basis (Cook and Rowe 1986, p.116.)

6. See, for example, Estrella (1987), Hurley (1977), Judd (1979), and Cook and Rowe (1986). Hurley does mention that dealers who take relatively high-risk paper (i.e., when the issuer is unrated by two rating services) into inventory have to hold more capital. This rule went into effect in mid-1977, but would have been of very little consequence to the commercial paper market as a whole, because the vast majority of commercial paper is rated.

7. The list of explanatory variables used here is far from exhaustive. For example, I have not considered variables that may affect a bank's choice between making short-term business loans and making other types of investments. However, the ratio of bank short-term business credit to total bank loans and leases has changed relatively little between 1972

example, Diamond (1984) pointed out that information-gathering and evaluation of borrowers and their projects is more efficiently conducted once by a single intermediary, such as a bank, than repeatedly by numerous individual lenders. In addition, long-term relationships with borrowers can be a unique source of information. Such relationships, by their nature, can only be maintained between a borrower and at most a handful of lenders. This comparative advantage in information-gathering and analysis presumably enables intermediaries to make higher-risk loans than those that are made in the direct debt market, because information may lower the effective risk to the lender. This intuition is consistent with the observation that issuers of commercial paper tend to be quite low-risk borrowers.

When intermediaries' information-gathering includes monitoring borrowers' adherence to loan commitments, their relative ability to serve higher-risk customers may be even further enhanced. In this view, monitoring is an additional form of information gathering. Diamond (1991) shows that intermediaries who monitor are especially valuable to borrowers with credit ratings toward the middle of the spectrum. In the presence of moral hazard (the incentive that a borrower has to default on a loan because his *own* money is not at risk), borrowers need to offer potential lenders some assurance that they will not renege. The highest-rated borrowers can credibly "stake their reputation" on their promise to honor their obligations—their good reputation is what allows them to raise capital at a lower rate, and it must be maintained to retain this source of higher profits. These high-rated borrowers do not need to be monitored, and they access debt markets directly. In contrast, very low-rated borrowers have little to lose if they reveal bad news about themselves by defaulting, or by being caught when monitored. Medium-risk borrowers are the ones who need to be able to offer future direct lenders a good "track record" of having been monitored and not found wanting.

Among intermediaries, banks are thought to have special loan-monitoring capabilities, which may stem from banks' special access to information, including information regarding transactions activity, gained from deposit relationships with borrowers (Black 1975). In addition,

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(the earliest year for which such data are easily available) and 1990, ranging from around 30 to 34 percent. In addition, although increases in off-balance-sheet activities may have contributed to a decline in all types of loans, Baer and Pavel (1988) attribute the growth of off-balance-sheet activities partially to increases in banks' capital requirements, and this is controlled for in the model presented here. I also have not attempted to measure banks' cost of complying with numerous and varied consumer regulations.

even if banks do not lend to their own depositors, their general deposit relationships are likely to yield information about the state of local and regional economies that might be useful in monitoring. For example, a banker may assess a local customer's ability to meet loan commitments differently depending on whether or not that customer's industry is experiencing a downturn in the area. Banks may be able to glean advance knowledge of such a downturn from, for example, changes in the inflow and outflow of transactions deposits.<sup>8</sup>

The fact that banks monitor and may thereby have a comparative advantage in making risky loans indicates that the general level of risk in the economy may influence the relative demand for bank credit. However, the direction of influence can be positive or negative. For example, Diamond's model suggests that, as the general level of risk increases, more borrowers in the lowest-risk category may opt for bank credit, but, at the same time, the bank may lose more borrowers to the highest-risk category than it gained from the lowest-risk category.

The next factor to be considered is financial innovation. Here, it is suggested that the financial innovations that began in the 1970s may have put banks at a disadvantage relative to other lenders and therefore may have affected bank competitiveness in the period under study.

Any disadvantage stemming from financial innovation would have resulted largely from regulations that banks face but other lenders do not. In particular, the development and subsequent growth of money market mutual funds, beginning in the early 1970s, caused an outflow of savings from banks. This is because bank time and savings accounts had legally mandated ceilings on interest rates, and money market mutual funds offered a way to circumvent these restrictions. Thus, money market mutual fund growth accelerated significantly in 1973 and 1974, when market rates increased to new highs, and also in later periods of high rates.

Whether savings outflows into money market mutual funds actually decrease banks' short-term business lending is somewhat debatable. One reason to suspect that they may not is that such outflows affect only a subset of funding sources. Banks can obtain funding from sources other than retail deposits (including money market mutual funds themselves, which may purchase bank certificates of deposit) and may therefore substitute purchased funds for

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8. See Fama (1985) for a model in which banks have special monitoring capabilities and in which bank borrowing is useful to borrowers because it generates information which is useful to the borrower's other potential lenders. James (1987) also has found empirical evidence that the information generated by bank loans is useful to borrowers as a signal of creditworthiness.

retail deposits. In addition, banks can shift asset portfolios, and therefore there is no a priori reason to believe that a reduction in funding affects short-term business credit in particular. However, despite the fungible nature of bank liabilities and assets, the development of money market funds may indeed curtail bank competitiveness in short-term business lending. In addition, other financial innovations, such as advances in corporate cash management techniques and greater use of security repurchase agreements, which both reduce the demand for demand deposits, also may affect banks' short-term business lending.

Moreover, the growth of money market mutual funds in particular may affect bank competitiveness not only by way of savings outflows, but also by way of a beneficial synergistic effect on the competitiveness of finance companies and the commercial paper market. This is because the largest single category of money market mutual fund investments is commercial paper, and finance companies raise most of their funds through the commercial paper market, selling mainly to money market mutual funds.<sup>9</sup>

The next few variables to be considered as influences on bank competitiveness also derive their potential importance from the unique regulation of banks. First, banks face reserve requirements—that is, they must hold non-interest bearing deposits at the central bank—while their competitors do not. Reserve requirements therefore impose a cost on banks relative to their competitors, who may optimally invest all their funds. However, as with savings outflows, whether a general increase in required reserves affects banks' business lending in particular might be questioned. The implicit tax on banks might be passed on mainly to banks' borrowers (but even then perhaps mostly to non-business customers) in the form of higher interest rates on loans, thereby decreasing the equilibrium supply of loans, but it might be passed on mainly to depositors in the form of lower interest rates on deposits, thereby having little effect on bank credit.<sup>10</sup> In Section IV, I will investigate empirically whether reserve requirements really do affect banks' share of business credit.

Second, banks have access to deposit insurance, while their competitors do not. Deposit insurance benefits banks because it allows them to raise funds at risk-free interest rates, no matter how risky their loans. As Merton (1977) has shown, banks hold a put option in the form of deposit

insurance that, all other things equal, increases the profitability of high-risk loans by allowing banks to reap a high payoff if they "win," while letting the insurer pay off depositors if they "lose." However, banks do pay premiums for deposit insurance. Various authors have attempted to determine whether, in practice, the net value of deposit insurance to banks is positive or negative, with inconclusive results. For example, Pennacchi (1987) concluded that the answer depends on the degree of the insurance authority's regulatory control over banks. However, whether deposit insurance has, on net, a positive or negative value, we can say that an *increase* in the value should increase banks' returns, enhance their ability to attract funds, and thereby increase their relative supply of credit. Likewise, a decrease in the value of deposit insurance would be expected to decrease banks' relative supply of credit.

Third, over much of the period under study, Regulation Q ceilings on bank interest rates were in effect, and these may have played a role in bank competitiveness, complementary to but separate from their role as spurs to innovation. As mentioned above, an important feature of the economy in the early to mid-1970s was the increase in short-term interest rates in the face of ceilings on consumer deposit rates at commercial banks. Even if increases in spreads between market rates and deposit ceilings had not encouraged the *development* of money market mutual funds, they still likely would have increased disintermediation, that is, the flow of funds out of banks and into whatever higher yielding market assets existed at the time.

Fourth, market structure in the banking industry has likely changed due to the liberalization of interstate banking. Laderman and Pozdena (1991) found that the liberalization of interstate banking laws tends to increase the competitiveness of banking markets, as new opportunities open up for competitors to enter from out-of-state. Consequently, because output and total revenue are greater under perfect competition than under monopoly, interstate banking may increase banks' total dollar value of assets. Therefore, assuming no change in the level of competition within other sectors of the short-term business credit market, it is reasonable to suppose that the liberalization of interstate banking may increase bank competitiveness in short-term business lending.<sup>11</sup>

9. As of 1990, 48.4 percent of money market mutual fund assets consisted of commercial paper (Post 1992).

10. See Black (1975) for a model in which the interest foregone on reserves is passed on in the form of lower interest for depositors. See Fama (1985) for a model in which the reserve tax on certificates of deposit is borne by bank borrowers.

11. Because I am viewing banks as competing with other intermediaries and the direct debt market, I do not actually think of any bank as having as much market power as a monopolist would have. Even if it is the only bank in the area, any bank would have competitors in the form of other types of lenders. Despite this, it still is reasonable to examine the effect of bank market structure on aggregate bank credit, because banks remain the major providers in several areas, including payments system services, demand deposits, and short-term business credit itself.

### III. MODEL OF BANKS' SHARE OF SHORT-TERM BUSINESS CREDIT

In this section, I present a model of bank competitiveness in short-term business lending. This model is a function of the factors that were discussed in Section II, and it uses the following empirical measures for these factors.

RISK = 6-month commercial paper interest rate  
 - 6-month Treasury bill interest rate  
 - mean of this difference over the period 1960-1990;

TBHIGH = highest 6-month Treasury bill interest rate to date;

RESREQ = (aggregate required reserves/total bank assets)  $\times$  6-month Treasury bill interest rate;

KARATIO = total bank capital/total bank assets;

PREM = net aggregate deposit insurance assessments/total insured deposits;

SPREAD = difference between 3-month Treasury bill interest rate and ceiling on interest rate on savings deposits, if this difference is positive, zero otherwise;

and

INTERST = percentage of total bank assets held by bank holding companies that are headquartered in states that permit interstate banking.

RISK measures the level of risk in the economy. Since the commercial paper interest rate reflects a default risk, while the interest rate on Treasury bills is essentially risk-free, the spread between the two rates may be an indicator of overall risk in the economy (Friedman and Kuttner 1991).<sup>12</sup> I use the deviation of the paper-bill spread from its mean to measure the level of risk relative to a "normal" level of risk for the period. It should be noted that the paper-bill spread also can be interpreted as a

measure of the tightness of monetary policy, with a higher spread indicating greater tightness. It is expected that monetary policy tightening would differentially affect bank lending, lowering banks' share of short-term business credit.<sup>13</sup>

It may also be noted that, as a measure of default risk, the effect of an increase in this variable on bank market share is expected to be either positive or negative, as explained in Section II. On the other hand, as a measure of the tightness of monetary policy, its effect is expected to be unambiguously negative.

TBHIGH measures financial innovations. Rather than attempt to measure particular financial innovations directly, I use a variable that other researchers have used as an indicator of the *incentive* for financial innovations, because it should serve well as a general measure of all such innovations, not just particular innovations. For example, financial innovations like money market mutual funds, security repurchase agreements, and cash management methods become more attractive as interest rates rise. For consumers, the spread between market interest rates and ceilings on bank rates rises with market rates, creating a market for money market mutual funds. For businesses, the spread between market rates and bank deposit rates is positive and also tends to rise with market interest rates, creating a market for ways to economize on transactions balances, such as repurchase agreements and cash management.

So, increases in market interest rates may increase the profitability of investing in financial innovations. However, if there is a fixed cost to such innovation (for example, the cost of training staff to manage repurchase agreements or the writing of mutual fund management software), it will not be undertaken unless the present discounted value of the interest gained thereby is at least as high as the fixed cost.

Previous authors, for example, Enzler, Johnson, and Paulus (1976), have suggested using the previous highest interest rate as a measure of the perceived net profitability of financial innovation. The idea here is that only if interest rates rise to unprecedented levels will firms perceive that the high rates will persist long enough to make the benefits of innovation outweigh the costs. In addition, subsequent

12. As Friedman and Kuttner point out, even if the actual incidence of default by commercial paper issuers is relatively rare, the paper-bill spread still may be a satisfactory gauge of the perceived level of overall default risk. One reason simply may be that subjective probabilities of default, even if rational, may not equal the frequency rate of default observed within any finite time period. Another possibility is that subjective probabilities are not in fact rational. Because it is subjective default probabilities that matter in the context of the explanation given above for the potential importance of risk, the paper-bill spread would seem to be satisfactory.

13. Friedman and Kuttner (1991), in contrast, argue that changes in bank loans relative to total credit resulting from a tightening of monetary policy cause changes in the paper-bill spread. In the model presented here, monetary policy would simultaneously raise the paper-bill spread (as well as other interest rate spreads, such as the bank loan-bill spread and the certificate of deposit-bill spread) and lower banks' relative supply of business credit.

reductions in interest rates will not reverse the process, because the innovations already will be in place.<sup>14</sup>

RESREQ measures the cost of reserve requirements. Aggregate required reserves is multiplied by a nominal interest rate, the 6-month Treasury bill rate, because required reserves pay no interest. This means that the opportunity cost that banks face as a result of having to hold such reserves rises with the return that would be earned were such reserves not required. The reserve requirement variable has total bank assets in the denominator as a scaling factor.

KARATIO and PREM measure changes in the value of deposit insurance. Deposit insurance can be thought of as a put option, and, as shown by Merton (1977), its value to the bank depends negatively on the bank's capital-to-assets ratio. I measure this ratio with the aggregate book value of capital divided by the aggregate book value of assets, which equals the weighted average of individual bank capital-to-assets ratios, where the weight is the ratio of that bank's assets to total bank assets.<sup>15</sup> PREM, which controls for banks' cost of deposit insurance, measures premium assessments, net of credits, per dollar of insured deposits. (Up until the early 1980s, the Federal Deposit Insurance Corporation refunded to banks a portion of assessment income at the end of each year.)

SPREAD measures the level of disintermediation. The 3-month Treasury bill rate is used rather than the 6-month rate because the 3-month bill is the more liquid of the two instruments. The same reasoning applies to the use of the ceiling on savings deposit interest rates rather than the ceiling on rates on bank certificates of deposit.<sup>16</sup>

14. Enzler, Johnson, and Paulus (1976) use previous peak interest rates rather than peak interest rates to date, presumably because they see this variable as working with a lag. I include in my regression eight lags on the highest interest rate to date.

