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The Demand for M2, Opportunity Cost, and Financial Change

by John B. Carlson and Sharon E. Parrott

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Introduction

The role of money in the implementation of monetary policy has waxed and waned over the past 30 years. Policymakers' attention to money has been largely related to their confidence in the stability of the relationship between measures of money and the ultimate objectives of monetary policy, particularly the rate of inflation.

The link between inflation and money growth has long been grounded in the quantity theory of money. A key relationship in this link is the demand for money. Indeed, in an influential restatement of the quantity theory, Milton Friedman (1966) argued that "the quantity theory is in the first instance a theory of money demand." Friedman's point was predicated on the empirical hypothesis that the demand for money is one of the most stable relationships in the economy.[1] Despite some unexplained behavior in the mid-1970s, the money demand function was widely perceived as reasonably stable and reliable through the balance of that decade.[2]

The high-water mark for the role of money in monetary policy was reached in the late 1970s, when the Federal Reserve adopted a disinflation strategy in which annual targets for monetary growth played a key role. This strategy was coupled with an operating procedure that automatically reacted to deviations of money from prespecified short-run paths. Although some analysts criticized the procedure for not producing gradually slowing money growth, trend money growth ultimately slowed, as did the inflation rate.[3] Moreover, money markets reacted systematically to announced changes in the money supply, providing evidence that the short-run financial market implications of the procedure were widely understood and anticipated.

In 1980, Congress passed legislation authorizing significant changes in U.S. banking regulations, including the elimination of most interest-rate restrictions. Many analysts believed that such deregulation would enable depository institutions to pay higher yields on deposits and thereby

■ 1 Hendry and Ericsson (1990) provide some evidence that a constant, conditional money demand model cannot be inverted to obtain a constant model of prices for narrow measures of money. We do not pursue this issue.

■ 2 For evidence on the breakdown of conventional money demand models in the mid-1970s, see Goldfeld (1976) and Judd and Scadding (1982).

■ 3 To appreciate the difficulty in choosing prespecified monetary targets to reduce the inflation rate, see Poole (1988).

claim a larger share of the household portfolio. This, in turn, would affect the relationship between money measures (comprised largely of deposits) and the level of economic activity.

Concerns about the impact of deregulation on the stability of money demand appeared to be warranted for the narrower money measures such as M1. The introduction of interest-bearing checking nationwide and new deposit instruments such as money market deposit accounts (MMDAs) greatly affected long-established depositor behavior. Common specifications for M1 demand did not survive deregulation. And while attempts have been made to rectify M1 demand in the short run, no consensus has yet emerged on any particular empirical form.[4]

Research on M2 demand, however, has yielded evidence of stable short-run specifications for this aggregate, at least in the post–World War II period (see Moore, Porter, and Small [1990], Hetzel and Mehra [1987], and Mehra [1991]). But in 1989 and 1990, M2 grew more slowly than these models had predicted. Two hypotheses have been proposed to account for this. The first is that at least part of the unexplained behavior is related to the mismeasurement of the opportunity cost of M2. The second is that the restructuring of the savings and loan (thrift) industry has affected M2 growth.

This paper presents a specification of M2 demand that adopts the general framework used by Moore, Porter, and Small (hereafter referred to as MPS), but uses an alternative measure of opportunity cost. We attempt to capture the effects of thrift restructuring on the adjustment of M2 to its equilibrium level. The estimated regression remains stable throughout the period of deregulation, and the results suggest that the model's performance can be improved by measuring opportunity cost more precisely. Moreover, our results are consistent with the hypothesis that recent M2 weakness is partly related to the thrift industry restructuring and is thus largely a temporary phenomenon.

I. The Error-Correction Framework

Empirical aggregate money-demand functions estimated in the postwar period typically include some measure of the opportunity cost of holding money (most often a short-term interest rate) and a scale variable such as income or spending. This research has generally found evidence of inertia in the response of money demand to changes in opportunity costs and spending. Early postwar specifications attempted to capture this inertia as a partial-adjustment specification. This approach was sometimes identified as the conventional specification or the Goldfeld equation (see Goldfeld [1973]). Alternatively, researchers have handled the inertia by using a distributed lag (of either the levels or the first differences of the levels) of the regressors.

MPS were among the first advocates of specifying the inertia in an error-correction framework. They noted two advantages to this approach. First, error-correction regressors—entered as first differences in the levels—are more likely to be stationary and are much less colinear than they would be as undifferenced regressors. Second, the long- and short-run money demand relationships are clearly distinguished.

In addition, Hendry and Ericsson note that the error-correction framework generalizes the conventional partial-adjustment model in a way that allows for separate rates of reaction to the various determinants of money demand, reflecting different costs of adjustment. They further argue that the error-correction specification is related to theories of money adjustment such as the model developed by Miller and Orr (1966). In these models, the short-run factors determine money movements *given* desired bands, while the long-run factors influence the levels of the bands themselves.

We follow the approach of MPS, but specify the long-run money demand function as

$$(1) \qquad m_t = \alpha + y_t + \beta s_t + e_t,$$

where $m_t = \log(M2)$, $y_t = \log(\textit{nominal GNP})$, and $s = \log(\textit{opportunity cost})$.

Note that the unitary coefficient on nominal GNP ensures that this expression also specifies a relationship in which long-run velocity varies only with opportunity cost.[5] The second component is a dynamic specification based on an error-correction adjustment specification:

$$(2) \qquad \nabla m_t = a + be_{t-1} + \sum_{i=1}^{u} c_i \nabla m_{t-i} + \sum_{i=0}^{v} d_i \nabla s_{t-i} + \sum_{i=0}^{w} f_i \nabla y_{t-i} + \sum_{i=1}^{q} \sum_{j=0}^{n} g_{ij} \nabla x_{i,t-j} + \varepsilon_t,$$

■ **4** For a stable short-run specification of M1 demand, see Hendry and Ericsson (1990). For an examination of long-run M1 demand, see Hoffman and Rasche (1989).

■ **5** MPS include a time index as a regressor to estimate any drift in M2 velocity directly. Although they find the coefficient to be significant, the drift is negligible—about 0.03 percent per year (see appendix).

where e_{t-1} is the deviation of money from its long-run equilibrium value (derived from equation [1]) and ε_t is white noise. Adjustment speed is determined by changes in the lagged values of M2 and in the current and lagged values of opportunity cost and the scale variable. The general form of the model allows other variables, x_{it}, to affect adjustment speed (both current and lagged values). These variables, which need not affect equilibrium money balances, include any factors that influence the adjustment process.

Equation (2) essentially specifies the short-run convergence process of M2 to its equilibrium value. When the coefficient on the error-correction term is negative, convergence is assured. Substituting (1) into (2) yields

$$(3)\quad \nabla m_t = a - b\alpha - b\beta s_{t-1} + b(m_{t-1} - y_{t-1}) + \sum_{i=16}^{u} c_i \nabla m_{t-i} + \sum_{i=0}^{v} d_i \nabla s_{t-i} + \sum_{i=1}^{w} f_i \nabla y_{t-i} + \sum_{i=1}^{q}\sum_{j=0}^{n} g_{ij} \nabla x_{i,t-j} + \varepsilon_t .$$

We estimate a version of equation (3).

II. Measuring Opportunity Cost

By definition, the opportunity cost of money is the forgone interest income from holding a monetary asset in lieu of some higher-yielding nonmonetary, but otherwise comparable, asset. A common practice in the money demand literature has been to measure opportunity cost using a market yield on some short-term security, such as a Treasury bill (T-bill) or commercial paper. This seemed appropriate for the narrow money measures during much of the postwar period, because holders of currency and demand deposits did not receive explicit interest payments on these instruments.

However, many instruments in the broader monetary aggregates, such as M2, have yielded explicit interest. During regulation, yields responded at least partially to market conditions when interest-rate ceilings were not exceeded. In principle, the forgone interest for each of these instruments is the difference between its yield and the yield on some close substitute.

An innovation of MPS was to measure the opportunity cost of M2 as the difference between the rate paid on M2 deposits and the rate earned on a T-bill. The rate paid on M2, or its *own* rate, is a weighted average of the rates paid on M2 components (which include small time deposits, MMDAs, other checkable deposits, passbook savings accounts, and repurchase agreements [RPs]), where the weights are equal to the corresponding component's share of M2.

