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Adrian W. Throop — A Generalized Uncovered Interest Parity Model of Exchange Rates

Elizabeth S. Laderman — Determinants of Bank Versus Nonbank Competitiveness in Short-term Business Lending

Carl E. Walsh — What Caused the 1990–1991 Recession?

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.[1]

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.[2] 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.[3] 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.

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).

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.[4] 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.[5]

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)

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.[6]

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,[7] A is a 4×4 matrix, $B(\,)$ is a 4×4 matrix polynomial in the lag operator L, and ϵ is a 4×1 vector of the unobserved structural disturbances, $\epsilon' = (\epsilon^{as}\ \epsilon^{is}\ \epsilon^{md}\ \epsilon^{ms})$.

It is assumed that the elements of ϵ are mutually uncorrelated and serially independent with diagonal variance-covariance matrix Σ_ϵ. 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 ϵ 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 Δz_t on lagged values of itself,[8] 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 ϵ 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 $\Delta z_t = A^{-1}B(L)\Delta z_{t-1} + A^{-1}\epsilon$.

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.[9]

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.[10] If so, then money demand and money supply shocks will also have no long-run effect on the nominal rate of interest.[11] 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):[12]

$$\Delta y_t = \sum_{1}^{N} \alpha_{1i} \Delta y_{t-i} + \sum_{0}^{N-1} \beta_{1i} \Delta^2 i_{t-i} + \sum_{0}^{N-1} \gamma_{1i} \Delta^2 (m-p)_{t-i} + \sum_{0}^{N-1} \delta_{1i} \Delta^2 m_{t-i} + \epsilon_t^{as}$$

$$\Delta i_t = \sum_{0}^{N} \alpha_{2i} \Delta y_{t-i} + \sum_{1}^{N} \beta_{2i} \Delta i_{t-i} + \sum_{0}^{N-1} \gamma_{2i} \Delta^2 (m-p)_{t-i} + \sum_{0}^{N-1} \delta_{2i} \Delta^2 m_{t-i} + \epsilon_t^{is}$$

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.

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.

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

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

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 Δi, $\Delta(m-p)$ and Δm in the equation for Δy 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 Δi, 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 Δy, the estimated residual for the output equation is used, since ϵ^{as} and ϵ^{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 Δm 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 generate the estimated contribution of each shock are themselves estimated relatively imprecisely. Any conclusions, therefore, should be viewed as suggestive only.[13]

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.[14] 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_μ 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.[15] 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_μ

	Levels	First Differences
GDP	−1.76	−8.90
3MTB	−2.40	−9.56
CPI	−0.80	−3.89
M2	−0.41	−5.20
M2–CPI	−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	λ_{MAX}	λ_{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 ϵ'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.[16] 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.

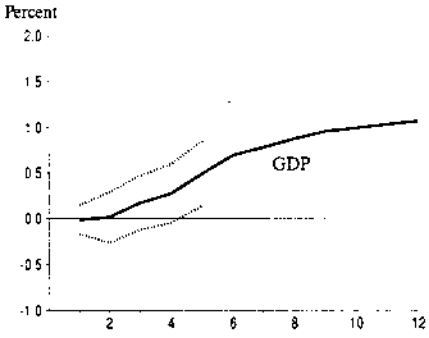
The impulse response functions obtained from the estimated system accord well with the predictions of the basic IS-LM-AS framework. They also are generally consistent with the findings of Galí (1992) and Keating (1992), although some of the specific estimated responses differ. Galí's basic set of identifying 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.