15. The capital-to-assets ratio may also affect bank competitiveness through its effect on banks' tax burden. Because debt is generally favored in the tax structure, an increase in the capital-to-assets ratio tends to increase taxes, and thereby, all other things equal, impair bank competitiveness relative to other creditors. It is also possible that an increase in regulatory capital minimums is at least partially an indicator of an increase in omitted factors that have reduced bank profitability and competitiveness. In other words, regulators may have increased required capital-to-assets ratios *in response to* deteriorating bank health. However, this explanation of the effect of capital ratios is more plausible for the late 1980s than for the period under study as a whole.

16. I use the savings deposit interest rate ceiling even after December 1982, when money market deposit accounts (MMDAs) were introduced at banks. Even though MMDAs were not in general subject to a ceiling on interest rates, ceilings did apply until January 1986 for accounts that maintained an average balance of less than \$2,500. However, see Furlong (1983) for an account of the instant popularity of MMDAs, despite this restriction.

INTERST measures interstate banking.<sup>17</sup> As a measure of interbank competition, the interstate banking variable is preferable to other variables such as concentration ratios because it is more of an underlying driving force. For example, the concentration ratio in a local or regional banking market may fall *in response to* the passage of liberalized interstate banking laws. One could say that it is the change in concentration that affects competition, but the real driving force is the change in laws. In addition, the measure used here allows for competition to be affected by the mere threat of entry, whereas concentration measures do not.<sup>18</sup> Finally, interstate banking was found to be correlated with higher levels of interbank competition (Laderman and Pozdena 1991).

### The Model

Let nominal short-term business loans from banks,  $L_b$ , and other nominal short-term business credit,  $L_o$ , be exponential functions such that

$$(1a) \quad L_b = \exp(c_b + \gamma_b t + \beta'_b X + \epsilon_b)$$

and

$$(1b) \quad L_o = \exp(c_o + \gamma_o t + \beta'_o X + \epsilon_o),$$

where  $c_b$  and  $c_o$  are constants,  $\gamma_b$  and  $\gamma_o$  are coefficients,  $t$  is a time trend,  $\beta_b$  and  $\beta_o$  are vectors of coefficients,  $X$  is a vector of the seven explanatory variables, and  $\epsilon_b$  and  $\epsilon_o$  are error terms.

Because the dependent variable is banks' *share* of short-term business credit, it has a value that is restricted to be between zero and one. The error term in the ordinary least squares linear regression model takes on values between negative infinity and infinity, so it is necessary to transform the dependent variable so that it has the same range. A customary transformation, the logistic transform, maps  $(0, 1)$  symmetrically into  $(-\infty, \infty)$ . The logistic transform of the share,  $s$ , is  $S$ , where

17. These data are from the Compustat bank file, which contains headquarters location and asset data for a sample of about 150 leading U.S. bank holding companies, representing about 80 percent of U.S. bank assets.

18. It is possible that the interstate banking variable is endogenous; states with weak banks may pass interstate banking laws with the hopes of increasing the market values of their banks as potential acquisition targets. However, this may not be a significant concern, because on average, the liberalization of interstate banking laws *decreases* bank stock returns (Laderman and Pozdena 1991). Nevertheless, some concern remains that the type of effect described might impart a negative bias to the coefficient on the interstate banking variable.

$$S = \log\left(\frac{s}{1-s}\right).$$

Letting  $L_T$  be total short-term business credit, we have, from (1a) and (1b),

$$\begin{aligned} (2) \quad \log\left(\frac{s}{1-s}\right) &= \log\left(\frac{\frac{L_b}{L_T}}{\frac{L_o}{L_T}}\right) = \log\left(\frac{L_b}{L_o}\right) \\ &= c_b - c_o + (\gamma_b - \gamma_o)t \\ &\quad + (\beta'_b - \beta'_o)X + \epsilon_b - \epsilon_o. \end{aligned}$$

Simplifying,

$$(3) \quad S = c + \gamma t + \beta'X + \epsilon,$$

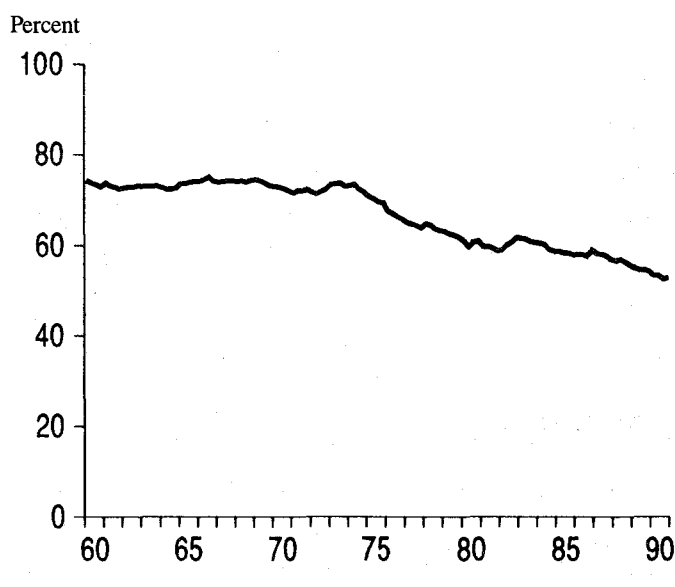
with the coefficients and the error term in (3) corresponding to the differences between the coefficients and the error terms, respectively, in the underlying equations (1a) and (1b). Thus, the coefficients in (3) show the response of outstanding nominal short-term bank credit relative to the response of nominal other credit to changes in the explanatory variables.

### Data

The model is estimated using quarterly data from the Board of Governors' Flow of Funds Accounts for the first quarter of 1960 through the end of 1990.<sup>19</sup> Aggregate required reserves, total assets, and capital are measured in billions of current dollars and were obtained from the Board of Governors' *Annual Statistical Digest*.<sup>20</sup> The 6-month Treasury bill rate, the 3-month Treasury bill rate, the ceiling rate on savings deposits, and the 6-month commercial paper rate all are in percentage terms.

The nontransformed version of banks' share of total U.S. short-term nonfinancial business debt outstanding is shown in Figure 1. The most striking feature is the steady decline in banks' share that begins in about 1974. However,

FIGURE 1  
BANKS' SHARE OF SHORT-TERM BUSINESS LOANS  
OUTSTANDING



the goals of this paper are, first, to explain only short-run variations in bank competitiveness and then to use these results to explore only informally the possible reasons for the long-run decline. Thus, Figure 1 mainly provides a basis for subsequent discussion of econometric and measurement issues. (For the interested reader, plots of each of the explanatory variables are included in the Appendix.)

As shown in Table 1, the dependent variable, TSHARE ( $S$  in equation (3)), and all but one, or possibly two, of the explanatory variables have unit roots and are thus nonstationary. The variable RISK stands out as the one definitely stationary variable, while the reserve requirement variable may or may not be stationary. However, the treatment of RESREQ as stationary or nonstationary did not affect the results.

19. The numerator of the underlying (nontransformed) share variable is labeled "bank loans not elsewhere classified" in the total credit outstanding to nonfinancial business schedule of the Flow of Funds. The majority of bank loans to nonfinancial business that are "elsewhere classified" are real estate loans. The denominator is bank loans not elsewhere classified plus "other loans" (which excludes real estate loans) plus "commercial paper."

20. The construction of the data series for KARATIO involved splicing together capital and assets measures from two sets of data series—one for domestic offices of domestically chartered banks ("RCON") from 1960.Q1 to 1969.Q1 and the other for domestic and foreign offices of domestically chartered banks ("RCFD") from 1969.Q2 to 1990.Q4—

because the RCON set changed the definition of capital in 1983, and the RCFD set only began in 1969.

This is a reasonable approach because U.S. banks had very few foreign operations in 1969, and consequently, the changes in the spliced series at the crossover points are very small—only 21 percent of the standard deviation of RCFD assets (calculated over the subsequent three years), and only 14 percent of the standard deviation of RCFD capital, for assets and capital, respectively.

The variables KARATIO and RESREQ use this spliced asset series (based on data from the *Annual Statistical Digest*), while the variable INTERST uses the total assets of banks included in the Compustat sample.



TABLE 1  
TESTS FOR UNIT ROOTS  
(AUGMENTED DICKEY-FULLER TESTS)

VARIABLE	LEVELS <sup>a</sup>	FIRST DIFFERENCES <sup>b</sup>
TSHARE	-1.99	-3.52***
RISK	-4.04***	N/A
TBHIGH	-2.28	-3.53***
RESREQ	-3.23*	-4.83***
KARATIO	-0.87	-3.91***
PREM	-0.51	-3.57***
SPREAD	-1.95	-3.68***
INTERST	-0.92	-3.83***

\*Reject null hypothesis (unit root) at 10% level.

\*\*\*Reject null hypothesis at 1% level.

<sup>a</sup>With constant and trend, 119 observations. Critical values for 100 observations: -4.04 (1%), -3.45 (5%), -3.15 (10%).

<sup>b</sup>With constant, 118 observations. Critical values for 100 observations: -3.51 (1%), -2.89 (5%), -2.58 (10%).

In the presence of nonstationarity, the normal procedures of statistical inference for ordinary least squares regression are invalid. There are two possible remedies. One is to find a cointegrating relationship between the nonstationary variables in the equation. The other is to estimate the equation in first difference form, transforming each nonstationary variable into the difference between itself and itself lagged one period.

Despite several explanatory variables with strong trends (one indication of the *possibility* of causal relationships between levels of the explanatory variables and the level of the dependent variable), statistical tests showed that the dependent variable is not cointegrated with the set of nonstationary explanatory variables (whether or not RESREQ is included in this set). Also, the dependent variable is not cointegrated with any of the individual nonstationary explanatory variables.<sup>21</sup>

A final data issue pertains to the dependent variable. McCauley and Seth (1992) have argued that the Flow of Funds data significantly underestimate the volume of busi-

ness credit booked offshore. If this is true, then the dependent variable is an overestimate of bank share as defined, and regression results could be misleading. However, as will be discussed below, results using the McCauley and Seth measures of offshore loans are qualitatively similar to those obtained using the Flow of Funds data.

#### IV. REGRESSION RESULTS

##### *Results Using Flow of Funds Measure of Offshore Loans*

Given the lack of cointegration, equation (3) was estimated using the first differences of the variables TSHARE, TBHIGH, RESREQ, KARATIO, PREM, SPREAD, and INTERST, and the level of the RISK variable. Note that the time trend appears as a constant in the model in first difference form.

It is reasonable to suppose that, if bank market share responds to any of the explanatory variables, it is likely to be only with a lag. Therefore, lags were applied to the explanatory variables, and no contemporaneous terms were included on the right-hand side of the regression. In addition, because the dependent variable could have its own important dynamics, lagged values of the dependent variable were included as explanatory variables. To economize on degrees of freedom and simultaneously pick the lag lengths, the model was estimated using a final prediction error (FPE) procedure, with the possibility of up to eight lags on each explanatory variable. The FPE technique essentially selects the variables and the number of lags on those variables to minimize the model's prediction error.

The regression results are presented in Table 2.<sup>22</sup> Note that the FPE procedure did not select three of the variables at all: TBHIGH, RESREQ, and PREM. (RESREQ was not selected whether it was included in levels or first difference form.) Apparently, changes in these variables, representing financial innovations, reserve requirements, and deposit insurance premiums, respectively, do not aid in predicting changes in banks' share of short-term business lending. As discussed in Section II, it may not be surprising that TBHIGH and RESREQ do not appear to affect banks' share of short-term business credit in particular. In light of uncertainty regarding the incidence of reserve requirement

21. A residual-based test for cointegration was used. TSHARE was regressed on a constant, a time trend, and the levels of all of the explanatory variables except RISK. Then, a unit root test was performed on the residual from this regression, with four lags on the first difference of the residual in the unit root regression. Critical values were obtained from Table IIc in Phillips and Ouliaris (1990).

22. Two common diagnostic tests, a general Lagrange Multiplier (LM) test for autocorrelation of the errors, and an Autoregressive Conditional Heteroskedasticity (ARCH) test for heteroskedasticity of the errors, found that the null hypotheses of no autocorrelation and no heteroskedasticity could not be rejected, lending further credence to the results presented in Table 2.

costs, an alternative measure, a variable based on the reserve requirement ratio for certificates of deposit, was substituted for RESREQ in the FPE regression (following a determination that the new variable was nonstationary).<sup>23</sup> However, the FPE procedure also did not choose this alternative measure.

Two of the included variables, the lagged dependent variable and SPREAD, have negative coefficients at some lags and positive coefficients at others. As indicated by the sums of the coefficients, the net effect after two years of both of these variables appears to be positive. Whether these net effects are statistically significant is debatable. However, *F* tests point toward the lagged dependent variable and the SPREAD being of some importance; *F* tests indicate that the entire group of coefficients on the lagged dependent variable likely is statistically significant and that the group of coefficients on the SPREAD variable likely also is statistically significant.

The importance and direction of influence of RISK, KARATIO, and INTERST are easier to interpret. These three variables have consistent signs on their lags, and the net effects all appear to be statistically significant.

Recall that RISK enters the regression in levels form. Therefore, the results show that when the risk premium is above its mean, the change in banks' market share over the course of the following period is negative, all other variables held constant in levels. Furthermore, an increase in an above-average risk premium strengthens the subsequent period's decrease in market share. On the other hand, an increase in interbank competition appears to increase banks' market share in the next period, as predicted. The capital-to-assets ratio enters with four lags, with a negative coefficient and a fairly high *t* statistic on each of them. Not surprisingly, the *t* statistic for the sum also is high. As predicted then, increases in banks' aggregate capital-to-assets ratio seem to erode bank competitiveness, at least in the short run.

A priori, the sign on the risk variable was ambiguous. An explanation for this was that banks tend to serve customers with a medium absolute amount of risk, so that, as the general level of risk rises, the net inflow into banks' pool of customers may be positive or negative. Apparently, neither result obtains; instead, it appears that as long as the risk premium is simply above its average, banks tend to

23. Two versions of the variable were tried. One was the reserve requirement ratio for certificates of deposit with a denomination of at least \$100,000 and a maturity of less than 90 days. The second was the same ratio multiplied by the 6-month Treasury bill interest rate. These alternatives to RESREQ were chosen following Fama (1985), which showed that reserve requirement costs for certificates of deposit are passed on to borrowers.