The three-month T-bill is generally considered a close substitute for many M2 components because, like most of these, it is of short maturity and is relatively risk free. However, M2 components vary in liquidity. Some deposits, such as interest-bearing checking accounts, are available on demand, while other components, such as small time deposits, may not be accessible without penalty for several years.

One hypothesis of this paper is that the opportunity cost of M2 is more appropriately calculated as a weighted average of the differences between each M2 component and a market instrument of comparable maturity. Such a measure would allow for the variation in M2 maturities and hence would account for the interest forgone by not holding more likely substitutes. Unfortunately, data constraints make such a calculation impossible before 1983.

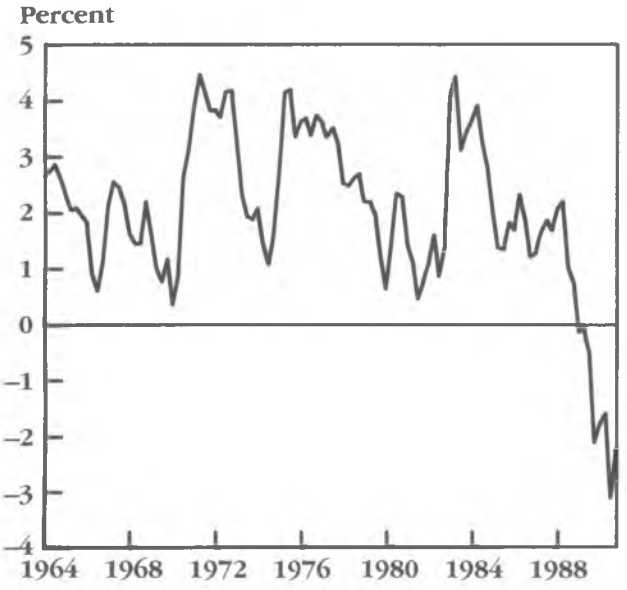
Although it is not possible to match each M2 component perfectly with a market instrument of equal maturity, one can achieve closer correspondence between rates paid on these components and on alternative assets than is realized by the measure now employed. For example, a closer approximation of the alternative asset rate can be constructed using a weighted average of the three-month T-bill rate and the three-year Treasury note (T-note) rate. The weight for the three-year T-note rate is the small time deposit share of M2, and the weight for the three-month T-bill rate is the non-small time deposit share of M2.[6]

Some analysts have found that yield curve steepness variables are statistically significant in money demand models that use the conventional opportunity cost measure. Using our measure of opportunity cost, however, the yield curve variable becomes insignificant. This suggests that the M2 components' relative shares are important in calculating opportunity cost.

■ **6** It should be emphasized that this alternative measure is still an approximation. We are not matching maturities, since our measure of the own rate uses the interest rate paid on the six-month certificate of deposit (CD) as the rate paid on all time deposits. Nevertheless, the introduction of the longer-term T-note rate into the calculation appears to improve the model.

FIGURE 1

Change in Thrift Deposits, 1964 – 1990



NOTE: Percent changes are expressed as quarterly rates.
SOURCE: DRI/McGraw Hill.

III. The Thrift Hypothesis

Over the past two years, many models of M2 demand have been consistently overpredicting M2 growth. Some analysts have argued that the unexplained weakness in this aggregate is related to the ongoing restructuring of the savings and loan industry (see Furlong and Trehan [1990]). As figure 1 shows, thrift deposits have contracted significantly since 1988. Although banks have acquired some of these funds, the additional increase in bank deposits has only partially offset the contraction at thrifts.

After the savings and loan industry's problems became evident, these institutions came under increasing regulatory pressure. Regulators no longer allowed thrifts to bid for funds above market interest rates. And the closure of thrifts, as Furlong and Trehan argue, led to changes in deposit pricing strategy for the entire deposit market. To the extent that institutions paying above-market rates were eventually closed, their competitors were able to offer lower interest rates because they no longer had to compete against the insolvent thrifts. Furthermore, when the insolvent thrifts were closed and their assets sold to other financial institutions, many contracts were abrogated. When the assets were absorbed, the interest-rate "contracts" were renegotiated. This meant that the above-market interest rates offered by the thrifts were no longer available.

As Furlong and Trehan note, interest rates on MMDAs and on small time deposit accounts have recently been lower than one would have expected prior to the thrift industry restructuring. This has caused an increase in the opportunity cost of M2 and has led many depositors to transfer their funds, at least temporarily, out of M2.

While the thrift restructuring hypothesis explains why deposit rates may be unusually low, it is unclear why the money demand function is overpredicting M2 growth. If deposit rates are lower than expected, then opportunity cost should be higher than expected, which in turn should imply lower money demand. That is, the weakness in M2 growth should be explained by higher opportunity cost.

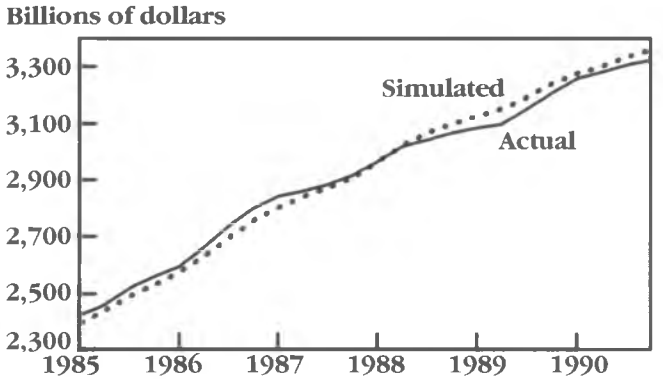
One hypothesis for the shortfall in money demand is that the changed pricing behavior is not captured completely by the measured opportunity cost. Although refining the opportunity cost measure by partially accounting for the variation in rates across maturities does improve the model, the measurement of the M2 own rate also presents problems for our analysis. As noted previously, the own rate is computed as a weighted average of the rates paid on various M2 deposits. Surveys conducted by the Federal Reserve and the Office of Thrift Supervision (OTS) ask respondent depositories to indicate the "most common rate paid" on various types of deposits.

The aggregated own rate computed from these surveys masks the shape of the interest-rate distribution in two ways. First, if depositories pay different rates on accounts of the same type, then the Federal Reserve uses the rate paid on the largest number of deposits to compute the own rate. For example, depositories may have many levels, or tiers, of MMDAs, each requiring a different minimum balance and paying a different interest rate. Second, the distribution of rates across depositories could be skewed if a few institutions pay much lower or much higher rates than average.

Depositories that need funds are more likely to be on the high end of the interest-rate distribution and are therefore likely to be the institutions most responsible for the growth of deposits. Unfortunately, the own rate now used will drown out the rates reported by banks paying the "fringe" rates; that is, those banks having the greatest effect on

FIGURE 2

Simulated and Actual M2: Estimation Period = 1964:IQ – 1986:IVQ



SOURCE: Simulations based on authors' model.

the demand for deposits by drawing funds from outside the depository sector.[7]

A key hypothesis of this paper is that the change in thrift deposits is a proxy for deposit pricing effects not captured by our measure of opportunity cost. In other words, the effect of thrift restructuring on M2 demand may be viewed as another kind of measurement problem. Because deposit pricing has at times been more aggressive at thrifts than at banks, thrift deposit growth could incorporate information about the skewness in the distribution of deposit rates. The rates on the extreme end of the distribution might well account for a disproportionate share of the change in thrift deposits. For example, in the early to middle 1980s, some thrifts expanded their market share of deposits and other money market instruments by offering extremely attractive (and, more important, unsustainable) rates.