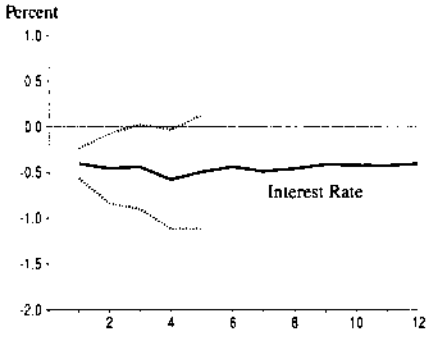
FIGURE 1

Responses to an AS Shock

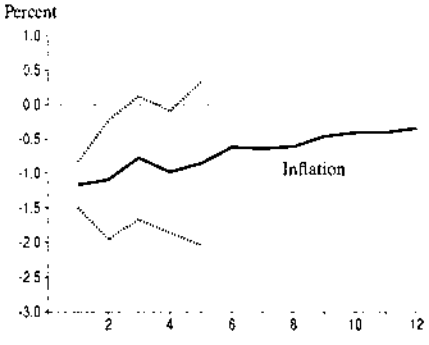
GDP



Interest Rate



Inflation



M2 Growth

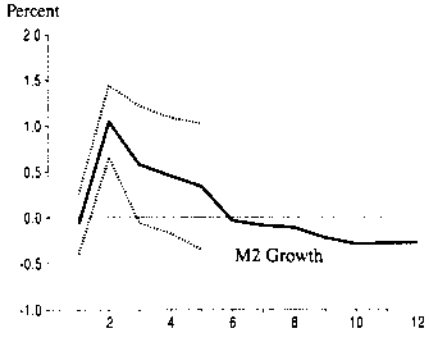
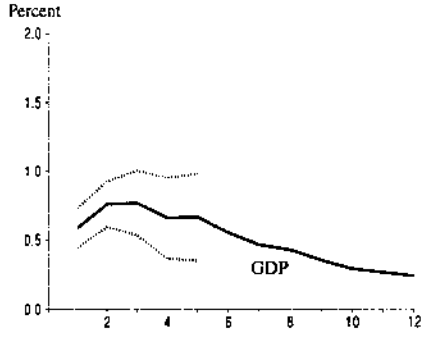


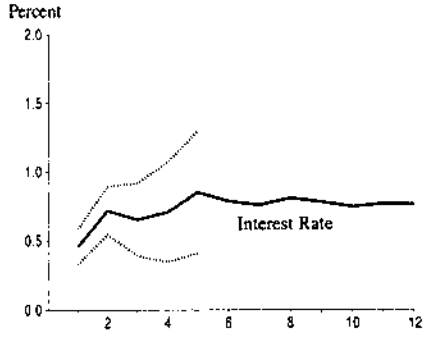
FIGURE 2

Responses to an IS Shock

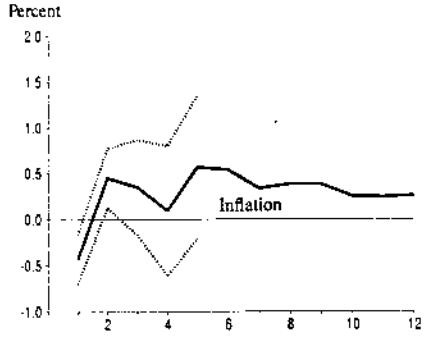
GDP



Interest Rate



Inflation



M2 Growth

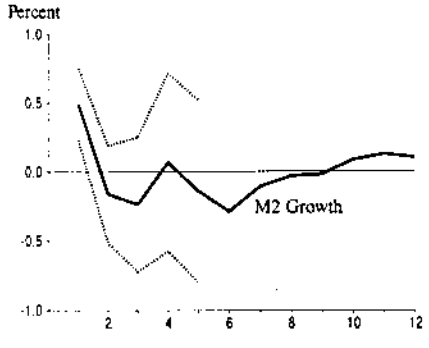
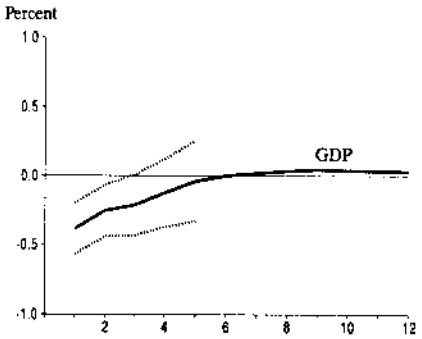