TABLE 2  
FPE REGRESSION RESULTS

TRANSFORMED BANK SHARE OF SHORT-TERM CREDIT			
EXPLANATORY VARIABLE	Lag	Coefficient	<i>t</i> -ratio
Constant	0	-0.0093	-3.4785
TSHARE	1	-0.0451	-0.4728
	2	0.1802	2.0046
	3	0.0365	0.3964
	4	0.0279	0.3100
	5	0.1977	2.3018
	6	0.1017	1.1306
	7	-0.0147	-0.1715
	8	-0.2821	-3.3478
	Sum	0.2021	1.1055
RISK	1	-0.0159	-2.9771
KARATIO	1	-3.7615	-2.2272
	2	-2.7047	-1.6682
	3	-3.1887	-1.9449
	4	-3.3731	-2.0883
	Sum	-13.0280	-2.8388
SPREAD	1	-0.0052	-1.8652
	2	-0.0069	-2.5331
	3	0.0066	2.1711
	4	-0.0042	-1.3372
	5	0.0067	2.0993
	6	0.0021	0.6615
	7	0.0062	1.9893
	8	-0.0017	-0.5739
	Sum	0.0034	0.4534
INTERST	1	0.0013	2.2679
Adjusted <i>R</i> <sup>2</sup>		0.3461	
Total observations		115	

NOTE: All variables except RISK in first difference form.

lose market share in short-term business lending, all other things equal. Again, though, it must be pointed out that the proxy used to measure economy-wide default risk could instead be a proxy for the tightness of monetary policy. It is not unreasonable to suppose that when monetary policy is tighter than average, banks lose market share in short-term business lending.

The apparent statistical significance of the coefficient on the constant term (as indicated by the size of the *t* statistic) also should be noted. With the model in first-difference form, the coefficient on the constant represents the simple effect of the passage of time on the *level* of banks' market share and is in that sense representative of the unexplained portion of the general downward trend in that variable.

### *Results Using McCauley and Seth Measure of Offshore Loans*

McCauley and Seth (1992) have argued that the Flow of Funds data significantly understate the volume of business credit booked offshore. More specifically, they estimate that from 1984 through 1991, offshore credit to U.S. businesses (mostly corporations) was actually more than double the amount reported by the Flow of Funds, and the discrepancy increased over time. If this is true, then the dependent variable is an overestimate of bank share as defined, at least from 1984 on, and regression results could be misleading.<sup>24</sup> To test the possible importance of this, I substituted McCauley and Seth's measure of offshore loans for the Flow of Funds measure of offshore loans and recalculated the dependent variable for the years 1984 through 1990.<sup>25</sup> The qualitative results were the same as those seen in Table 2.<sup>26</sup>

## V. BANKS' LOSS OF COMPETITIVENESS IN SHORT-TERM BUSINESS LENDING

As seen in Figure 1, between 1974 and the end of 1990, banks' share of short-term business credit fell from 73.3 percent to 53 percent. This decline in share took place

24. McCauley and Seth speculate that U.S. businesses miss large amounts of offshore loans when reporting on the Treasury forms that the Flow of Funds uses, because they do not know that these loans are booked offshore. McCauley and Seth therefore use data reported by foreign banking authorities, which is based on reports filed by lenders, who presumably have more accurate information than borrowers regarding the booking location. On the other hand, the definition of offshore loans used by other central banks may not be strictly comparable with the definition used in this paper; for example, some central banks may report that their banks are lending to U.S.-based firms from non-U.S. sites, when they are actually lending to foreign subsidiaries of U.S.-owned firms.

25. Offshore credit to total nonfinancial business is not broken out separately in the Flow of Funds tables, but offshore credit to nonfinancial corporate business is. Therefore, I assumed that all offshore loans were made to corporations, and I simply subtracted the Flow of Funds measure of offshore credit to corporations from total "other credit" to nonfinancial businesses and then added the McCauley and Seth measure to this category. I also assumed that, prior to 1984, the Flow of Funds measure of offshore loans was roughly correct. The lack of comparable information on offshore credit before 1984 leaves little alternative but to make such an assumption if one wants to incorporate the McCauley and Seth information. In addition, this approach is partially justified by the relative lack of incentives for offshore booking prior to 1984.

26. As before, diagnostic tests for autocorrelation and heteroskedasticity were conducted. The null hypothesis of no autocorrelation could not be rejected. However, the ARCH test for heteroskedasticity indicated that the null hypothesis of no first order autoregressive conditional heteroskedasticity could be rejected at the 9 percent level. While this result is not definitive, it does indicate that some caution should be used in interpreting the *t* statistics reported in Table 2.

because, although banks' short-term business credit increased in absolute terms, as shown in Figure 2, the two other categories of short-term business credit increased at a faster rate. As it turns out, other intermediaries' share of short-term business loans outstanding increased 15 percentage points between 1974 and 1990, from 23.3 percent to 38.3 percent, accounting for 73.9 percent of banks' share decrease. So, for the most part, stronger growth in other intermediated credit accounted for banks' loss of market share in short-term nonfinancial business credit. Only 26.1 percent of banks' share loss went to commercial paper.

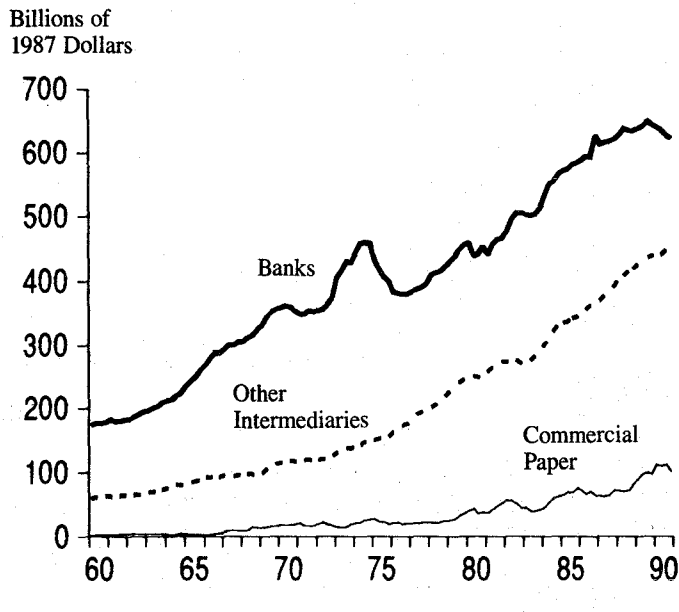
Given the steady decline in banks' market share, it is natural to try to seek an explanation. For this purpose, I will use the regression results presented in the last section, but the shortcomings of that regression model must be pointed out.

Specifically, because the model is estimated in first difference form, there exists the possibility that, even if it fits quite well, it is a very poor predictor of *long-run* changes in the dependent variable. For example, a *single* non-zero residual in one period in the first-difference equation means that the implied underlying *level* of the dependent variable (calculated using a starting point and accumulating one-period changes) will be off by the value of the residual in *all* subsequent periods. Thus, using the regression results to predict long-run changes in levels from a fixed starting point, as opposed to predicting period-to-period changes, can be misleading, and there is no objective way to judge the extent of the error.

However, even though I have no estimated model of the long-run change in banks' market share, I can use the estimated model of short-run changes to demonstrate informally the plausibility of certain explanations for banks' market share decline. First, in Figure 3, Panel A, I use the estimated model to predict the transformed level of bank share, by using the level at the beginning of the period as a starting point and then sequentially adding the sum to date of the predicted period-to-period changes. Although the predicted levels generally are too low during the period up to 1972, the predicted series does a fairly good job of tracking the *fluctuations* in the actual series. Then, the predicted series misses the brief surge in 1972 that precedes the plunge in 1974, but seems to catch the plunge itself. Then, from 1976 through mid-1978 and from 1983 through 1990, the predicted series tracks the actual series fairly closely in *levels*. Between mid-1978 and 1983, the predicted level is off, but the changes are approximately correct.

The implied levels model includes lagged values of the dependent variable as explanatory variables, and the predicted series depends on these lagged values. The effect of

FIGURE 2  
SOURCES OF SHORT-TERM NONFINANCIAL  
BUSINESS CREDIT



lagged values of the dependent variable can be calculated in two ways. One way uses the *actual* lagged values, as shown in Panel A. The alternative, “dynamic forecasting,” uses the lags of the *predicted* values of the dependent variable. This more rigorous “test” of the model is shown in Panel B. Judging by appearances, the dynamic forecasting procedure gives a picture that is roughly similar to the one seen in Panel A.

Finally, Panel C presents a third test that is again somewhat more rigorous than the last. Here, the dynamic forecasting procedure is used, but the model is estimated with data from 1960 through 1985 only. The fitted model is then used for out-of-sample prediction of the level over the period 1986 through 1990. Again, the model does fairly well capturing changes in bank market share. The model seems to have the most trouble from mid-1986 through the third quarter of 1987.<sup>27</sup>

All in all, though, the model seems to capture banks’ fall-off in market share fairly well. Therefore, it seems reasonable to speculate that the same factors that appear to contribute to negative *first* differences may also have contributed to the long, fairly steady decline seen since 1974.

27. Figure 3 uses the regression results based on the Flow of Funds measure of offshore credit, rather than the McCauley and Seth measure. Comparable results were obtained with the McCauley and Seth data.

To judge this, the difference between the predicted level at the beginning of the period and the end of the period was calculated, and the contributions of beginning- to end-of-period changes in the various explanatory variables to the predicted decline were estimated.

As it turns out, the only explanatory variables that changed so as to contribute to a decline in the dependent variable were the lagged values of the dependent variable, the time trend, and the risk premium. The simple effect of the passage of time between 1962 and 1990 accounted for 86.1 percent of the total predicted decline, this total being the sum of the effects of only those variables that contributed to a *decline*. (The sum of the negative predicted effects was  $-1.25$ , while the net predicted change in the dependent variable, adding in the positive effects of the changes in the capital-to-assets ratio, the savings spread, and the extent of interstate banking, was  $-0.88$ .) The *actual* change in the dependent variable between the first quarter of 1962 and the fourth quarter of 1990 was  $-0.86$ .) The change in the lagged dependent variable accounted for 13 percent, and the risk premium accounted for 0.9 percent. Attributing the effect of the change in the lagged dependent variable proportionally to the time trend and the risk premium, the passage of time accounted for close to 99 percent of the decrease, while the change in the risk premium accounted for about 1 percent of the decline.<sup>28</sup>

However, if we restrict our attention to the period after 1973, a slightly different picture emerges. The capital-to-assets ratio started to increase around 1974. (See Figure A4 in the Appendix.) The increase was at first rather sharp, then reversed itself in the second half of the 1970s, and then resumed around 1980. Given the negative coefficients on the capital-to-assets ratio, the net increase in the capital-to-assets ratio *since 1974* must have contributed to the decline in banks’ share since then. However, the part that the change in the capital-to-assets ratio played still was relatively small; the change in the capital-to-assets ratio alone accounted for 7.3 percent of the estimated decline. The other factors in the decline, the passage of time, the lagged dependent variable, and the risk variable, accounted for 68.4 percent, 21.5 percent, and 2.9 percent of the predicted decline, respectively. (In the 1974 to 1990 period, the sum of the negative predicted effects was  $-0.93$ , while the net predicted change in the dependent variable, adding in the positive effects of the other variables, was

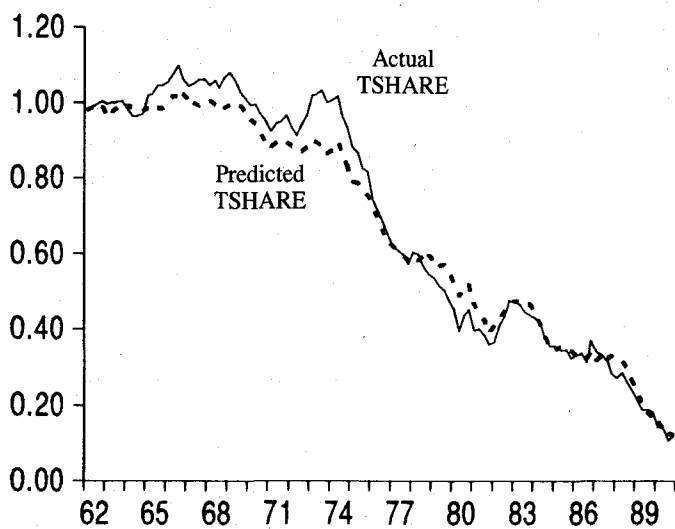
28. This assumes that the model is correctly specified in that no explanatory variables have been omitted. Because this is open to question, the actual sizes of the effects of the passage of time and the change in the risk premium likely are somewhat less than this, but still greater than those calculated without attributing any of the effect of the change in the lagged dependent variable to changes in those variables.

-0.77. The *actual* change in the dependent variable between the first quarter of 1974 and the fourth quarter of 1990 was -0.89.) Again, attributing the effect of the change in the lagged dependent variable proportionally to the other variables, the passage of time, the change in the capital-to-assets ratio, and the change in the risk premium accounted for about 87 percent, 9.3 percent, and 3.7 percent, respectively, of the decline in bank market share.

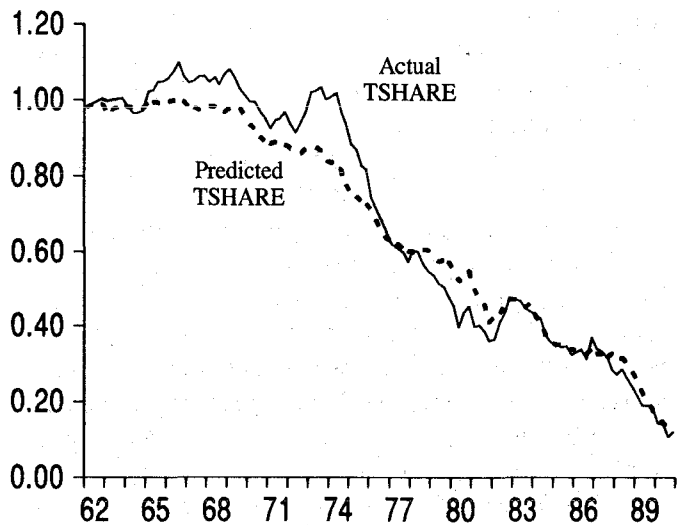
Given the apparent unimportance of changes in the capital-to-assets ratio and of the risk premium, relative to the importance of the unexplained effect of the time trend, the model presented in this paper does not really "explain" why banks' market share in short-term business lending shrank over the past 30 years. However, *among the factors considered in this study*, it is fair to say that the capital-to-assets ratio and the risk premium are the two variables that are most likely to have played a part in that decline, with the capital-to-assets ratio of slightly more importance than the risk premium.