Interest-rate skewness, while not sustainable in the long run, might affect the adjustment of M2 to its equilibrium level. To examine this hypothesis, we include both the lagged change in thrift deposits and the lagged change in M2 in the error-correction equation.[8] Because the thrift variable is largely a component of M2, we would not expect it to add anything to the regression unless it includes information not contained in the lagged change in M2.[9]

IV. Empirical Results

The regression estimated in this paper as an alternative to the MPS equation is given by

$$
\begin{aligned}
(4)\quad \nabla m_t = {} & -.053 - .009\, s_{t-1} \\
& \quad (4.44) \quad (4.60) \\
& - .138(m_{t-1} - y_{t-1}) + .245\, \nabla m_{t-1} \\
& \quad (5.13) \qquad\qquad (3.08) \\
& - .007\, \nabla s_t - .007\, \nabla s_{t-1} \\
& \quad (3.32) \qquad (3.39) \\
& + .186 \nabla c_t + .214\, \nabla x_{t-1} \\
& \quad (2.87) \qquad (3.30) \\
& + .031 REGDUM + \varepsilon_t \\
& \quad (7.38)
\end{aligned}
$$

Adj. R^2 = .74; est. period = 1964:IQ to 1986:IVQ,

where s is our alternative measure of opportunity cost, c is personal consumption expenditures, x is thrift deposits (including other checkables, MMDAs, savings deposits, small and large time deposits, and term RPs), and *REGDUM* is a qualitative variable that equals zero in all quarters except 1983:IQ, when it equals one.[10] Because thrift restructuring has been ongoing since 1988, and because we seek to avoid high influence points given the substantial changes in the industry since that time, equation (4) is estimated before the thrift crisis (1964:IQ to 1986:IVQ) and simulated through 1990. All parameters are significant at the 5 percent level or better.

■ **7** A second problem is that the Federal Reserve and the OTS neither collect the same information on their surveys nor compute the aggregate rate for M2 deposits in the same manner. The OTS computes an aggregate rate for each type of deposit at thrift institutions. This is calculated by asking for the "most common rate paid" on a given type of account and weighting that rate by the *total number of deposits* at the entire institution, not by deposits in the given type of account. This method implicitly assumes that every thrift has a similar distribution of deposits. The Federal Reserve, on the other hand, weights its aggregate rates by the amount of deposits in the given type of account—a more accurate method of computing weighted averages. However, the own rate is calculated using both OTS and Federal Reserve data.

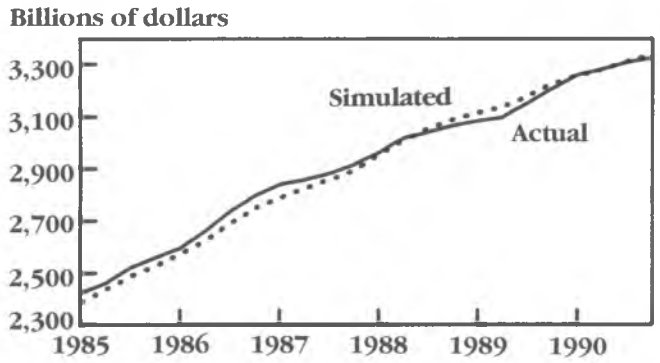
■ **8** We also looked at the thrift share of the deposit market as a proxy for deposit pricing effects. Although this variable enters significantly in some models of money demand, it is not significant here.

■ **9** An underlying assumption is that pricing strategies persist over several quarters. This persistence is reflected in the strength (weakness) of thrift deposit growth relative to M2 growth, and accounts for the unique information when both variables are included in the regression.

■ **10** Following the practice of MPS, we present results that approximate s using a first-order Taylor series expansion (Taylog) when the opportunity cost is less than 0.5. We also estimate the model using the simple log of opportunity cost. While the simple measure improves the in-sample fit, out-of-sample simulations are less favorable. Nevertheless, the usefulness of the Taylog transformation remains an open issue, though beyond the scope of this study.

FIGURE 3

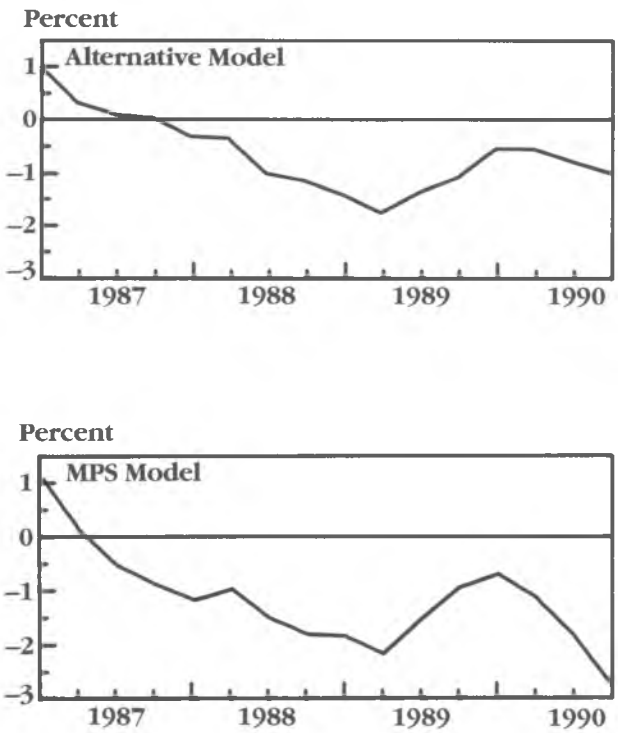
Simulated and Actual M2: Estimation Period = 1964:IQ – 1989:IVQ



SOURCE: Simulations based on authors' model.

FIGURE 4

Simulation Residuals: Estimation Period = 1964:IQ – 1986:IVQ



SOURCE: Simulations based on authors' and MPS's models.

Figure 2 illustrates that although the model overpredicts M2 growth in 1989, the gap narrows in 1990. When we extend the estimation period through 1989:IVQ, the adjusted R^2 increases further, to 0.77, and the out-of-sample simulation errors become smaller (see figure 3).

The measure of opportunity cost discussed above appears superior to the measure calculated by MPS, improving fit and out-of-sample simulation performance.[11] Changes in the estimates of the opportunity cost variable coefficients show that the choice of opportunity cost measure is also important. When the alternative rate is used, the coefficients for each of the opportunity cost variables—the first difference, the lagged difference, and the lagged level of opportunity cost—increase in absolute value, indicating that those variables explain a larger share of the changes in M2.

The change in thrift deposits is also highly significant, both before and after 1986. When this variable is excluded from the model, out-of-sample simulation errors cumulate substantially after 1988. Moreover, the lagged thrift variable clearly adds something that the lagged change in M2 does not explain. This suggests that the thrift variable is capturing potential effects related to the thrift restructuring, and is consistent with the hypothesis that our thrift variable is capturing part of the skewness of the own-rate distribution.

Our equation compares favorably with that of MPS (see appendix). Improvement in fit is substantial, from 0.68 to 0.74, and as figure 4 indicates, the bias in the MPS model appears to be widening. More important, the stability of our model does not rely on the inclusion of numerous qualitative variables. Indeed, we account only for the temporary effect caused by the watershed of regulatory changes that occurred in 1983. To test for stability before and after 1983, we employ a Chow test and reject the hypothesis that the parameters have changed.

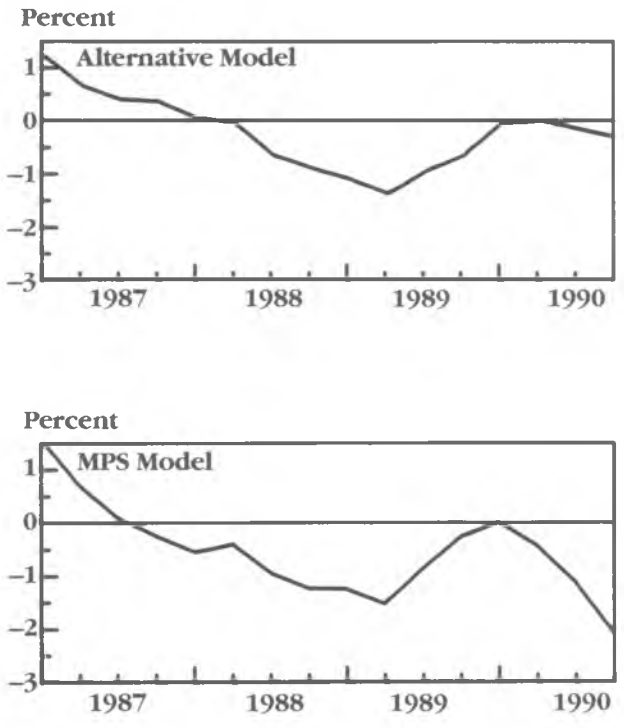
Figure 5 compares the simulation residuals for the two models when the sample periods are extended through 1989:IVQ. Note that both models improve. The 1990 errors are negligible in the alternative model, while the MPS model continues to underpredict M2 growth.