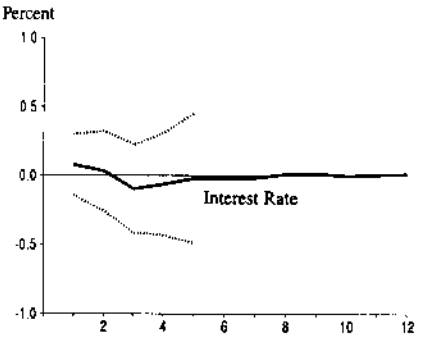
FIGURE 3

RESPONSES TO AN MD SHOCK

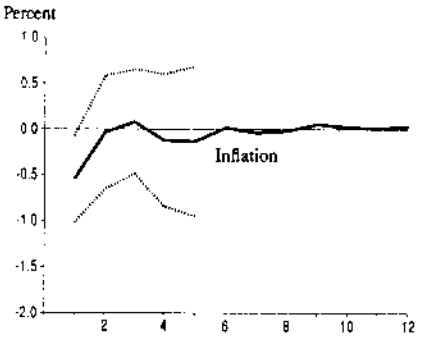
GDP



INTEREST RATE



INFLATION



M2 GROWTH

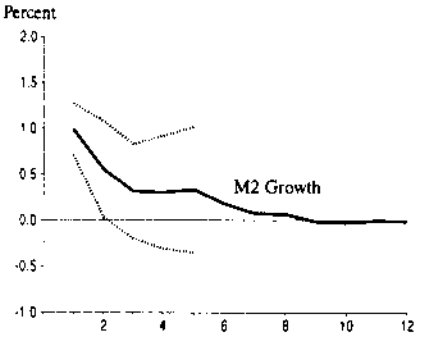
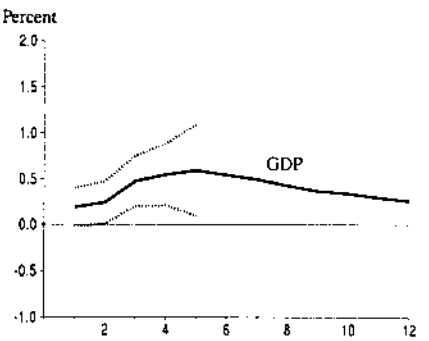


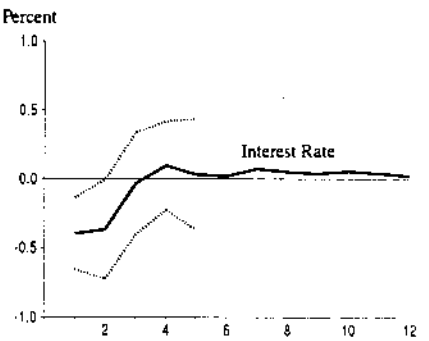
FIGURE 4

RESPONSES TO AN MS SHOCK

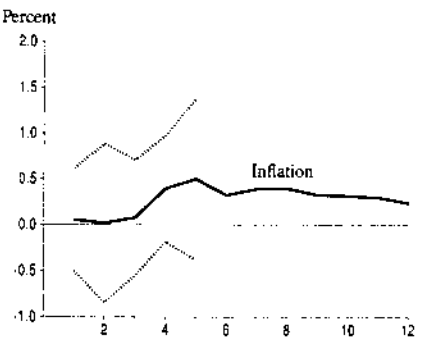
GDP



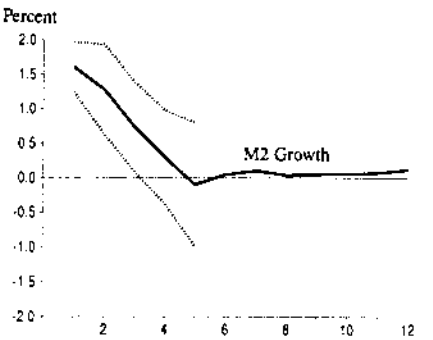
INTEREST RATE



INFLATION



M2 GROWTH



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

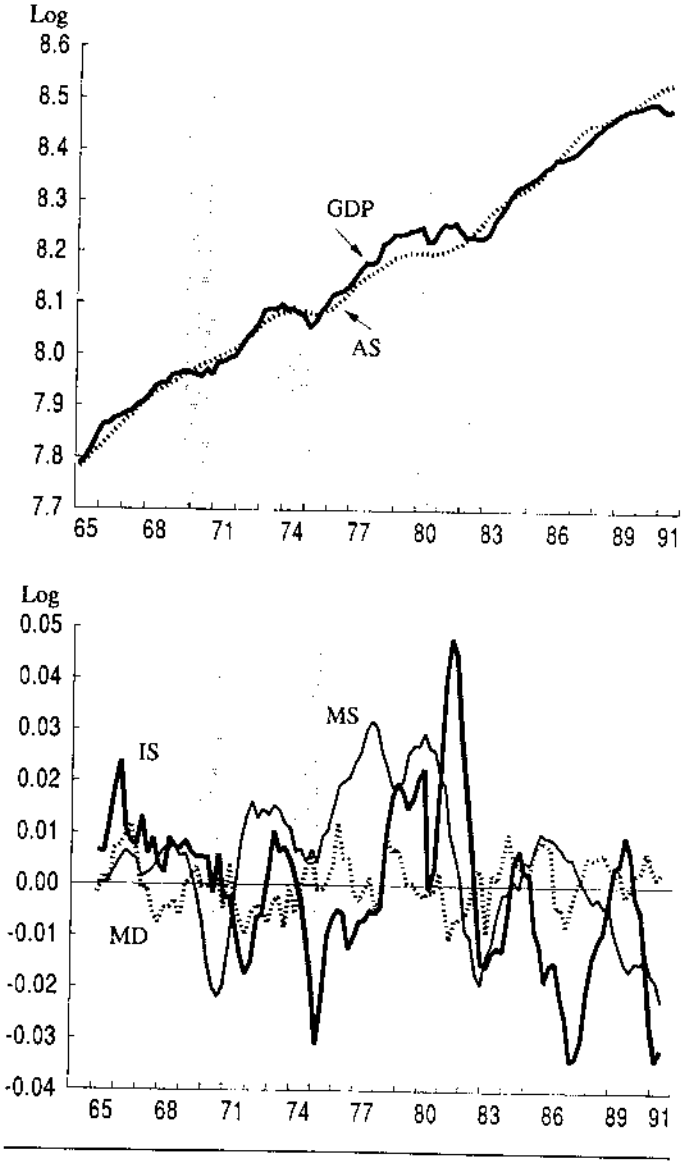
The role of the four shocks identified by estimating the model is most informatively displayed by expressing the actual movement in GDP as the sum of the individual contributions of each of the four disturbances.[17] That is, GDP in a specific quarter can be written as the sum of the contribution of 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.[18]