FIGURE 3  
DEPENDENT VARIABLE PREDICTIONS

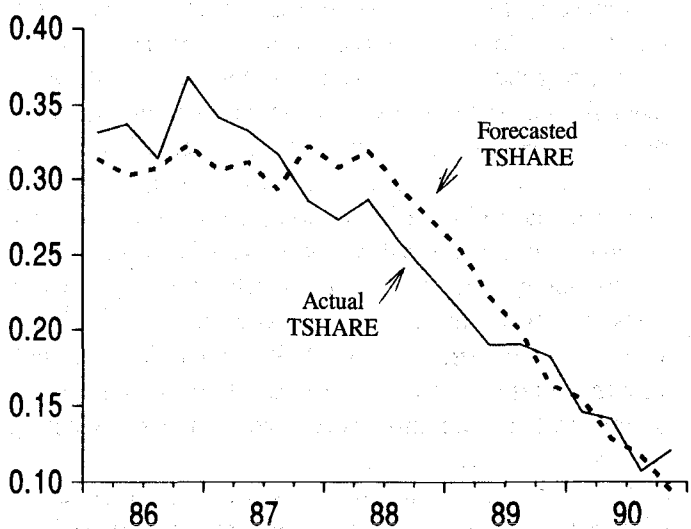
A: ACCUMULATION OF PREDICTED FIRST DIFFERENCES



B: ACCUMULATION OF PREDICTED FIRST DIFFERENCES AND DYNAMIC FORECASTING PROCEDURE



C: OUT-OF-SAMPLE FORECAST OF FIRST DIFFERENCES



NOTE: In all three panels, TSHARE =  $\log s/(1-s)$ , where  $s$  = (short-term bank business loans/total short-term business credit).

NOTE: Based on 1962.Q2 to 1985.Q4.

As discussed in Section II, an increase in its capital-to-assets ratio decreases the value of a bank's subsidy from deposit insurance and thereby reduces the bank's profitability and competitiveness. Put another way, a bank with a higher capital-to-assets ratio must compensate for the loss in subsidy in some way—for example, by charging higher loan rates, reducing services to borrowers and/or depositors, or paying lower deposit rates—to maintain an adequate return on equity. But this strategy cannot be followed for long without the bank losing market share to creditors offering more favorable terms.

Whether a general increase in the capital-to-assets ratio is in fact an important element of the story of why banks have become less and less competitive in the provision of short-term business credit since the mid-1970s remains very open to question. If, however, increases in the capital-to-assets ratio did have the effect that is being posited here, it is important to point out that this study does *not* then imply that required capital-to-assets ratios for banks should be lowered. *If* banks have been receiving a positive subsidy through deposit insurance, then it very likely is *desirable* to raise capital requirements to eliminate that subsidy and give banks the incentive to control their risk-taking. Unless there are specific welfare or market failure reasons for continuing to subsidize banks, a cutback in subsidization is necessary, despite the possible effect on bank competitiveness. Extreme caution must be used in assessing the net effect of any decrease in capital requirements, given that such a move would likely increase the public's potential deposit insurance liability.

Regarding the risk variable, whether this variable is in fact representative of a risk premium or the stance of monetary policy, it appears that, as long as it is above its mean for the period, banks lose market share in short-term business lending. As it turns out, over the 1962 to 1990 period for which the level of bank market share is simulated (and over the 1974 to 1990 period), the sum of the above-average values of the risk variable exceeds the sum of the below-average values, so the overall effect of the risk variable is to lower bank market share between 1962 and 1990 (and between 1974 and 1990).<sup>29</sup> This is consistent with the interpretation of the risk variable as representative of either a risk premium or the stance of monetary policy. An increase in the risk premium was predicted to have an ambiguous effect on bank market share, while a tightening of monetary policy was predicted to have a negative effect.

29. The mean of the risk variable was taken to be the mean for the entire 1960 through 1990 period. Therefore, had the contemporaneous instead of the lagged value of risk been included in the model, and had the change in bank market share between 1960 and 1990 been the focus, the risk variable would have played no role. This is because the above-average

## VI. CONCLUSION

In this paper, I have attempted to identify some of the factors that may affect bank competitiveness in short-term business lending in the short run. The theoretical part of the paper emphasized four general types of variables: the level of risk in the economy, the relative benefits to banks versus other types of creditors of financial innovation, bank regulatory costs and benefits, and the level of interbank competition. After discussing the theoretical effects of these variables on the supply and demand for short-term bank business credit relative to other types of short-term business credit, empirical measures of these variables were introduced and a simple linear model in first differences was presented and estimated.

Estimation of the model yielded several interesting conclusions. First, banks' market share in short-term business lending appears to respond to only some of the theoretical variables that were considered. Among the variables considered, only the risk premium, the aggregate weighted capital-to-assets ratio, the spread between the market interest rate and the deposit interest rate ceiling, and the extent of interstate banking laws seem to matter in the determination of short-run changes in banks' market share. In addition to these, the mere passage of time plays an important but non-illuminating role.

Second, banks' market share appears to fall in the short run when the risk premium is above its long-run mean and when the capital-to-assets ratio rises. On the other hand, market share rises in the short run as the opportunities for interstate banking become more widespread, in accordance with interstate banking being a proxy for the level of interbank competition. The effect of an increase in the interest rate spread is positive at some lags and negative at others, but is positive on net after two years.

Third, the model in first differences was used to explore informally the reasons for the steady decline in bank

values of risk, by construction, would have exactly offset the below-average values. However, because of the lag structure of the model, the first period for which a level of bank share is simulated is the first quarter of 1962. This means that I examine the role of risk in explaining the change in market share between only 1962 and 1990. Furthermore, the first difference of the dependent variable depends on the first lag of the risk variable. As a consequence of these factors, the risk variable contributes to a 28-year decline in bank market share, largely because the sum of the above-average values of the risk variable, summed over the 28 years over which the simulation is conducted, exceeds the sum of the below-average values.

Separately, it is interesting to note that the large spike in the risk variable occurs at precisely the same time that banks' market share began to plunge. (See Figure A1 in the appendix.)

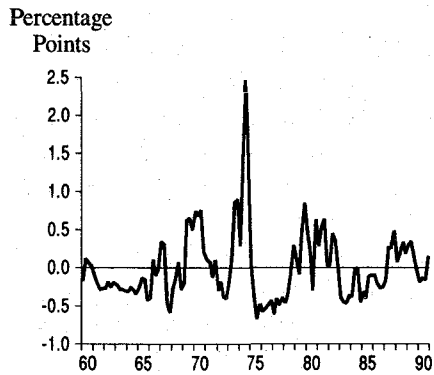
competitiveness in short-term business lending since the mid-1970s. After demonstrating that the estimated model may shed some light on this issue, despite the lack of cointegration, it was concluded that, among the variables considered, only the capital-to-assets ratio and the risk variable could have played any role. Although these variables “explain” only a small proportion of the decline, their effects appear to be consistent with plausible theo-

retical explanations. First, the increase in the aggregate capital-to-assets ratio since about 1974 may have contributed somewhat to the decline in bank competitiveness by decreasing banks’ deposit insurance subsidy. Second, the above-average values of the risk variable since the mid-1970s, representing either an unusually high economy-wide default risk premium or unusual tightness in monetary policy (or both), also may have made a slight contribution.

APPENDIX

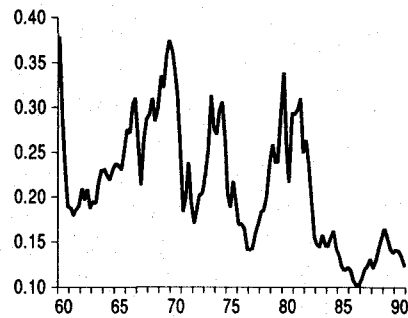
The following are plots of the seven explanatory variables:

FIGURE A1  
RISK



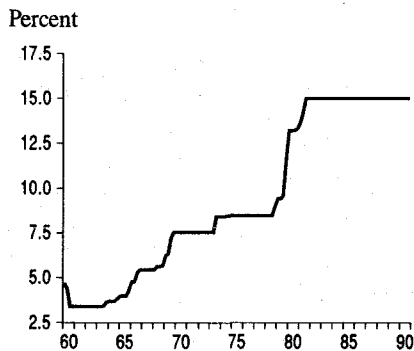
NOTE: RISK = 6-month commercial paper interest rate–6-month Treasury bill interest rate–mean of this difference over the period 1960-1990

FIGURE A3  
RESREQ



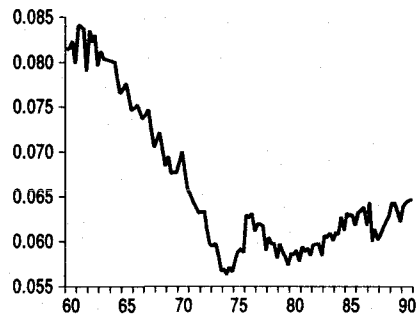
NOTE: RESREQ = (aggregate required reserves/total bank assets) × 6-month Treasury bill interest rate

FIGURE A2  
TBHIGH



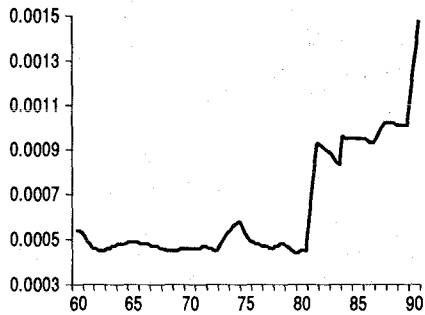
NOTE: TBHIGH = highest 6-month Treasury bill interest rate to date

FIGURE A4  
KARATIO



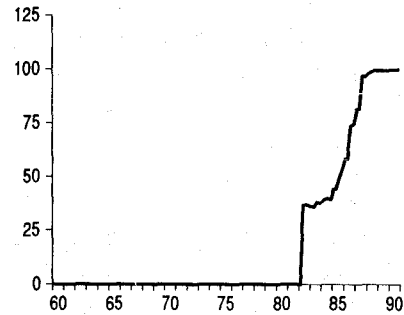
NOTE: KARATIO = total bank capital/total bank assets

FIGURE A5  
PREM



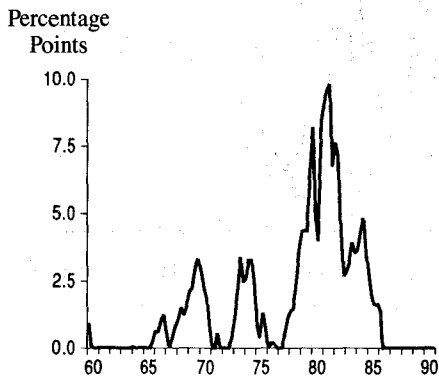
NOTE: PREM = net aggregate deposit insurance assessments/total insured deposits

FIGURE A7  
INTERST



NOTE: INTERST = percentage of total bank assets held by bank holding companies that are headquartered in states that permit interstate banking

FIGURE A6  
SPREAD



NOTE: SPREAD = difference between 3-month Treasury bill interest rate and ceiling on interest rate on savings deposits, if this difference is positive, zero otherwise



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# What Caused the 1990–1991 Recession?

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*This article decomposes U.S. GDP into components associated with major macroeconomic disturbances in order to identify the likely causes of the 1990 recession. Four types of disturbances—aggregate supply, aggregate spending, money demand and money supply—are identified in the empirical analysis. The results suggest the general slowing of the economy relative to trend prior to the actual downturn was due to restrictive monetary policy. Aggregate spending factors turned contractionary in mid-1990, however, and accounted for most of the subsequent decline in GDP during the rest of 1990.*

July 1990 marked the end of the longest peacetime expansion in the history of the U.S. economy. Real GDP grew at an average annual rate of 3.3 percent from the fourth quarter of 1982, the end of the previous recession, until the third quarter of 1990. Unlike the two recessions the U.S. suffered in the early 1980s, which were associated with policies designed to bring inflation down from double digit levels, the causes of the 1990-1991 recession have been less apparent. Pessimistic consumers, the debt accumulations of the 1980s, the jump in oil prices after Iraq invaded Kuwait, a credit crunch induced by overzealous banking regulators, and attempts by the Federal Reserve to lower the rate of inflation all have been cited as causes of the recession.

When economists discuss the sources of economic fluctuations within the context of their theoretical models of the macroeconomy, they normally do so in terms of a small number of fundamental disturbances. The structure of the economy then leads these disturbances to be propagated throughout the economy and over time in ways that generate the behavior typically associated with a business cycle. The assumed nature of both the initiating shocks and the propagation mechanism varies among different schools of macroeconomic thought. For real business cycle proponents, disturbances to the economy's productive capacity, usually referred to as technology shocks or, more generally, as aggregate supply shocks, are the initiating factor, while the attempts by households and firms to respond optimally to these supply shocks result in the propagation over time of the initial shock's impact on output, consumption, and investment.<sup>1</sup>

Other economists emphasize a wider range of possible initiating shocks, including factors originating in the demand side of the economy (consumption, investment, government spending and taxation, net exports) and financial factors such as monetary policy shocks or shifts in the demand for financial assets. These disturbances affect the economy over time in ways that depend importantly on the adjustment of expectations, wages, and prices.

If these views of the economy are useful in understanding the behavior of the macroeconomy, then it should be

1. For a survey of the real business cycle approach, see McCallum (1989).

possible to identify the actual disturbances responsible for observed fluctuations in terms of the small number of shocks typically cited by economists in their discussions of economic activity. That is, one can ask how important aggregate supply, aggregate demand, and financial market disturbances were in causing a recession. In turn, such an identification may be useful both in deciding whether those factors emphasized by a particular theory have in fact been important, and, since the appropriate policy response may differ depending on the source of fluctuations, in judging how well policy has been implemented.

This paper decomposes output into components due to various macroeconomic disturbances in order to identify the factors that are most likely to have caused the 1990 downturn. To do so, the paper focuses on the evidence obtained by estimating a structural vector autoregression. This approach is similar to that adopted by Blanchard and Watson (1986) and Galí (1992) and represents a starting point for understanding the causes of the recession. By identifying the general nature of the disturbance, or disturbances, responsible for the downturn, the paper represents a starting point, leaving for future research a more detailed analysis of the determinants of these disturbances.

The empirical analysis suggests that the economy was growing relative to its underlying trend through the middle of the 1980s. Inflation also was rising during this period. As measured by the Consumer Price Index, the rate of inflation rose from 1.2 percent in 1986 to 4.4 percent in 1987 and remained at that level through 1989.<sup>2</sup> In response to signs that inflation was beginning to revive, monetary policy began to shift toward a more contractionary stance in 1986. The Federal Reserve was motivated during this period by a desire to move the economy towards zero inflation, as many economists have argued that zero inflation will contribute to higher average real economic growth.<sup>3</sup> Restrictive monetary policy is estimated to have had a significant role in slowing real economic growth relative to trend in the period from 1986 to 1989. Beginning in 1989, however, aggregate spending factors turned sharply downward. It is these factors that pushed the slowly growing economy into recession.

Since the end of the recession in March 1991, the recovery has been very slow, and many factors have been identified as responsible for the weakness of the current expansion. Such factors are not the focus of this paper, nor are the factors that were at work once the recession started. Instead, I focus exclusively on the developments leading to the downturn in the middle of 1990.