To assess the robustness of our thrift proxy, we examine the stability of its coefficient as the sample size is varied. Figure 6A illustrates the estimated value of the sample (bounded by two standard deviations) as the sample size is increased by one quarter, beginning with 1985:IQ

■ **11** We estimate the model without the thrift variable for the period 1964:IQ to 1986:IVQ. Although the in-sample fit is only marginally better for the MPS measure, the average out-of-sample bias is 57 percent higher.

FIGURE 5

Simulation Residuals: Estimation Period = 1964:IQ – 1989:IVQ



SOURCE: Simulations based on authors' and MPS's models.

to 1989:IVQ and moving backward in time. Although the coefficient does vary to some extent, it tends to stabilize as the sample is increased and is never statistically insignificant.

To see how important the most recent experience is, we repeat this experiment with an initial sample period of 1982:IQ to 1986:IVQ (see figure 6B). The results, while not as favorable, illustrate the relative stability of the thrift factor as a determinant of money demand. However, our findings also suggest that the influence of the recent data is relatively substantial.

Finally, figure 6C shows the value of the coefficient for an initial estimation period of 1964:IQ to 1968:IVQ, and for each quarter forward. The coefficient begins to stabilize in the early to middle 1970s. This finding is consistent with the hypothesis that the thrift deposit change may proxy for deposit pricing skewness. Prior to this time, deposit-rate competition for funds was largely constrained by Regulation Q. In 1973, however, regulators began to erode this constraint by introducing exempt deposit instruments such as "wild card CDs."[12]

V. Summary and Conclusions

We investigate two hypotheses that may explain the unexpected slowness in M2 growth. First, we attempt to measure more accurately an aggregate opportunity cost of M2. The results suggest that some share of small time deposits is more likely to be a substitute for instruments with maturities of longer than three months. Although the alternative measure is a crude approximation of an "ideal" aggregate, it improves the fit of the model substantially.

Second, we explore potential effects of the change in thrift deposits on the adjustment of money demand to its long-run equilibrium level. Although the economic foundations of the latter hypothesis may be unclear, our preliminary analysis suggests that the inclusion of lagged thrift deposit growth in the error-correction equation helps to account for the weakness in M2. The thrift variable's statistical significance in estimation periods predating the recent restructuring is surprising and needs to be explained.

We are encouraged by the out-of-sample performance of our model and believe that further improvements can be made in the measurement of opportunity cost. Our results are consistent both with the hypothesis that thrift restructuring has played a role in the recent weakness of M2 and with the belief that the restructuring will have only a minimal effect on long-run velocity.

This study also highlights the difficulty that policymakers face in choosing the appropriate target for M2. Our findings suggest that desired M2 growth should be conditioned on expectations concerning the continued effect of thrift restructuring, as well as on future movements in the term structure of interest rates. The analysis does not address how to predict the behavior of these conditioning factors, however.

Appendix: The MPS Money Demand Model

The MPS model, like the one described above, is an error-correction model that assumes a long-run velocity following a constant, but nonzero, trend.[13] The regression and estimated coefficients are given in box 1 on page 10.

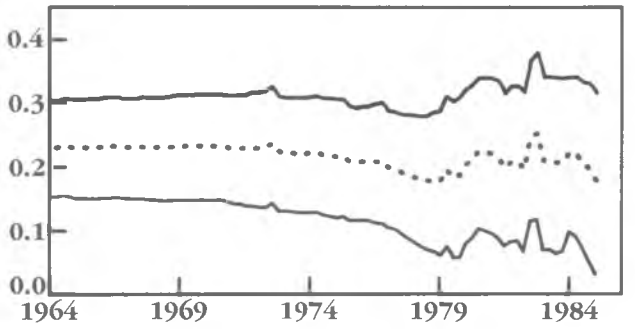
■ **12** For an analysis of the competitive implications of this exempt instrument, see Kane (1978).

■ **13** Much of this discussion is based on Small and Porter (1989).

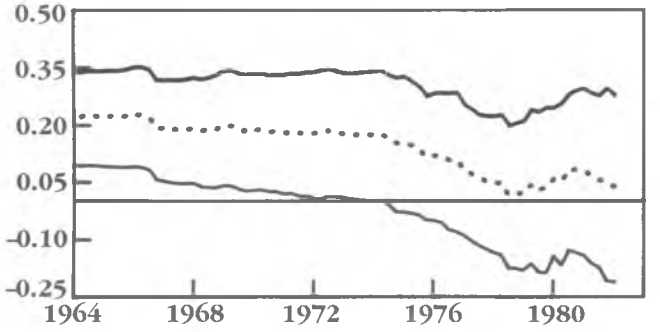
FIGURE 6

Coefficient of the Thrift Variable

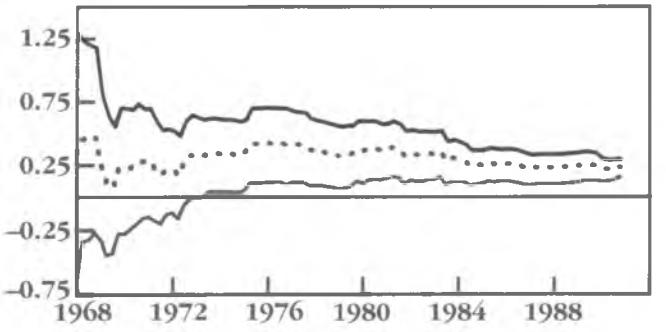
A. ESTIMATED FOR EACH PERIOD BACKWARD FROM 1985:IQ TO 1989:IVQ



B. ESTIMATED FOR EACH PERIOD BACKWARD FROM 1982:IQ TO 1986:IVQ



C. ESTIMATED FOR EACH PERIOD FORWARD FROM 1964:IQ TO 1968:IVQ



—— Plus two standard deviations
—— Minus two standard deviations

SOURCE: Simulations based on authors' model.

MPS specify the long-run equilibrium money demand function as

$$m_t = \alpha + y_t + \beta s_t + \gamma T_t + e_t,$$

where $m_t = \log(M2)$, $y_t = \log(\textit{nominal GNP})$, $s = \log(\textit{opportunity cost})$, and T = time. This specification allows M2 velocity to drift over time, although the estimated coefficient indicates that this drift is negligible in the short run. Since MMDA in the adjustment equation is essentially an intercept shift variable, the statistical significance of its coefficient can be interpreted as a one-time downward shift in the M2 velocity trend.

In addition to imposing convergence of long-run equilibrium through the error-correction term, MPS also impose a short-run "convergence" restriction that requires the sum of the coefficients of $\nabla\log(M2_{t-1})$, $\nabla\log(\textit{Consump}_t)$, $\nabla\log(\textit{Consump}_{t-1})$, and $\nabla\log(\textit{Consump}_{t-2})$ to equal one.

There are a number of other differences between the MPS model and ours. Aside from differences in the measurement of opportunity cost, MPS include variables that are not employed in our new specification of money demand, specifically, *DUM83Q2*, $\nabla\log(\textit{Consump}_{t-1})$, $\nabla\log(\textit{Consump}_{t-2})$, *Time*, ∇*CCDUM*, and *MMDA*. We tested the restriction on the sum of the coefficients on consumption and M2 variables, but since the restriction was not statistically justifiable, we did not impose it in our specification. In addition, the coefficients on *MMDA* and *Time* became statistically insignificant under our specification. Thus, our results are consistent with the hypothesis that, in the long run, M2 velocity depends only on its opportunity cost.

While both models fit reasonably well during the estimation period, the new specification behaves better out of sample, yielding smaller forecast errors. In addition, our model is less reliant on hard-to-predict dummy variables whose effects are unlikely to be permanent with respect to the growth rate of M2.