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.[19] 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.[20] 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

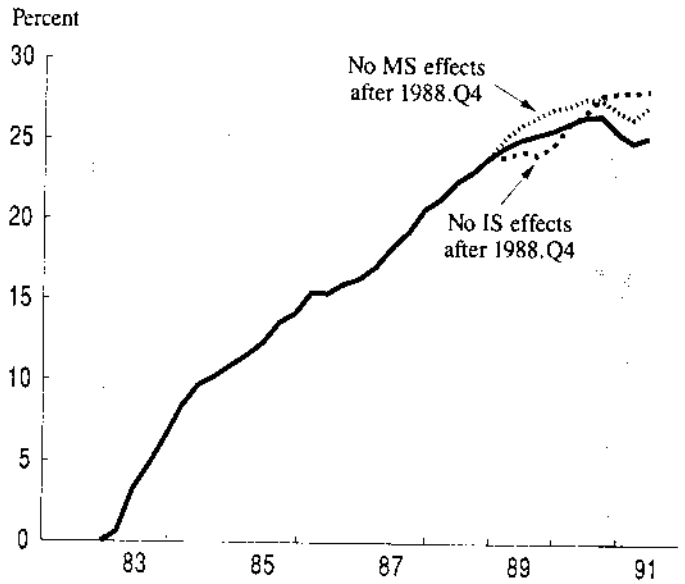
18. A dummy was included in the GDP growth equation to allow for a shift in the trend growth rate in 1973. However, the coefficient on the dummy was statistically insignificant, so it was dropped from the version of the model used to generate the results reported here.

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.[21] 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 impact 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.[22]

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.[23] 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.[24]

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

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.)

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.

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.

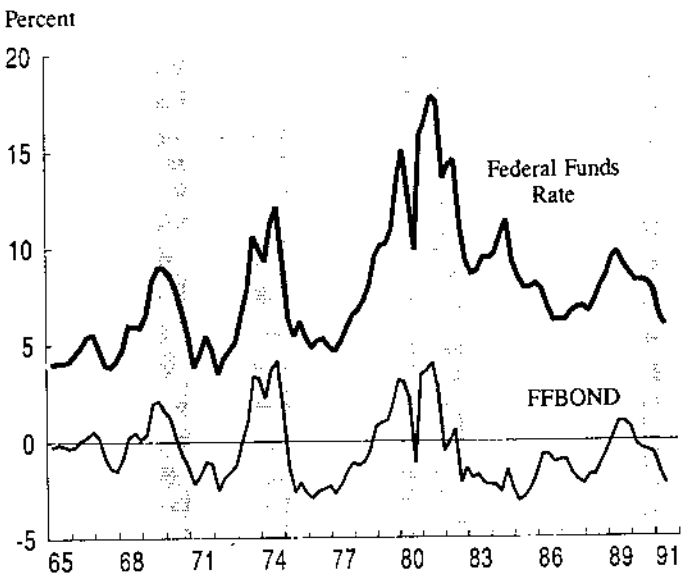
In addition to quantity measures, interest rate movements are often used to gauge the stance of monetary policy, although these too are controversial as measures of policy. Since the Federal Reserve has generally used operating procedures oriented toward interest rates, short-term interest rate changes 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.[25] 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 1½ 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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