In order to understand the possible causes of the recession, this paper will employ a simple model that is used by most intermediate level textbooks in macroeconomics—the IS-LM model combined with an aggregate supply (AS) function. This framework is reviewed in Section I. An explanation of the approach adopted to implement the framework empirically is contained in Section II. Section III discusses the implications of the estimated model to see how well it conforms to the standard conclusions from the IS-LM-AS framework. Section IV then uses the model to obtain a decomposition of GDP that attributes movements in GDP to underlying aggregate supply, IS, money demand, or money supply disturbances. This decomposition leads to a further examination of the role of monetary policy in Section V. Conclusions appear in Section VI.

## I. A MACRO FRAMEWORK

Many economists organize their thinking about the macro economy by using some variant of a simple framework that links real and financial developments to a small number of basic economic disturbances. The most common of these frameworks is the IS-LM model of aggregate demand, combined with an aggregate supply function. The resulting aggregate demand-aggregate supply model (AD-AS) forms the core of most intermediate level textbooks in macroeconomics.<sup>4</sup> This model attributes movements in GDP to disturbances originating in either the factors affecting aggregate demand or aggregate supply, and within aggregate demand, to either IS shifts (government fiscal policy, consumption, investment, net exports), money demand shocks, or money supply disturbances. Aggregate supply shocks arise from disturbances such as technology shocks or oil price changes that influence the economy's supply of output. The purpose of this section is to outline a simple AD-AS model that can be used to assess the role of these various shocks on GDP during the period leading to the downturn in mid-1990.<sup>5</sup>

The building blocks of the basic IS-LM-AS model are:

1. An IS relationship showing the real demand for domestically produced output for given levels of interest rates and prices
2. A monetary sector specifying the demand for money and its supply (the LM relationship)

2. Inflation averaged 4.4 percent in 1988 and 4.6 percent in 1989. It then rose to 6.1 percent in 1990 before dropping to 3.1 in 1991.

3. For a discussion of the benefits of zero inflation, see Laidler (1990).

4. For example, Abel and Bernanke (1992), Dornbusch and Fischer (1990), Gordon (1992), Hall and Taylor (1992), and Mankiw (1992) all make use of an IS-LM plus aggregate supply framework.

5. For an empirical analysis of postwar U.S. economic activity before 1988 using an IS-LM-AS framework, see Galí (1992).

3. An aggregate supply function showing the output level consistent with the economy's capital stock and labor market equilibrium.

These components of the IS-LM-AS model serve to explain the determination of real output, prices, and interest rates. The framework is also used to predict the general effects that various economic disturbances would have on these macroeconomic variables. For example, since money wages appear to adjust relatively slowly and sluggishly, increased demand for output, caused by a shock such as a rise in government purchases, will raise domestic production, increase employment, and push up the level of interest rates. Over time, wages and prices will rise, reducing the level of output firms find it profitable to produce, and production will return to its initial level. A positive shock to the supply of money (or a shock that lowers the demand for money) will act to lower interest rates in order to maintain equilibrium in the money market. Lower interest rates help to stimulate investment spending, producing a rise in aggregate demand and output in the short run. As prices then rise, the real supply of money is reduced to its initial level, reversing the temporary movements in interest rates and output. Finally, a positive shock to aggregate supply, such as an unanticipated decline in oil prices, raises the level of output firms wish to produce. Output expands and interest rates must fall to stimulate a corresponding rise in aggregate demand.<sup>6</sup>

The exact pattern of responses exhibited by the economy as a result of economic disturbances will be determined by the degree of flexibility in money wages and prices, the extent to which disturbances are anticipated, and the role played by expectations of both inflation and the policy responses induced by economic fluctuations.

The next two sections describe the empirical approach used to obtain estimates of the four basic disturbances and their contributions to GDP movements. These sections are somewhat more technical than the rest of the paper and could be skipped by readers who wish to proceed directly to the discussion in Section IV of the role of the various disturbances.

## II. THE EMPIRICAL FRAMEWORK

It is convenient to represent the empirical framework by a four-equation system, consisting of an aggregate supply equation, an IS equation, a money demand function, and a money supply function (AS, IS, MD, and MS equations),

that determines equilibrium values of real output ( $y$ ), a nominal interest rate ( $i$ ), real money balances ( $m - p$ ) and the nominal supply of money ( $m$ ). In its most general form, we could write the model as

$$A\Delta z_t = B(L)\Delta z_{t-1} + \epsilon_t,$$

where  $\Delta z' = (\Delta y, \Delta i, \Delta m - \Delta p, \Delta m)$  is the vector of endogenous variables, assumed to require first differencing to induce stationarity,<sup>7</sup>  $A$  is a  $4 \times 4$  matrix,  $B(\cdot)$  is a  $4 \times 4$  matrix polynomial in the lag operator  $L$ , and  $\epsilon$  is a  $4 \times 1$  vector of the unobserved structural disturbances,  $\epsilon' = (\epsilon^{as} \epsilon^{is} \epsilon^{md} \epsilon^{ms})$ .

It is assumed that the elements of  $\epsilon$  are mutually uncorrelated and serially independent with diagonal variance-covariance matrix  $\Sigma_\epsilon$ . These represent the fundamental disturbances impinging on the macroeconomy. Insight into the cause, or causes, of the 1990–1991 recession can be gained by obtaining an estimate of  $\epsilon$  and the contributions of its four elements to movements in GDP leading up to the onset of the recession.

While consistent estimates of  $A^{-1}\epsilon$  can be obtained from OLS regressions of  $\Delta z_t$  on lagged values of itself,<sup>8</sup> the estimation of  $A$  requires the imposition of identifying restrictions. A variety of means have been employed to identify "structural VARs" (Bernanke 1986, Blanchard and Watson 1986, Sims 1986, Walsh 1987, Shapiro and Watson 1988, Blanchard 1989, Blanchard and Quah 1989, Judd and Trehan 1989, King, Plosser, Stock and Watson 1991, Hartley and Walsh 1992, Hutchison and Walsh 1992, Galí 1992, Moreno 1992). These generally take the form either of zero restrictions on the  $A$  matrix or restrictions on the long-run effects of elements of  $\epsilon$  on elements of  $z$ .

Zero restrictions imposed on elements of  $A$  directly restrict the channels through which shocks can contemporaneously affect the macro variables in the system. For example, in Walsh (1987), the aggregate supply relationship was taken to contain only output and prices. Therefore, any direct shock to interest rates was assumed to affect aggregate output only by first affecting prices (relative to expectations). Restrictions on contemporaneous interactions are, however, controversial. When expectations play an important role and agents use all relevant information to form expectations, for instance, zero restrictions are difficult to justify.

Recent attempts to identify structural disturbances have focused on the long-run effects of various disturbances and the ways in which economic theory might imply restric-

6. Increases in the price of imported oil also act as a tax on domestic consumers, thereby reducing aggregate demand. The discussion in the text presumes the supply effect dominates.

7. The results of unit root tests, reported below, are consistent with this assumption.

8. That is, by estimating  $\Delta z_t = A^{-1}B(L)\Delta z_{t-1} + A^{-1}\epsilon_t$ .

tions on these effects. For example, economists who employ a wide range of approaches generally agree that the long-run effects of purely nominal disturbances fall entirely on prices and not on real magnitudes like the level of output. Restrictions of this sort have been used by Shapiro and Watson (1988), Blanchard (1989), King, Plosser, Stock and Watson (1991), Hutchison and Walsh (1992), Galí (1992), and Moreno (1992). Since similar long-run restrictions are implied by a variety of models, they have generally been viewed as less controversial than restrictions on the contemporaneous interactions.

Four types of restrictions, all long-run in nature, are used in this paper to identify the structural disturbances and their impact on the variables in  $z$ .<sup>9</sup>

Type 1. The long-run effect of IS, money demand, and money supply shocks on the level of real GDP is zero (3 restrictions)

Type 2. The long-run effect of money demand shocks on the level of nominal interest rates is zero (1 restriction)

Type 3. The long-run effect of money supply shocks on the level of nominal interest rates is zero (1 restriction)

Type 4. The long-run effect of the level of money supply shocks on the level of real money balances is zero (1 restriction)

The first category of restrictions (no long-run effect on output of IS, money demand, or money supply disturbances) has been used previously by others in order to distinguish between aggregate supply shocks, which potentially do have long-run output effects, and aggregate demand shocks, which do not (for example, Blanchard and Watson 1986, Blanchard 1989, Blanchard and Quah 1989, Judd and Trehan 1989, Hutchison and Walsh 1992, Galí 1992, and Moreno 1992).

The next three types of restrictions are based on the long-run dichotomy between the real and financial sectors implied by most macroeconomic models. This dichotomy implies that the real interest rate, the nominal rate corrected for the expected rate of inflation, should be independent of money demand and money supply disturbances in the long run. If monetary disturbances, whether originating on the demand or the supply side of the money market, do not permanently alter the rate of growth of the money supply, so that the rate of inflation is stationary, both real interest rates and the rate of inflation should be unaltered in the

long run as a result of monetary disturbances.<sup>10</sup> If so, then money demand and money supply shocks will also have no long-run effect on the nominal rate of interest.<sup>11</sup> The final restriction reflects the assumption that changes in the level of the money supply ultimately produce proportionate changes in the price level. This implies that real money balances will not be affected in the long run by shocks that affect only the level of the nominal supply of money. This restriction is also consistent with conventional money demand equations; if real money demand depends on output and interest rates, neither one of which is affected in the long run by shifts in the level of the money supply, then real money balances also must be independent of money supply shocks in the long run.

Incorporating these restrictions implies the following system of equations which can be estimated by 2SLS as discussed in Shapiro and Watson (1988):<sup>12</sup>

$$\begin{aligned}\Delta y_t = & \sum_1^N \alpha_{1i} \Delta y_{t-i} + \sum_0^{N-1} \beta_{1i} \Delta^2 i_{t-i} \\ & + \sum_0^{N-1} \gamma_{1i} \Delta^2 (m-p)_{t-i} \\ & + \sum_0^{N-1} \delta_{1i} \Delta^2 m_{t-i} + \epsilon_t^{as}\end{aligned}$$

$$\begin{aligned}\Delta i_t = & \sum_0^N \alpha_{2i} \Delta y_{t-i} + \sum_1^N \beta_{2i} \Delta i_{t-i} \\ & + \sum_0^{N-1} \gamma_{2i} \Delta^2 (m-p)_{t-i} \\ & + \sum_0^{N-1} \delta_{2i} \Delta^2 m_{t-i} + \epsilon_t^{is}\end{aligned}$$

10. Dickey-Fuller statistics reported in Section III are consistent with the assumption that the inflation rate and the growth rate of money are stationary processes.

11. Tax effects that arise when nominal interest income, and not real interest income, are taxed might lead permanent changes in money growth to have long-run effects on real interest rates by altering the rate of inflation. As noted in the previous footnote, however, both money growth and inflation are consistent with the assumption that they are not subject to permanent shifts. Even in the presence of tax effects, there is no reason to expect permanent changes in the *level* of the nominal money supply to cause long-run changes in either real or nominal interest rates.

12. A constant also was included in each equation for the purposes of empirical estimation.

9. After an earlier draft of this paper was written, I read Keating (1992) in which a VAR identified only through long-run restrictions, as is done here, is reported. Keating's restrictions are the same as those used here.

$$\begin{aligned}\Delta(m-p)_t &= \sum_0^N \alpha_{3i} \Delta y_{t-i} + \sum_0^N \beta_{3i} \Delta i_{t-i} \\ &+ \sum_1^N \gamma_{3i} \Delta(m-p)_{t-i} \\ &+ \sum_0^{N-1} \delta_{3i} \Delta^2 m_{t-i} + \epsilon_t^{md}\end{aligned}$$

$$\begin{aligned}\Delta m_t &= \sum_0^N \alpha_{4i} \Delta y_{t-i} + \sum_0^N \beta_{4i} \Delta i_{t-i} \\ &+ \sum_0^N \gamma_{4i} \Delta(m-p)_{t-i} \\ &+ \sum_1^N \delta_{4i} \Delta m_{t-i} + \epsilon_t^{ms}\end{aligned}$$

The zero long-run impacts of IS, money demand, and money supply shocks on real output are imposed by constraining the sum of the coefficients on the current and  $N$  lagged values of  $\Delta i$ ,  $\Delta(m-p)$  and  $\Delta m$  in the equation for  $\Delta y$  to be zero. This can be done directly by entering these variables in second difference form (that is,  $\Delta^2 i$ ) and including only  $N-1$  lagged terms. Since contemporaneous values appear on the right hand side of the output equation, the equation is estimated by 2SLS. As instruments,  $N$  lags of the first differences of  $y$ ,  $i$ ,  $m-p$ , and  $m$  were used.

In the equation for  $\Delta i$ , the zero long-run effect of money demand and money supply shocks on the level of the nominal interest rate is imposed by including  $N-1$  lags of the second differences of  $m-p$  and  $m$ . In addition to the instruments used in estimating the equation for  $\Delta y$ , the estimated residual for the output equation is used, since  $\epsilon^{as}$  and  $\epsilon^{is}$  are assumed to be orthogonal.

Because the level of  $m$  is assumed to have no long-run impact on the level of  $m-p$ , the money supply is entered in second difference form with a lag length of  $N-1$  in the equation for  $\Delta(m-p)$ . This is the only restriction imposed on this equation. The estimated residual from the interest rate equation is added to the set of instrumental variables to estimate this equation. Finally, the equation for  $\Delta m$  is unconstrained, and the residuals from the previous three equations are used as instrumental variables, in addition to  $N$  lags of the first differences of all the variables.

Once estimated, this system of equations can be used to determine the contribution of the four fundamental shocks to the movement of GDP during 1990. This will serve to indicate the general source of the contractionary forces that led to the downturn in 1990. However, alternative identifying restrictions could be used and might result in different conclusions. The impulse response functions used to gen-

erate the estimated contribution of each shock are themselves estimated relatively imprecisely. Any conclusions, therefore, should be viewed as suggestive only.<sup>13</sup>

Galí (1992) estimates an IS-LM-AS model but uses somewhat different identifying restrictions. He obtains three restrictions by assuming the long-run output effects of IS, money demand, and money supply disturbances are equal to zero. These are the same restrictions listed as Type 1 above and used in this paper. The remaining restrictions Galí uses constrain the contemporaneous interactions of output, interest rates, prices, and money. Specifically, he assumes that neither money demand nor money supply shocks have any contemporaneous effect on output. For his final restriction, Galí considers three alternatives: (a) prices do not enter the money supply rule contemporaneously; (b) GNP does not enter the money supply rule contemporaneously; (c) price enters with coefficient one in nominal money demand (money demand homogeneity).