BOX 1

MPS Model and Estimated Coefficients

$$\nabla \log(M2_t) = \underset{(5.55)}{-.076} + \underset{(6.04)}{.508}\,\nabla\log(M2_{t-1}) - \underset{(-2.57)}{.000077}\,Time$$

$$- \underset{(-6.25)}{.010}\,\text{Taylog}(Opp_{t-1}) - \underset{(-5.60)}{.185}\,[\log(M2_{t-1}) - \log(GNP_{t-1})]$$

$$+ \underset{(3.89)}{.288}\,\nabla\log(Consump_t) + \underset{(1.64)}{.120}\,\nabla\log(Consump_{t-1})$$

$$+ \underset{(1.37)}{.085}\,\nabla\log(Consump_{t-2}) - \underset{(-5.56)}{.0089}\,\nabla\text{Taylog}(Opp_t)$$

$$+ \underset{(2.43)}{.0056}\,MMDA - \underset{(-2.86)}{.0103}\,\nabla CCDUM$$

$$+ \underset{(5.64)}{.0271}\,DUM83Q1 - \underset{(-1.36)}{.0075}\,DUM83Q2$$

Adj. R^2 = .68; estimation period = 1964:IQ to 1986:IIQ.

Taylog :	The natural logarithm of values greater than 50 basis points and the linear approximation of those values less than 50 basis points.
Time :	Time trend, which increases by one each quarter.
Opp :	Opportunity cost of M2.
Consump :	Personal consumption expenditure.
MMDA :	Dummy variable used to denote the permanent shift in money growth resulting from the introduction of money market deposit accounts. It takes the value zero before 1983:IQ and one thereafter.
CCDUM :	Dummy variable to correct for credit controls in place in 1980:IIQ. It takes the value one in 1980:IIQ, zero otherwise.
DUM83Q1:	Dummy variable to correct for the short-run shock to M2 caused by deregulation, which led to the introduction of MMDAs and negotiable order of withdrawal (NOW) accounts. It takes the value one in 1983:IQ, zero otherwise.
DUM83Q2:	Dummy variable to correct for the second quarter in which NOW accounts were allowed. It takes the value one in 1983:IIQ, zero otherwise.

NOTE: *T*-statistics are in parentheses.

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Central-Bank Intervention: Recent Literature, Continuing Controversy

by Owen F. Humpage

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Introduction

Since the inception of floating exchange rates nearly 20 years ago, governments have refused to give private markets free reign in determining the exchange values of their currencies. They have instead bought and sold foreign exchange in an attempt to influence the path of exchange rates or to reduce the volatility of exchange rates around that path. Nearly all governments contend that intervention is effective. Less certain—and fundamental in the continuing debate about intervention—is whether central banks can separate intervention from their overall monetary policies and have it remain an effective tool for influencing exchange rates.

If nations could successfully intervene without altering their monetary bases (sterilized intervention), then any country could manipulate its exchange rate without jeopardizing price stability, and any group of countries could coordinate its exchange-rate goals without sacrificing monetary sovereignty. If, instead, intervention is effective only when it induces a change in the monetary base or, possibly, when it signals future changes in monetary policies, then one must weigh the merits of attempting to influence exchange rates against the potential conflicts with domestic monetary policy objectives.

This paper surveys theoretical arguments and recent empirical literature bearing on this controversy. Two conclusions emerge: First, the recent literature offers some threads of evidence to support the view that intervention can sometimes influence market expectations and exchange rates. Nevertheless, these threads cannot be woven into a strong fabric of support for an active intervention policy, whereby central banks acquire huge portfolios, enter markets frequently, and undertake large, sterilized transactions. I find little evidence to support interventions of the type that the Group of Three Countries (G3)—West Germany, Japan, and the United States—undertook in late 1985, mid-1987, and 1989. Instead, the evidence suggests that under rather specific and unusual circumstances, sterilized intervention might temporarily influence exchange rates. Second, I find that exchange-rate intervention and price stability are not always incompatible, but they can be difficult to combine.

BOX 1

Sterilized and Nonsterilized Intervention

Monetary Authority's Balance Sheet	
Assets	**Liabilities**
Net Foreign Assets	**Monetary Base**
Gold	Currency held by the public
Foreign exchange	Reserves
SDR	
Net position in IMF	
Domestic Assets	**Net Worth**
Government securities	
Loans to depository institutions	
Other	

The table above, which presents a stylized balance sheet for a hypothetical central bank, helps to illustrate the important distinction between sterilized and nonsterilized intervention. On the asset side of the ledger are net foreign assets (*NFA*), which consist of foreign reserves less liabilities to foreign officials, and domestic assets (*DA*), which consist primarily of loans to depository institutions and government securities. On the liability side of the ledger is the monetary base (*MB*). Assume that net worth is zero. Then both sides of the ledger will balance such that

$$NFA + DA = MB.$$

When a central bank intervenes in the foreign exchange market, it buys or sells foreign assets (*NFA*) in exchange for its domestic currency. The transaction increases the nation's monetary base, in keeping with the balance-sheet identity:

$$\Delta MB = \Delta NFA.$$

The change in the monetary base leads to a multiple expansion of the nation's money stock. This intervention is nonsterilized. Notice that it is similar to a domestic open-market transaction, except that it is undertaken with foreign exchange rather than with government securities.

The monetary authority can offset the impact of this intervention on the monetary base, or sterilize it, by undertaking offsetting transactions with other assets. Typically, central banks do this by selling government securities or by altering their lending to depository institutions until

$$\Delta MB = -\Delta DA.$$

If nations undertake intervention in close consultation, all governments could sterilize intervention in a similar manner.

The process of intervening, especially if that intervention is completely sterilized, will change the mix of foreign and domestic assets held by central banks. Correspondingly, sterilized central-bank intervention must change the mix of domestic and foreign governmental assets held by the public.

I. Monetary Policy and Intervention

From an academic perspective, the distinction between sterilized and nonsterilized intervention, upon which this controversy ultimately focuses, is straightforward, if not trivial. A central bank can easily stabilize its monetary base, despite any exchange-market activity, by undertaking countervailing transactions through open-market operations or through other conventional monetary policy instruments. Nonsterilized intervention involves no monetary offset and differs from a typical monetary policy transaction only in that a central bank alters its monetary base through a change in its foreign asset holdings rather than through a change in its domestic asset holdings (see box 1).

Despite its academic clarity, the practical distinction between sterilized and nonsterilized intervention is neither obvious nor simple. Most countries, including the United States, claim to sterilize their intervention, but do so in the sense of not allowing their foreign exchange transactions to interfere with monetary policy goals, which may include an exchange-rate objective. When these countries factor exchange-rate targets into their monetary policy objectives, they need not offset their intervention activities currency unit per currency unit to conform with this definition of sterilized intervention. Although U.S. officials and many others accept this definition of sterilized intervention, it seems to violate the spirit of the term, because it no longer offers a means of pursuing independent exchange-rate and domestic monetary policy objectives. Throughout this paper, I define intervention as central-bank actions to influence exchange rates, and I define monetary policy only in terms of domestic price stability.

None of the G3 countries completely divorces its intervention activities from its domestic monetary policies; these countries either occasionally adopt exchange-rate targets for their monetary policies, or they do not always completely sterilize their intervention. Pauls (1990, p. 901), for example, observes, "During times when the dollar's exchange value raised particular concern—1977–79, 1984–85, and 1987—it became a significant factor in Federal Reserve decisions regarding monetary policy." Furlong (1989) also shows that FOMC directives from 1986 through 1988 gave substantial weight to exchange rates. Although the United States routinely sterilizes its intervention, in accordance with the definition mentioned in the previous paragraph, it does

not completely separate its exchange-rate and monetary policies.

In a recent article, Neumann and von Hagen (1991) show that the German Bundesbank has often permitted deviations between actual money growth and targeted money growth because of exchange-rate considerations. Following von Hagen (1989), they also argue that when the mark is strong against both the dollar and the Exchange-Rate-Mechanism currencies, the Bundesbank does not permanently sterilize its intervention.[1]

The situation is similar for Japan. Hutchison (1988) indicates that the Bank of Japan factored an exchange-rate objective into its monetary policy decisions between 1978 and 1985, and Takagi (1989) shows that since late 1985, the Bank of Japan has allowed intervention to affect its monetary base.