If all three of these alternatives were imposed, the system would be overidentified, and the overidentifying restrictions could then be tested. Galí finds that assuming (a), he rejects (c) but not (b). Assuming (b), he rejects (a) but not (c), and assuming (c) he rejects (a) but not (b). These conflicting results are difficult to interpret. Galí reports the results he obtains under assumption (a), but notes that generally similar results were obtained under the alternatives.

Keating (1992) estimates a four-variable system involving output, an interest rate, real money balances, and the money stock, using only long-run restrictions to achieve identification. His restrictions are identical to the ones employed here. The data used in the estimation differ however. Keating used GNP, the GNP deflator, and M1, while GDP, the CPI, and M2 are used in this paper.

### III. ESTIMATION OF THE MODEL

This section discusses some further issues associated with the estimation of the model. It also reports on the estimated effects of the four disturbances on output, interest rates, inflation, and money growth. These impulse responses will be compared to the implications of the simple IS-LM-AS framework that has motivated the model specification. These impulse response functions help cast light on whether the empirical results accord with the theory. This provides a check on the model; a close correspondence be-

13. As an alternative to the identifying restrictions listed above, real federal defense expenditures were used to identify the model under the assumption that these expenditures were correlated with IS shocks but not with money demand shocks. The effects of using this alternative specification were basically the same as those discussed in the text.

tween the theory and the estimated effects of the shocks identified by the model should increase our confidence that the restrictions used to identify the disturbances are appropriate. Differences between the results obtained in this paper and those obtained by Galí and Keating also will be discussed.

Estimation was carried out using quarterly data on the logs of real GDP, M2, the CPI, and the level of the 3-month Treasury bill rate over the period 1961:Q1 to 1991:Q2. All data were taken from CITIBASE.<sup>14</sup> A lag length of four was used ( $N = 4$ ), the same as used by Galí and Keating.

Implicit in the specification of the basic four-equation system are two assumptions: (1) that the four variables in the system (GDP, the 3-month T-bill rate, real M2, and M2) are integrated of order 1, so that first differencing is required in order to induce stationarity, and (2) that there exist no cointegrating relationships linking the variables. Both aspects of the specification are testable.

Table 1 reports the values of Phillips'  $z_{\mu}$  test statistic for the unit root null. For all four variables in level form, the test fails to reject the null hypothesis of a unit root. In each case, however, first differencing induces stationarity in that a unit root in the first difference can be rejected.

While the four variables in the system appear to be integrated of order 1, there may exist linear combinations of the variables that are stationary (integrated of order 0). If so, the long-run behavior of the levels of the four variables would be restricted, and these restrictions should be incorporated into the estimated model.<sup>15</sup> Table 2 reports the results of employing the multivariate test for cointegration developed by Johansen (1988). Johansen's trace test and maximum eigenvalue test give conflicting indications about the possible presence of cointegrating relations among the four variables. The trace test fails to reject the null that the number of cointegrating vectors is less than or equal to 1, taking on a value of 23.2 as compared to the 95 percent critical value of 35.07. The test statistic for the null that the number of cointegrating vectors equals zero takes the value 51.56 which is not significant at the 5 percent level. In contrast, the maximum eigenvalue statistic for the null of zero cointegrating vectors against the alternative of 1 is 28.36 which just exceeds the 95 percent critical value of 28.17. While the evidence indicates that the system contains no more than one cointegrating vector, the results do not point unambiguously to

TABLE 1

UNIT ROOT TESTS: PHILLIPS'  $z_{\mu}$ 

	LEVELS	FIRST DIFFERENCES
<i>GDP</i>	-1.76	-8.90
<i>3MTB</i>	-2.40	-9.56
<i>CPI</i>	-0.80	-3.89
<i>M2</i>	-0.41	-5.20
<i>M2-CPI</i>	-1.98	-5.39

NOTE: *GDP*, *M2*, and *CPI* are in log form.

TABLE 2

## COINTEGRATION TESTS

FOUR-VARIABLE SYSTEM: *GDP*, *3MTB*, *CPI*, *M2*

$H^*_2$	TRACE	TRACE 0.95	$\lambda_{MAX}$	$\lambda_{MAX}$ 0.95
$r \leq 3$	4.90	9.09	4.90	9.09
$r \leq 2$	12.07	20.17	7.17	15.75
$r \leq 1$	23.20	35.07	11.13	21.89
$r = 0$	51.56	53.35	28.36	28.17

0 or 1. Consequently, I have proceeded under the assumption that the four variables are not cointegrated, leaving for future work the estimation and analysis of an IS-LM-AS model within the framework of an error correction model that would incorporate the single cointegrating relationship that might hold among these variables.

It should be noted, however, that other researchers have found cointegrating relationships among the variables used in this paper. Both Miller (1991) and Hafer and Jansen (1992) report finding cointegrating relationships between M2, prices, real output and interest rates. However, Miller's sample ends in 1987 and Hafer and Jansen's ends in 1988, and there is evidence of an apparent downward shift in M2 demand beginning in 1990 (see Duca 1992 and Feinman and Porter 1992). This may imply these variables are no longer cointegrated. Since data up to the second quarter of 1991 are used in this paper, the conflicting evidence on cointegration may reflect the different sample periods used in the various studies. Because cointegration captures long-run relationships among time series variables, and long-run restrictions are employed to identify the model in this paper, different assumptions about the presence or absence of cointegrating relationships may

14. In the notation of CITIBASE, the basic variables used were *GDPQ*, *FM2*, *PUNEW*, and *FYGM3*.

15. See Engle and Granger (1987), King, Plosser, Stock, and Watson (1991), Johansen and Juselius (1990). In the presence of cointegrating relationships, short- and long-run dynamics can be modeled by a vector error correction (VEC) model.

influence the model estimates. The outcome of cointegration tests, however, has no necessary implications for the long-run identifying restrictions, since cointegration is a property of the stochastic disturbances (the  $\epsilon$ 's) while the identifying restrictions are restrictions on the coefficients of the model.

The objective is to obtain estimates of the disturbance terms that can be interpreted within the framework of the AD-AS model. For this interpretation to be valid, the estimated effects of each type of disturbance should agree with the basic implications of the theoretical framework. The estimated model can be used to calculate the path of output, prices, and interest rates in response to each of the four underlying disturbances. Since the AD-AS framework predicts the general shapes of these response functions, the estimated responses can be used to see whether the data are broadly consistent with the basic framework and the identifying assumptions made in the estimation process. For example, a positive money supply shock is predicted to lower nominal interest rates and raise real GDP in the short run. Over time, real GDP should return to its initial path, as should nominal interest rates, if the growth rate of money is stationary. If the impact of the money supply shock identified by the estimation process does not have these characteristics, it would suggest that the shock has not been correctly identified.

In addition to comparing the estimated impulse response functions to the predictions of the AD-AS framework, the findings are also related to the IS-LM-AS model of Galí (1992) and to the recent paper by Keating (1992) which used the same long-run restrictions as are employed here.<sup>16</sup> With the exception of money demand shocks, the results are in basic agreement with the implications of the simple AD-AS framework. This provides some support for the identifying restrictions used to obtain estimates of the underlying disturbances.

Figure 1 shows the estimated responses to a positive aggregate supply shock together with one standard deviation bands. Responses are shown out to 12 quarters; the standard errors tend to become very large quickly and are shown only for the first six quarters. The point estimates indicate aggregate output is permanently increased by a positive supply shock. Since equilibrium requires that aggregate demand also rise permanently, the rate of interest falls. While inflation initially drops, money growth increases, accommodating the rise in output. The effects on money growth and inflation, however, are temporary, so

the decline in the nominal rate of interest implies a fall in the real rate. These estimated responses are consistent with a textbook model of AD-AS (for example, Hall and Taylor 1992) and look similar to the predicted capital accumulation path in a neoclassical growth model.

The estimated effects of a positive aggregate demand shock are shown in Figure 2. Output peaks after five quarters, and then declines gradually until it returns to its initial level. Inflation is increased, but IS shocks have no permanent impact on either money growth or inflation. The permanent increase in the nominal interest rate, therefore, represents a rise in real rates. The rise in real rates is needed to crowd out expenditures in order to reduce aggregate demand to its initial level.

The AD-AS model predicts that a positive money demand shock should, if the monetary authority fails to accommodate it, raise nominal interest rates temporarily and contract aggregate demand. As Figure 3 shows, a positive money demand shock does initially raise the nominal interest rate slightly. The money supply also rises, reflecting the fact that the Fed has partially accommodated money demand shocks. However, the money demand shock is still estimated to reduce real output, despite the accommodative policy response. It should be noted, however, that the standard errors around the estimated money demand effects are very large and none of the effects except the accommodative response of the money supply are statistically different from zero.

Finally, Figure 4 shows the estimated responses to a money supply shock. Output exhibits the familiar hump-shaped pattern associated with money shocks (King 1991), and nominal interest rates initially decline. The impact of the shock on the rate of growth of money is temporary, so the impact on inflation is also.

The impulse response functions obtained from the estimated system accord well with the predictions of the basic IS-LM-AS framework. They also are generally consistent with the findings of Galí (1992) and Keating (1992), although some of the specific estimated responses differ. Galí's basic set of identifying restrictions differ from those used in this paper. He assumes, as I do, that IS, MD, and MS shocks have no long-run effects on real output. He then assumes that neither money demand nor money supply shocks have contemporaneous effects on real output. In contrast, I allow both money market shocks to affect GDP contemporaneously. Finally, Galí assumes that the money supply does not respond contemporaneously to prices. As discussed in the text, I impose the restrictions that money supply and money demand shocks have no long-run impact on the level of nominal interest rates and that money supply shocks have no long-run impact on the level of real money

16. Both Galí and Keating use GNP and M1 in contrast to the use of GDP and M2 in this paper. Some of the differences may therefore be due to variable definition as well as to identifying restrictions.



FIGURE 1  
RESPONSES TO AN AS SHOCK

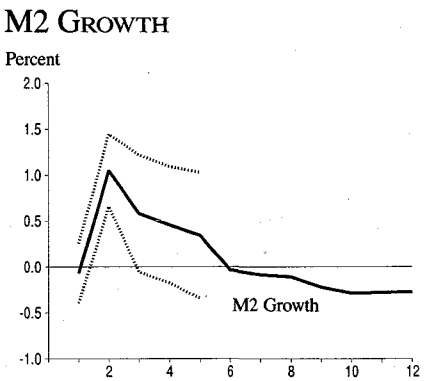
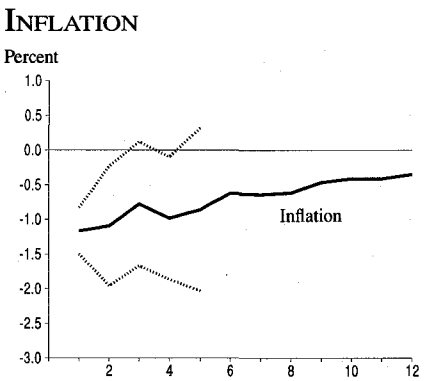
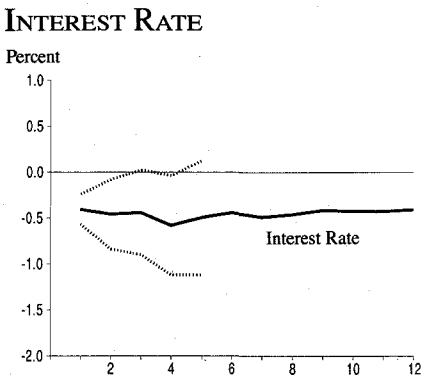
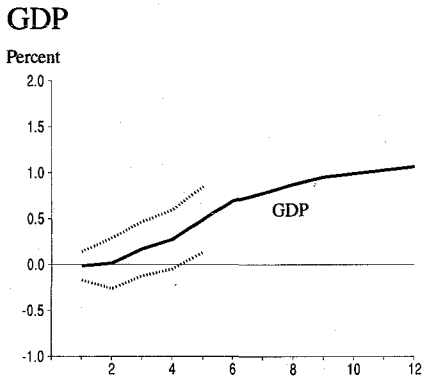
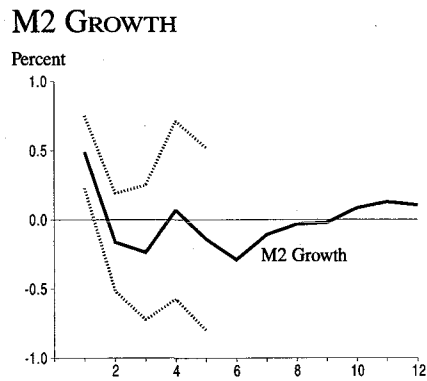
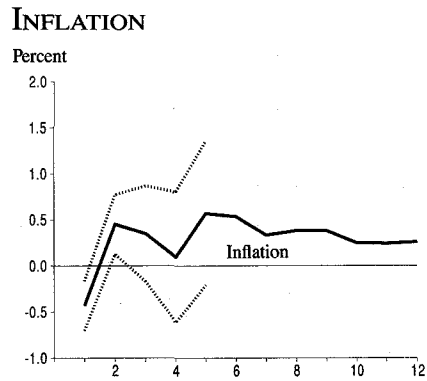
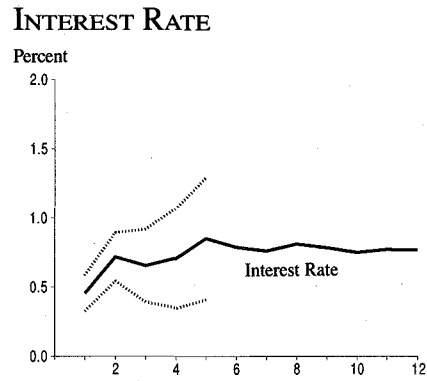
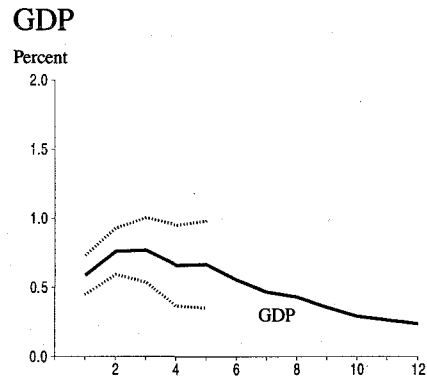
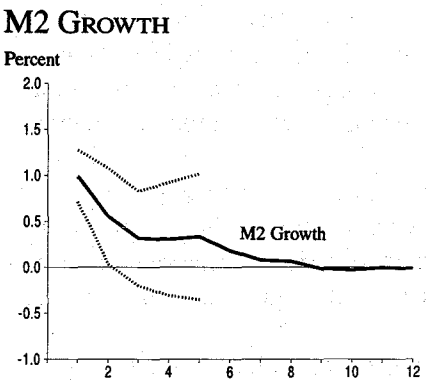
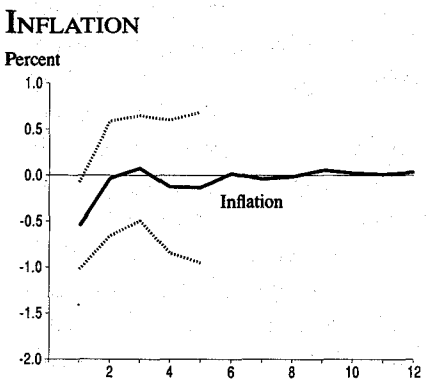
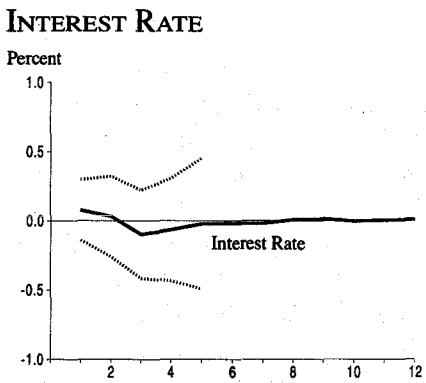
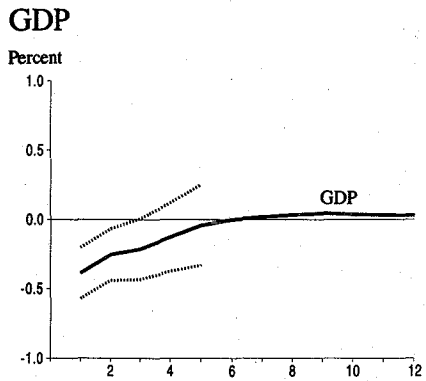