II. Intervention and Exchange Rates

Economic theory suggests three linkages between intervention and exchange rates, which differ in their implications for sterilized intervention. Only one of these, the portfolio-adjustment channel, allows completely sterilized intervention to affect exchange rates permanently. Through a second mechanism, the signaling channel, intervention can influence market expectations and, thereby, exchange rates. The literature presents two versions of signaling. According to the first, intervention might supplement monetary policy by strengthening a central bank's credibility with respect to its stated monetary policy objectives. According to the second version, if exchange markets are not informationally efficient, intervention that improves the flow of information might influence exchange rates. Central banks could sterilize such intervention, but the effect would be temporary. A third channel, the monetary channel, views intervention as a type of open-market operation that, by definition, does not admit even temporary sterilization.

Portfolio Adjustment

By sterilizing intervention through open-market transactions, central banks change the relative supplies of publicly held government debt. A sterilized intervention to depreciate the dollar, for example, increases the amount of publicly held U.S. Treasury securities. Under certain circumstances, such changes in asset stocks affect exchange rates.

According to the asset-market approach to exchange-rate determination, risk-averse investors diversify their portfolios across assets denominated in different currencies.[2] At equilibrium, the expected nominal returns on domestic and foreign assets are equal. Equation (1) represents this in logarithmic form:

$$(1) \qquad r_t = r_t^* - f_t + s_t,$$

where r_t and r_t^* are one-period domestic and foreign interest rates, respectively; f_t is the current forward exchange rate for delivery one period ahead; and s_t is the current spot exchange rate (foreign currency units per domestic currency units).

If investors form their expectations rationally and view domestic and foreign assets as perfect substitutes, the forward exchange rate will equal the expected future exchange rate. If, however, investors believe that domestic and foreign assets have different risk characteristics, then the forward exchange rate will differ from the future expected exchange rate by a risk premium. Let

$$(2) \qquad f_t = E(s_{t+1}) - \theta,$$

which defines the domestic asset as the relatively risky asset. Under the assumption that domestic and foreign assets are imperfect substitutes, the equilibrium condition becomes

$$(3) \qquad r_t = r_t^* - E(s_{t+1}) + s_t + \theta.$$

As equation (3) indicates, investors compare the return on a domestic asset with the return on a foreign asset, which includes the interest earnings, the expected change in the exchange rate over the holding period, and a risk premium, θ. Rearranging equation (3), one can express the risk premium in terms of the interest-rate differential and the expected change in the exchange rate:

$$(4) \qquad \theta = (r_t - r_t^*) + [E(s_{t+1}) - s_t].$$

Although economists lack a widely accepted theoretical model of the risk premium, most express it, among other things, as a positive

■ 1 See also Kahn and Jacobson (1989) and, for a somewhat different opinion, Obstfeld (1983).

■ 2 Edison (1990), Humpage (1986), Obstfeld (1988), and Weber (1986) discuss this channel.

function of relative asset supplies.[3] When the relative supply of a country's assets increases, we expect that the risk premium on those assets also increases. Either a widening interest-rate differential, or a widening spread between the expected future exchange rate and the current spot exchange rate, or both, can accommodate a rise in the risk premium, as equation (4) indicates.

The exact mix of interest-rate and exchange-rate adjustments associated with a change in the risk premium would seem important for evaluating sterilized intervention. That both interest rates and the expected exchange rate could change is entirely plausible (Obstfeld [1988]). Many studies, however, assume that because sterilized intervention leaves the monetary base unchanged, it also does not affect interest rates (Edison [1990]). Still others assume that the market determines the expected future exchange rate exogenously, so that sterilized intervention affects only the spot exchange rate. Although these are testable assumptions, no studies explicitly address them. A policy to depreciate the dollar could conceivably put upward pressure on domestic interest rates.[4]

Economists have not investigated the influence of intervention on the underlying components of the risk premium, because generally they have found little evidence that intervention operates through this channel. Researchers typically conclude that risk premiums exist and that they vary through time, but they have not succeeded in relating these changes to relative asset supplies.[5] With near unanimity, researchers have found the relationship to be either statistically insignificant or quantitatively unimportant. Three notable exceptions are Kearney and MacDonald (1986), who study intervention in Great Britain and attribute their findings in part to capital controls during the estimation period, Dominguez and Frankel (1989), and Dominguez (1990a). The last two studies, which look at the heavy intervention by West Germany, Japan, and the United States during the 1980s, are particularly interesting. Using a two-equation, simultaneous system (discussed later), Dominguez and Frankel find statistical evidence of portfolio effects, which could have practical relevance under some conditions. Studying a similar period, however, Humpage and Osterberg (1990) find mixed evidence of portfolio effects, but none of the coefficients seem large (see appendix).

In attempting to explain the empirical evidence, many economists observe that intervention volumes are too small relative to the outstanding stock of publicly held assets to have a perceptible impact on portfolio decisions and exchange rates. The total stock of publicly held U.S. government securities, for example, was nearly $2.3 trillion at the end of 1989. U.S. intervention amounted to $22 billion that year, a record volume, but it was less than 1 percent of the total stock of publicly held U.S. securities. Even if dollar interventions of the other 10 major industrial countries are included, the total amount represents only about 3 percent of the total stock of publicly held debt.[6]

Empirical research on risk premiums is subject to another qualification that is important for understanding intervention. Studies of risk premiums assume that exchange markets are rational in the sense of using all available information and of not making systematic forecast errors. Under this assumption, the market's failure to exploit all profitable interest-arbitrage opportunities must reflect a risk premium, not market inefficiencies. Recent work on expectations, discussed below, casts doubt on the validity of this assumption. If exchange markets are not perfectly efficient, what empirical studies interpret as a time-varying risk premium could instead reflect market inefficiencies. This would open another door through which intervention might affect exchange rates.

Signaling

Without a portfolio-adjustment effect, sterilized intervention will not affect exchange rates permanently. Nevertheless, central banks might maintain some temporary leverage in the market if they could improve the flow of information to the market and influence market expectations. Some economists have suggested that sterilized intervention functions as such.

When making exchange-rate quotations, perfectly efficient traders incorporate all available information, including their best guess about future policy developments. Reflecting this process, economists typically specify the exchange rate as a function both of contemporaneous fundamentals and of the expected future change in the exchange rate:

■ **3** See Hodrick (1987) for a comprehensive survey of the literature and Osterberg (1989) for a theoretical model that explicitly includes intervention.

■ **4** The results of Dominguez (1990b) raise interesting questions with respect to this issue (see appendix).

■ **5** Edison (1990) presents an excellent annotated bibliography that covers portfolio-adjustment models.

■ **6** See Ghosh (1989), Hutchison (1984), and Loopesko (1984).

$$(5) \qquad s_t = z_t + \beta [E(s_{t+1} - s_t | \Omega_t)],$$

where s_t is the current spot exchange rate; z_t represents a linear combination of fundamentals; $[E(s_{t+1} - s_t | \Omega_t)]$ is the expected change in the exchange rate conditional on all information currently available, Ω_t; and β is the elasticity of the current exchange rate with respect to expectations. Solving equation (5) by successively substituting in future values of the spot exchange rate, one obtains

$$(6) \qquad s_t = (1 + \beta)^{-1} \sum_{i=1}^{\infty} (\beta/1 + \beta)^i E(z_{t+i} | \Omega_t),$$

which shows the spot exchange rate as the discounted sum of expected future values of the fundamentals.

Defining the relevant set of fundamentals is not an issue here. In general, economists employ factors that influence the supply and demand of domestic and foreign money.[7] For the purposes of this paper, equation (6) is important because it highlights the role of new information and expectations in determining exchange rates, and illustrates that intervention can affect current spot exchange rates if it provides information about fundamentals. Two such scenarios seem plausible: Through intervention, a central bank could reveal priority information about unanticipated changes in monetary policy to an otherwise perfectly efficient market.[8] Or, ignoring the possibility of priority information, a central bank might enhance the informational efficiency of the private sector through intervention, if it enjoyed unique economies in the acquisition and processing of publicly available information. I consider both of these cases below.

New Information

According to many economists, if sterilized intervention purchases (sales) of dollars create the expectation that the Federal Reserve System will tighten (ease) monetary policy, the dollar will appreciate (depreciate) as a result. Two recent studies focus directly on this mechanism and cast doubt on its universal applicability. Dominguez (1988), for example, reports evidence that following the October 1979 change in Federal Reserve operating procedures, the System signaled its intention to offset unanticipated money changes through intervention and that this intervention subsequently influenced exchange rates. Over two adjacent time periods, she found no evidence for signaling. Studying a more recent period, Klein and Rosengren (1991) conclude that neither the Federal Reserve nor the Bundesbank used intervention as a signal of policy changes. They did find, however, that coordinated intervention significantly affected daily exchange rates between the Group of Five Countries' (G5) Plaza meeting in September 1985 and the Group of Seven Countries' (G7) Tokyo meeting in May 1986, but at no later period.[9] Unilateral U.S. intervention also affected the exchange rate between the Tokyo meeting and the Louvre meeting in February 1987. The authors conclude that markets initially read intervention as a signal, but eventually learned that it was not intended as such.

If intervention is to affect exchange rates in a signaling context, it must provide new information about credible changes in future monetary policies. These studies suggest that intervention, at best, has fulfilled this task only once since the late 1970s. Perhaps we should expect this. Policy changes are not exogenous. Officials react to the state of the economy and to exchange markets in broadly discernible fashions, and private markets offer rewards to those who learn to predict those reactions accurately. When the market learns how central banks react, the scope for signaling diminishes. This limits the extent to which central banks can signal with intervention.

Why Signal with Intervention?

The signaling aspect of intervention is provocative not only for the possible channel of influence it portends, but also because of a question it raises: What possible signaling advantage does intervention have over a simple announcement of future policy intentions? Often, as already indicated, studies of intervention find a significant relationship after the Plaza meeting of the G5.[10]

■ **7** For a recent discussion, see Meese (1990).

■ **8** In most countries, the Treasury or the Ministry of Finance ultimately controls exchange-market intervention. Conceivably, intervention could then signal changes in fiscal policies. Given both the relative inflexibility of fiscal policy and the uncertainty about the effects of fiscal policy on exchange rates, I discount this possibility and discuss only monetary policy signals.

■ **9** The Group of Five Countries (G5) are France, West Germany, Japan, the United Kingdom, and the United States. The Group of Seven Countries (G7) are the G5 plus Canada and Italy.

■ **10** See also Marston (1988) for a discussion of signaling and a comparison of intervention after the Plaza period with intervention during the 1978 Carter dollar-defense period.

The dollar, however, began to fall against the mark and yen prior to the meeting, in anticipation of possible policy changes. Immediately after the meeting, the dollar fell precipitously, even before the major central banks began intervening. Through the subsequent days and weeks, as I indicate in a previous paper (Humpage [1988]), the dollar's day-to-day movements were not correlated with day-to-day intervention. Instead, the dollar responded to expectations generated by policy announcements and not to official currency transactions. When policymakers no longer reinforced or validated expectations of policy changes to promote a dollar depreciation, the dollar's decline slowed.

In attempting to explain the signaling mechanism, many economists have argued that the importance of intervention centers not on its ability to herald policy changes, but on its ability to cement governments' commitment to those policy changes.[11] Even when governments announce an optimal policy today, they can face incentives to renege on that policy tomorrow. Markets, of course, realize this and factor into their expectations the likelihood that policymakers will not follow through on their pronouncements. Policies allowing no opportunity for backing down, consequently, can have very different effects than similar policies that permit reneging.

To understand the role that intervention might play in cementing credibility, consider an example in which the Federal Reserve System tightens monetary policy to eliminate inflation and to prevent a continuing dollar depreciation. Markets recognize that political pressure will weigh on the System if, even temporarily, real interest rates rise and unemployment results. This possibility will temper market expectations. Intervention, however, increases the costs of reneging on an announced monetary policy change. Through intervention, the System acquires a short position in foreign currencies and a long position in dollars. Should it not subsequently tighten monetary policy sufficiently to appreciate the dollar, the dollar value of its foreign-currency debts will rise relative to its dollar assets. The United States will experience losses on its foreign-currency portfolio, which could have budgetary implications and could prove politically embarrassing.[12]

The importance of intervention profits in influencing central-bank monetary policy seems related to their size. Table 1 lists the reported Federal Reserve System profits from its foreign-exchange operations since 1975.[13] This table includes both realized profits, which reflect actual currency transactions, and unrealized profits, which result from currency swings that alter the value of foreign-exchange inventories.

Judging from the pattern and size of past profits, intervention probably has not significantly influenced the costs of reneging on Federal Reserve policy. Although on balance the System has shown a profit, it reported losses for 10 of the 15 years listed in the table without obvious political fallout. The reason is that balances associated with intervention have typically been small relative to profits remitted to the Treasury (usually less than 10 percent) and are only a trivial component of overall federal budget receipts (typically less than 2.5 percent).

In recent years, however, the System's portfolio of foreign currencies has increased sharply. To accommodate the rise, the Federal Open Market Committee increased the System's authorization for holding a net open position in foreign exchange to $25 billion in early 1990 from $12 billion in early 1989. This steep rise in holdings of foreign currency has greatly increased the chances of substantial unrealized losses should the dollar appreciate sharply.[14] The swings in profits could reach levels at which their practical significance might become important. As Obstfeld (1988, p. 43) notes, when the federal budget deficit is large, even marginal contributions become significant. The extent to which such considerations might influence monetary policy in the United States is unclear.

Signals and International Cooperation

Intervention might not provide a credible signal of future monetary policy in a particular country, but it could indicate to the market and to the participating governments the willingness of

■ **11** Dominguez distinguishes between signaling, as discussed above, and targeting, the sending of false signals. Because intervention leaves the monetary base unaffected, it allows central banks the opportunity to renege on policy. Central banks could not renege in this way very often without destroying their credibility, but in certain circumstances, sending false signals could prove effective. See Dominguez (1990b).

■ **12** As stated in Henderson (1984, p. 391), "... losses on foreign exchange positions can lead to significant political problems for the authorities. Thus, if the authorities undertake an intervention policy which would generate foreign exchange losses if their pronouncements about future monetary policy were not put into effect, there might be more reason for private agents to take these pronouncements seriously."

■ **13** Table 1 contains published data. Leahy (1989) attempts to capture the opportunity costs of intervention profits more closely.

■ **14** Leahy (1989) suggests how large portfolios make profits sensitive to exchange-rate changes.

TABLE 1

Federal Reserve Profits from Foreign Exchange Operations and Their Relationship to Treasury Receipts[a]

Year	Federal Reserve Profits[b]	Payments to Treasury	Ratio of Profits to Treasury Payments	Total Receipts[c]	Ratio of Payments to Total Receipts
1975	$-241.8	$ 5,382.1	-4.49 %	$280,642	1.92 %
1976	-25.1	5,870.5	-0.43	318,508	1.84
1977	-146.4	5,937.1	-2.47	365,199	1.63
1978	-505.7	7,005.8	-7.22	416,110	1.68
1979	-3.7	9,278.6	-0.04	480,526	1.93
1980	96.1	11,706.4	0.82	533,017	2.20
1981	-306.0	14,023.7	-2.18	622,485	2.25
1982	-149.6	15,204.6	-0.98	608,822	2.50
1983	-456.3	14,228.8	-3.21	612,915	2.32
1984	-454.8	16,054.1	-2.83	683,209	2.35
1985[d]	1,210.0	17,796.5	6.80	745,084	2.39
1986[d]	1,970.0	17,803.5	11.07	781,869	2.28
1987	1,804.3	17,738.9	10.17	868,996	2.04
1988	-510.9	17,364.3	-2.94	925,979	1.88
1989	1,204.2	21,646.4	5.56	979,923	2.21

a. Profits, payments, and receipts are expressed in millions of dollars.
b. Includes realized and unrealized profits.
c. Total of off-budget and on-budget items.
d. Unrealized profits; total profits not reported as a separate item.
SOURCES: "Income and Expenses of Federal Reserve Banks," Board of Governors of the Federal Reserve System, *Annual Report*, years 1975–1989; and "On-budget and Off-budget Receipts by Source," Table FFO-2, Department of the Treasury, *Treasury Bulletin*, years 1975–1989.

countries to coordinate their macroeconomic policy. Coordinated intervention could enhance the credibility of an announced coordinated monetary policy, because it might indicate that other countries found the proposed policy change appropriate and that they would not attempt to offset the exchange-rate implications. Indeed, some empirical results suggest that coordinated intervention is more effective than unilateral intervention. Dominguez (1988), for example, provides evidence in favor of this case. Moreover, Klein and Rosengren (1991) find a larger effect from coordinated intervention. Loopesko (1984), despite somewhat less conclusive results, finds that coordinated West German intervention had a significantly different effect than noncoordinated intervention. Humpage (1989) and Humpage and Osterberg (1990), on the other hand, could not attach special significance to coordination.