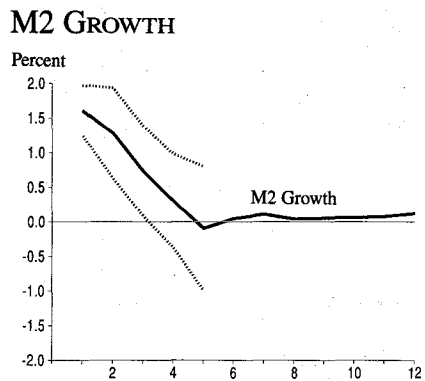
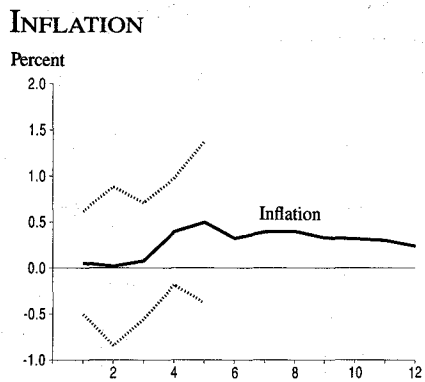
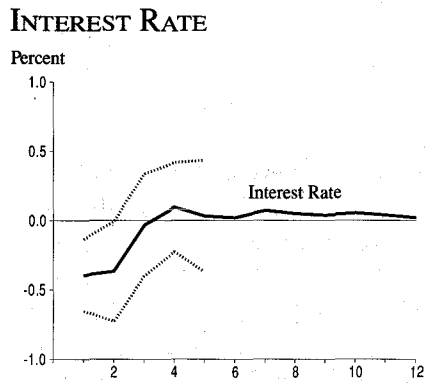
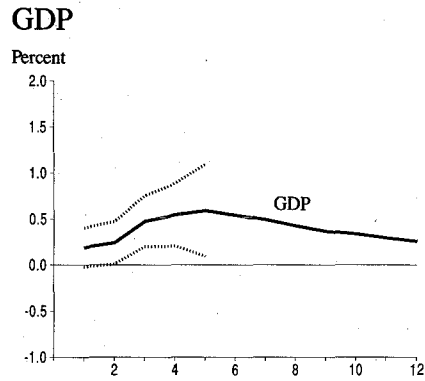
FIGURE 2  
RESPONSES TO AN IS SHOCK



**FIGURE 3**  
RESPONSES TO AN MD SHOCK



**FIGURE 4**  
RESPONSES TO AN MS SHOCK



balances. These last three restrictions seem better motivated by economic theory than do Galí's.

One difference that the alternative restrictions make is evident in the estimated impact of an IS shock. Galí finds that a positive IS shock permanently raises nominal money growth and inflation, with the inflation rate rising between two and three times the increase in the growth rate of the money supply. Under my restrictions, the long-run effect on the rate of money growth must be the same as the long-run effect on the rate of inflation; in the long run, inflation equals the rate of money growth. I estimate IS shocks to have no long-run effect on the rate of growth of M2, so such shocks also have no long-run effect on the rate of inflation. Galí also finds that a positive IS shock permanently lowers the real rate of interest. The real rate rises in the model I estimate.

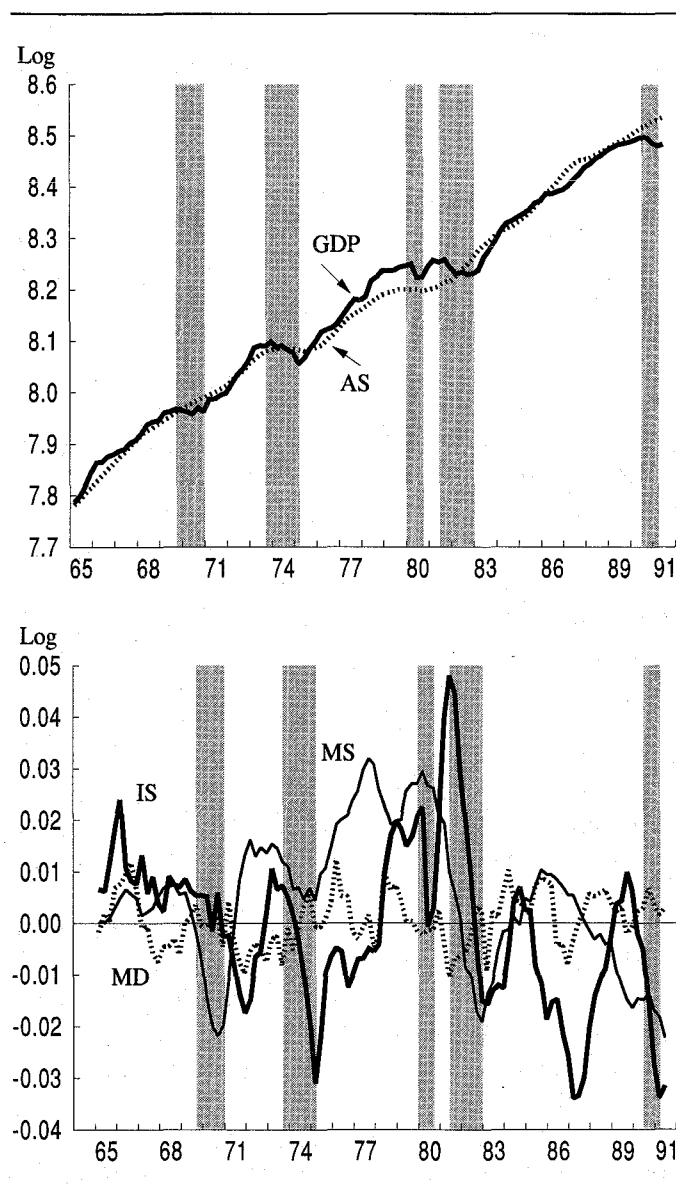
#### IV. DECOMPOSING GDP

The role of the four shocks identified by estimating the model is most informatively displayed by expressing the actual movement in GDP as the sum of the individual contributions of each of the four disturbances.<sup>17</sup> That is, GDP in a specific quarter can be written as the sum of the contribution of current and past aggregate supply shocks, current and past IS-shocks, current and past money demand shocks, and current and past money supply shocks plus any deterministic trend. Such "historical decompositions" provide estimates of the cumulative effect of the various shocks on GDP.

Before focusing specifically on the recent recession, it is useful to examine past recessionary experiences to determine if the model succeeds in identifying as their causes those factors that are generally accepted to have played important roles in previous downturns. Figure 5 presents the historical decomposition of GDP into components attributed to each of the four orthogonal shocks. In the upper panel, the solid line is actual GDP, while the dashed line is the estimated contribution of aggregate supply factors and the deterministic drift in GDP. These are the factors responsible for the stochastic trend in GDP. The lower panel shows the estimated contribution of IS, money demand, and money supply factors to the cyclical component of GDP. The sum of these three components equals the difference between actual GDP and the aggregate supply component shown in the upper panel.

17. Since the disturbances are, by assumption, orthogonal, the sum of the individual contributions of the four shocks exactly equals the nondeterministic component of GDP.

FIGURE 5  
HISTORICAL DECOMPOSITION OF GDP



The upper panel shows that aggregate supply disturbances exerted contractionary effects on the economy in 1973–1974 and in 1979–1980. These dates correspond to the oil price increases, indicating that the supply shock identified by the model is correctly picking up these disturbances. Money supply disturbances are estimated to have had major contractionary effects leading into the 1969 recession and during the two recessions in the early 1980s. This latter period is associated with the Volcker deflation, and the model successfully identifies monetary policy as an important cause of these recessions. Money supply factors are estimated to have had a major expansionary impact from 1974 to 1977, again agreeing with most

accounts that attribute the run-up in inflation during this period to excessively expansionary monetary policy.

While money demand factors often show large swings, these are not as clearly associated with specific business cycle fluctuations; IS shocks, however, are estimated to have contributed to the 1974 recession and the 1981-1982 recession. The Reagan fiscal expansion of the early 1980s fails to show up in any major way. These findings contrast somewhat with those of Galí who also finds a fiscal contraction contributing to the 1981-1982 downturn but finds a strong fiscal expansion occurring from 1982 to 1985.

According to the first panel of Figure 5, the expansion that began in 1982.Q4 and ended in 1990.Q3 started below GDP's estimated aggregate supply-trend component, but moved above this component in early 1984. After growing more slowly in 1986, GDP grew faster than its trend growth rate during 1987 and 1988. It then slowed again relative to its aggregate supply component during 1989 before the expansion ended in mid-1990. In evaluating the entire period shown in Figure 5, it is worth noting that the model assumes a constant average growth rate for the whole sample period.<sup>18</sup>

Confirming Galí's finding, money supply factors played a key role in the early stages of the expansion. From the end of 1982 until the first quarter of 1986, when output growth temporarily slowed, almost half of the rise in GDP is attributed to monetary expansion. Most of the remaining increase is attributed to aggregate supply factors. IS shocks and MD shocks, in contrast, each had essentially no net impact during this period. Apparently the fiscal expansion in 1983 and 1984 associated with the Reagan tax cuts and defense buildup was subsequently offset completely by the dollar appreciation of the first half of the 1980s.

From 1987 through 1989, IS factors become less contractionary and actually turn expansionary in 1989.Q1. This is almost completely offset by the contractionary shift in the money supply component of GDP. Thus, the dollar depreciation of this period appears to show up in the IS series, but the Federal Reserve's policy of gradually reducing the rate of inflation to zero stabilized real economic activity in the face of what otherwise would have been an IS-driven expansion. This period seems to be consistent with the Fed's desire at the time to engineer a smooth landing, reducing the rate of inflation by slowing the economy down without pushing it into a recession.

The economy is estimated to have weakened significantly relative to its aggregate supply component eighteen months before the official downturn in 1990.Q3. GDP peaked relative to its aggregate supply component in 1988.Q4.<sup>19</sup> Approximately 27 percent of the decline in the stochastic component of GDP from 1988.Q4 to 1990.Q2 was due to aggregate supply factors, while 56 percent was due to money supply factors. The remaining 17 percent was due to IS (12 percent) and MD (5 percent) factors. This composition changed markedly once the recession started during the second half of 1990. From 1990.Q2 to 1990.Q4, over 90 percent of the decline in the stochastic component of GDP is associated with the IS component. This is consistent with the marked decline in consumer confidence and consumption spending at the time of the Persian Gulf crisis. Consumption, for example, declined at a 15 percent annual rate during the fourth quarter of 1990, while private investment spending dropped at a 35 percent annual rate in this same quarter.<sup>20</sup> Net exports grew strongly in late 1990, but not enough to offset declines in the other components of aggregate spending.

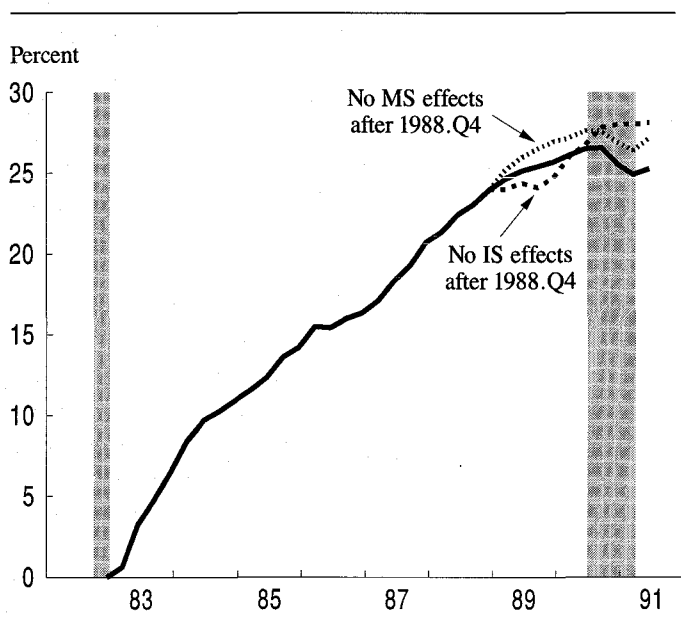
The evidence in Figure 5 seems to suggest that the positive contribution of money supply factors peaked in late 1985 or early 1986. These factors acted to reduce the level of GDP after late 1987. Growth was sustained mainly due to a turnaround in IS factors, possibly associated with the dollar depreciation that occurred during this period. This is illustrated in Figure 6 which shows the actual path of GDP (the solid line) and two hypothetical paths (dashed lines) assuming (1) no money supply effects after 1988.Q4 and (2) no IS effects after 1988.Q4. The line showing no money supply effects suggests that the economy would have grown more strongly in 1989 than it actually did if

18. A dummy was included in the GDP growth equation to allow for a shift in the trend growth rate in 1973. However, the coefficient on the dummy was statistically insignificant, so it was dropped from the version of the model used to generate the results reported here.

19. Romer (1992) argues that before 1927 NBER reference dates for U.S. business cycles were based on detrended data; those after 1927 were based on data in levels. Based on the earlier methods, the 1990 recession would have started in 1988.

20. The cause of the sharp fall in consumption during the initial quarter of the recession is probably attributable to the Gulf crisis. In August 1990, Iraq invaded Kuwait, and, over the next three months, the Michigan Index of Consumer Sentiment (ICS) registered its biggest three-month decline since its inception in 1956. And drops in ICS tend to be associated with reductions in consumer spending, particularly on durable goods (Throop 1991, 1992). Consumer purchases of durables fell at just over a 15 percent annual rate during the fourth quarter of 1990. Consumer sentiment is generally related to direct measures of economic conditions, such as unemployment, interest rates, oil prices, and inflation. In an error correction model of ICS, Throop (1992) finds a significant negative coefficient on a dummy variable for the Gulf War, indicating that the fall in consumer sentiment in late 1990 was not directly related to current or recent economic conditions. The Gulf crisis seems to have generated increased uncertainty on the part of households and to have led directly to a reduction in consumer spending.

FIGURE 6  
HYPOTHETICAL GDP



NOTE: 1982.Q4 = 0.

money supply factors had not turned more restrictive; however, a recession still would have occurred. The line showing no IS effect clearly indicates that the economy would have suffered a short recession in 1989 if IS effects had not been so expansionary. If both money supply and IS factors had remained unchanged after 1988.Q4, the economy would have continued on a relatively flat path at least through the middle of 1991, but no recession would have occurred.

The historical decompositions indicate that, while money supply shocks were pushing up GDP relative to trend growth until 1987, they had an increasingly contractionary effect on economic activity leading up to the cyclical peak as the Fed sought to prevent the economic expansion from putting upward pressure on inflation.<sup>21</sup> In terms of the timing of the peak in the stochastic component of GDP in 1988.Q4, the decline in the money supply contribution seems responsible. While the contractionary impact of IS factors in 1990 eventually would have generated an economic downturn, the role played by money supply factors deserves a closer examination. If the model-based measure of money supply disturbances actually reflects the im-

port of monetary policy on the economy, then the experience of the late 1980s may hold important lessons for the ability of the Federal Reserve to reduce inflation gradually without so weakening the economy that it is vulnerable to recession. Credible policies designed to reduce inflation are often thought to have little output cost. The contractionary impact of monetary policy in the late 1980s casts doubt on this view, or on the credibility of the Federal Reserve's policy of inflation reduction.<sup>22</sup>

The implications of these findings might be quite different, however, if the money supply disturbances identified by the model do not reflect monetary policy actions but rather capture nonpolicy related banking sector factors. Thus, the next section will examine some commonly employed indicators of monetary policy to determine whether they tell a similar story. This will help to provide a check on the robustness of the conclusions generated by the model.

## V. THE ROLE OF MONETARY POLICY

The previous section has suggested that money supply factors from 1987 to 1989 may have contributed to the slowing of the economy before the actual downturn in mid-1990. The money supply contribution to GDP is estimated to have flattened in 1988 and then become more contractionary during the first quarter of 1989. This raises the question of whether monetary policy was responsible for the contractionary shift.<sup>23</sup> In this section, several alternative indicators of monetary policy are examined to determine whether they also are consistent with the view that monetary policy became increasingly restrictive after 1988. The model-based measure is an estimate of the exogenous component of money supply movements. In contrast, these other indicators are endogenous variables whose movements will reflect both policy and nonpolicy factors.<sup>24</sup>

In contrast to the model-generated measure shown in Figures 5, the impact of monetary policy is more commonly measured by either a monetary aggregate, such as M2, or an interest rate or interest rate spread. While the importance of monetary aggregates, particularly M1, has been downplayed in the policy process over the past ten years, the Federal Reserve continues to establish target zones for the M2 aggregate. M2's behavior is influenced by

22. For evidence that the Fed's inflation policy did not have credibility, see Judd and Beebe (1993).

23. Given the lag between a change in monetary policy and its impact on GDP (see Figure 4), the quotation in footnote 21 is consistent with the downturn in MS in early 1989.

24. The Boschen and Mills index discussed below is an exception.

21. In reporting on its policies during 1989, the Fed stated that "Early in the year, the economy still was strong, and inflation appeared to be on the rise; to prevent the pressure on wages and prices from building, the Federal Reserve extended the tightening of money market conditions that had begun in early 1988." (Board of Governors 1989, p. 3.)

factors other than Federal Reserve actions. For example, the behavior of M2 in 1990 might reflect non-monetary policy disturbances such as a possible credit crunch resulting from tighter bank supervision. Despite this, movements in M2 are often taken to indicate the stance of policy. There was a marked slowdown in M2 growth in 1987.Q1. From 1982.Q4 to 1986.Q4, M2 growth averaged 9 percent; from 1987.Q1 to 1990.Q2, it averaged 5.2 percent. In Rotenberg, Driscoll, and Poterba (1991, Figure 1), their currency equivalent monetary aggregate also shows a slowdown in 1987. Such slowdowns in money growth would be expected to affect nominal income growth with a lag. King (1991) estimates that the lag between changes in M2 growth rates and M2's peak effect on real economic activity is approximately six to seven quarters, suggesting that monetary policy was contributing to a slowdown in the economy through late 1988 and 1989. This is consistent with the evidence from the historical decomposition based on the estimated AD-AS model.

In the standard IS-LM framework, changes in the money supply act on real interest rates and the real economy by affecting the real supply of money, the nominal supply adjusted for the price level. Real M2 growth, like M2 growth itself, indicates a sharp tightening of monetary policy in early 1987. The growth rate of real M2 fell from 7.5 percent in the fourth quarter of 1986 to -0.2 percent in the fourth quarter of 1987. From 1982.Q4 to 1986.Q4, the four-quarter growth rate of real M2 averaged 5.7 percent; it averaged only 1 percent from 1987.Q1 to 1990.Q2. After growing very rapidly through 1986, real M2 remained roughly constant from 1987 through 1991. However, several authors attribute the slowdown in real M2 growth, particularly after 1990, to a shift in M2 demand (Duca 1992, Feinman and Porter 1992). Duca finds that most of the fall in M2 demand was the result of the closing of thrifts by the Resolution Trust Corporation. If this is the case, the failure of real M2 to grow during the period from 1987 to 1991 reflects a shift in money demand, not money supply or monetary policy. The model does show a slight positive effect of money demand shocks on output during 1990 and 1991 (see Figure 5), but it may be that the money supply series is also picking up some of this money demand shift.

All three quantity indicators of monetary policy—the model-based series, M2, and real M2—paint a similar picture. They suggest monetary policy turned increasingly restrictive in early 1987. The model-based estimate suggests the expansionary effect of monetary policy peaked in early 1986, having a net negative impact on GDP beginning in late 1987. The Fed's own view is that its policy became more restrictive only later, in March of 1988 at a time when they felt the likelihood of higher inflation was increasing (Board of Governors 1988). In the absence of

offsetting developments, it is likely that a recession would have occurred sometime in the period from late 1987 to early 1990. Figure 5 suggests that the impact of monetary policy during this period was offsetting aggregate spending (IS) factors.

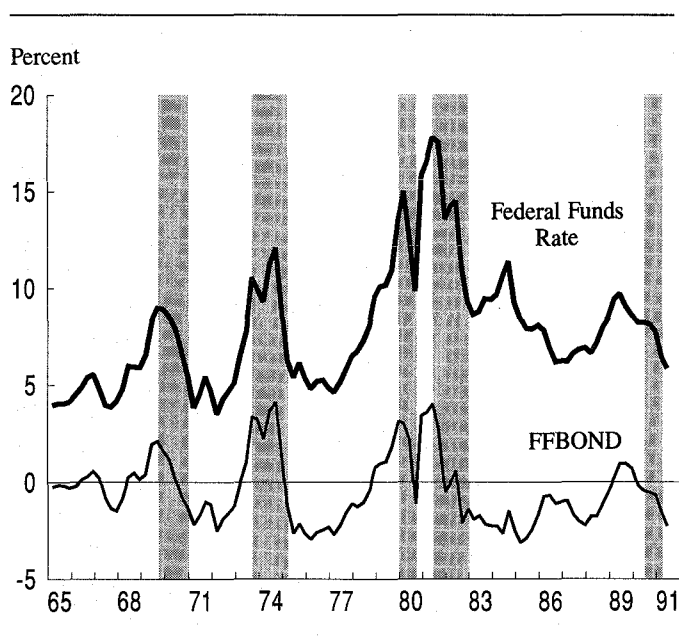
In addition to quantity measures, interest rate movements are often used to gauge the stance of monetary policy, although these too are controversial as measures of policy. Since the Federal Reserve has generally used operating procedures oriented toward interest rates, short-term interest rate changes provide information about the actions of the Fed. Recently, Bernanke and Blinder (1992) have argued that the federal funds rate is a good indicator of monetary policy. The federal funds rate adjusts to equate the demand for and supply of bank reserves, and Bernanke and Blinder use monthly and weekly data to demonstrate that the federal funds rate has been relatively insensitive to fluctuations in reserve demand. This is consistent with the view that movements in the funds rate reflect supply factors, including Federal Reserve policy actions. While the evidence presented by Bernanke and Blinder deals with the pre-October 1979 period, the funds rate also should reflect mainly policy actions by the Fed under the borrowed reserves operating procedure used during the past decade (Walsh 1990). Restrictive monetary policy, by reducing the supply of bank reserves, leads to a rise in the funds rate.

The sharp rise in the funds rate shown in Figure 7 prior to the business cycle peaks in January 1980 and July 1981 is consistent with the view that restrictive monetary policy played a major role in the recessions of the early 1980s. The funds rate did rise steadily beginning in 1986, moving from 6.21 percent in the third quarter of 1986 to a peak of 9.73 in the second quarter of 1989. The funds rate, therefore, indicates restrictive monetary policy continuing much longer than was suggested by the growth rate of either M2 or real M2. Given the lags with which monetary actions are normally thought to affect the real economy, the rise in the funds rate is consistent with a monetary-induced slowdown in 1990.

The funds rate is not an exogenous measure of monetary policy, and its level is affected by such factors as the prevailing expected rate of inflation. Variations in expected inflation make interpreting the funds rate as an indicator of monetary policy difficult. Since it is often thought that short-run movements in long-term interest rates predominantly reflect variations in expected inflation, the funds rate minus a long-term rate provides an alternative indicator of monetary policy (Laurent 1988, Goodfriend 1990). In Figure 7, FFBOND is the difference between the Fed funds rate and the rate on 10-year constant maturity government securities. An increase in this series—that is, a rise in the funds rate relative to the 10-year rate—would signal

FIGURE 7

## FEDERAL FUNDS RATE AND FFBOND



restrictive monetary policy. From the fourth quarter of 1987 to the third quarter of 1989, this series rose from  $-2.21$  percent to  $0.98$  percent. In describing this rise, Bernanke and Blinder (1992, p. 17) state that “only two sustained increases in FFBOND were *not* followed by recessions. The first such episode, which was long and gradual, ended with the 1966 credit crunch, which was followed by a ‘growth recession.’ The second is the very recent run-up which, as of this writing (September 1990), has not led to a recession.” We now know that the recession had begun in July 1990.

Indicators of monetary policy based either on monetary aggregates or on interest rates are indirect measures, since they are affected both by policy actions and by other factors. Shifts in money demand, the impact of a credit crunch, balance sheet restructuring and the S & L crisis are just a few of the developments that make it difficult to rely on only one indicator. In a recent study, Boschen and Mills (1991) have constructed a measure of policy that is based directly on their reading of the minutes of FOMC meetings.<sup>25</sup> They characterize policy as falling into five categories: contractionary, somewhat contractionary, neutral, somewhat expansionary, and expansionary. Values of  $-2$ ,  $-1$ ,  $0$ ,  $1$  and  $2$  are assigned to these categories. The series they construct is again consistent with the earlier evidence

of restrictive monetary policy through most of 1987 and 1988. The index was equal to  $1.0$  (somewhat expansionary) during all of 1986. It then fell to  $-1.0$  by the third quarter of 1987, rose to  $1.0$  in the fourth quarter of 1987 in response to the stock market crash, then declined to a value of  $-2.0$  (contractionary) in the second quarter of 1989. Beginning in the third quarter of 1989, monetary policy became progressively more expansionary according to the Boschen and Mills index. This timing is consistent with the Fed’s own view. According to the Federal Reserve Board’s 1989 Annual Report, “In June, the FOMC began a series of steps—undertaken with care to avoid excessive inflationary stimulus—that trimmed  $1\frac{1}{2}$  percentage points from short-term interest rates by year-end” (p. 3). Given the lags with which monetary policy affects the real economy, however, the Boschen-Mills series, like the other measures examined, suggests that monetary policy was exerting a contractionary effect on the U.S. economy from late 1986 or early 1987 until at least the middle of 1989.

Monetary policy clearly did not cause the 1990 downturn. Instead, monetary policy turned contractionary well before the end of the expansion. The model-based historical decomposition shown in Figure 5 indicates that a monetary-induced recession failed to occur in 1989 because it was offset by IS-originating factors. And it was the downturn of these factors that pushed an economy already slowed by restrictive monetary policy into recession in 1990.

## VI. SUMMARY AND CONCLUSIONS

An empirical model designed to represent a simple IS-LM-AS framework was estimated in order to associate movements in GDP with the four fundamental shocks emphasized by this framework. While the impulse response functions generally matched the behavior implied by the theoretical framework, thereby lending some support to the method used to identify the underlying shocks, the effects are not estimated with much precision. However, the historical decompositions derived from the estimated model did seem to capture those factors usually viewed as important in previous recessions.

When the model was used to identify the basic disturbances that might have caused the 1990 recession, three points emerged from the analysis. First, while the timing of the downturn in July 1990 was clearly related to the loss of consumer and business confidence at the time of the Gulf crisis, the economy had already significantly weakened, peaking relative to trend over a year earlier. Second, the general weakness in the economy in the period leading up to the actual cyclical peak was due to restrictive monetary policy that served to offset expansionary IS

25. Data through July 1991 were kindly supplied by John Boschen.

factors in a way that kept the economy relatively flat. Such a path seems consistent with the Federal Reserve's stated goal at the time to bring inflation gradually down closer to zero. Third, IS factors turned down in 1989:Q3, acting to reduce the level of GDP beginning in 1990:Q1. These IS factors accounted for most of the decline in GDP over the rest of 1990. Thus, a more detailed examination of the causes of the recession should begin by investigating the reasons for the downward shift in the IS curve.

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