In a similar vein, intervention could provide a quick, simple, and relatively inexpensive way for countries to signal to one another their continuing willingness to coordinate macroeconomic policies. Game theoreticians recognize that players will often act in a cooperative manner, even without a formal enforcement mechanism, if each perceives cooperation to be to his advantage and if each believes that the others will not revert to a noncooperative behavior. Formal enforcement structures do not exist to ensure international macroeconomic policy coordination. One might then view intervention as a signal to other countries, not of a future policy change, but of an ongoing commitment to previously agreed-upon policy changes; that is, a signal that the intervening country will not revert to noncooperative behavior.

The G5 Plaza accord in September 1985, for example, focused on eliminating current account imbalances in West Germany, Japan, and the United States, with the implication that these countries would undertake appropriate macroeconomic policies. Given the lack of evidence in support of prolonged sterilized intervention, one might view the subsequent intervention, at least in part, as a signal to do just that. By late October of that year, however, the United States and

West Germany were not reinforcing the G5 agreement with additional policy changes, and by November, both countries expressed concern about the underlying implications of the G5 initiatives for their domestic monetary policies. Joint intervention ended in early November, and the United States refrained from intervening until early 1987. During 1986, despite some joint changes in discount rates, international policy was not undertaken cooperatively. As Frankel (1990, p. 24) notes, "... [James] Baker was repeatedly quoted in the press as 'talking the dollar down,' in large part as a weapon to induce the trading partners to cut interest rates."

Market Inefficiency

Economists characterize exchange markets as informationally efficient, because traders face strong incentives to consider all available information. Nevertheless, a sufficient amount of anecdotal and empirical evidence suggests that exchange markets are not perfectly efficient. If central banks enjoy an informational advantage, they may intervene and improve market efficiency.

Grossman and Stiglitz (1980) argue that if information is costly to discover and to transmit, exchange rates sometimes must reflect informational inefficiencies. These inefficiencies explain the sizable expenditures and frequent large profits of leading market participants. Hung (1991a) contends that many market participants do not base their trades on generally recognized economic determinants of exchange rates. Instead, so-called noise traders assess recent exchange-rate trends or "psychological factors," whose long-term economic significance is not always obvious. Hung states that because noise traders use broadly similar techniques and often respond to the same news, they can sometimes dominate exchange markets, creating bandwagon effects and moving the exchange rate away from levels consistent with economic fundamentals. Although such activities create profit opportunities for those who trade on fundamentals, Hung notes that, in the short term at least, the potential rewards might not be great enough to justify the costs and the risks.

A number of empirical studies also suggest that information inefficiencies do exist. Loopesko (1984), in an early study of daily intervention, finds that lagged independent and dependent variables help to explain day-to-day unexploited arbitrage profits. This suggests inefficiency in the processing of information. More recently, in an important study that questions the rationality of exchange-market expectations, Frankel and Froot (1987) find evidence that survey respondents exhibit biased expectations and that bandwagon effects exist, but are stabilizing. In an extension of this work that uses more-detailed survey data, Ito (1990) determines that individuals and industries hold dissimilar expectations about future exchange-rate movements, and that industrial groups exhibit "wishful thinking" with respect to forecasts. His results question the assumption that expectations are formed rationally and lend further support to the view that bandwagon effects occur in the short run. Also analogous in opening a role for intervention, but not strictly the same, other investigators note the possible existence of multiple exchange-rate equilibria, of exchange-rate overshooting, and of bubbles, even allowing for rational expectations.

The existence of temporary informational inefficiencies could create an occasion when central-bank intervention might improve the functioning of exchange markets, even without priority information about future monetary policies. Monetary authorities have long recognized this possibility. According to the Jurgensen Report (1983, p. 21), "The authorities in each of the Summit countries at times undertook large scale intervention when they judged that market participants had not taken full account of fundamental factors, [or] had only reacted slowly to changes in fundamentals...." Official exchange transactions following the G5 meeting at the Plaza in September 1985 adopted this view; delegates characterized exchange rates as inconsistent with underlying fundamentals.

For intervention to improve exchange markets by dampening or eliminating near-term exchange-rate deviations from their equilibrium paths, central banks must have timely and precise information about market fundamentals and their relationship to exchange rates. Otherwise, the central banks could not determine that exchange-rate movements represented a deviation from equilibrium rather than an adjustment to a new equilibrium. As already noted, attempts to relate market fundamentals to exchange rates have not been very successful.

Although inefficiencies may exist in the short run, persistent deviations from equilibrium eventually will create profit opportunities sufficient enough to offset the risks for those who trade on fundamentals. Little empirical evidence exists to suggest that short-term inefficiencies disrupt trade or investment flows. Many economists claim to have identified periods (such as 1984) when exchange rates departed from

fundamental levels and disrupted trade, but such cases are exceptional.

Hung (1991a, 1991b) also notes that to offset market inefficiencies, central banks must have timely information about the trading strategies of noise traders and should conduct their operations in secrecy. Humpage (1984) suggests that knowledge of official intervention can have destabilizing effects if the market interprets intervention purchases of dollars, for example, as evidence that the dollar is fundamentally weak. This seems possible in the case of noise trading. Hung theorizes that central banks undertake such intervention in secrecy, because if they convince the noise traders that private participants are affecting the market trend, then the noise traders might sustain the exchange-rate movement.

These comments imply that the occasions on which a central bank might successfully exploit market inefficiencies are probably rare. They do not belie the possibility that intervention could operate through such a channel. Indeed, some preliminary papers by Dominguez and Frankel (1989), Dominguez (1990a), and Hung (1991b) offer tentative support. All of these papers incorporate survey data, which have shown informational inefficiencies in exchange markets, and they all find some evidence that intervention can significantly affect exchange rates.

Dominguez and Frankel estimate a two-equation simultaneous system that includes a portfolio-adjustment equation. As noted previously, they also find a significant influence through the portfolio channel. In evaluating the quantitative significance of their results, they suggest that this channel alone might not be important, but when combined with an effect on expectations, the magnitude of the influence could become decisive.

Hung (1991b) regresses unexpected exchange-rate changes on numerous "news" variables and on U.S. intervention cumulated over the survey horizon. After deriving expected volatility from currency-option prices, she also regresses unexpected changes in exchange-rate volatility on the news variables and on intervention. Hung's results are mixed, but do show significant exchange-rate effects.

General Observations on the Empirical Evidence

An appendix to this paper briefly summarizes recent literature covering G3 intervention. These studies lend some support to signaling, in the sense that they all find periodic correlations among the relevant variables. What they do not find is a persistent relationship between intervention and exchange rates across time periods.

As Meese (1990) notes, economists have enjoyed little success in specifying a reliable model of exchange-rate determination. This limits our conclusions about the efficacy of intervention, especially sterilized intervention. In addition, virtually none of the work on intervention derives from solid structural models, incorporating theoretical interactions among intervention, investors' portfolios, central-bank monetary policies, or expectations.[15] The results are consistent with many stories about how intervention works and how failure to find an influence might reflect an inadequate specification. The task of evaluating intervention would be much easier if we had reliable guides to the equilibrium path of exchange rates and to the formulation of expectations.[16]

The lack of a strong model increases the danger that any observed relationship between intervention and exchange rates could depend on factors not directly measured in the experiment: statements by officials, the degree of market uncertainty, the state of the economy at home and abroad, other domestic policies, or international agreements on policy. This is particularly true with high-frequency data, since most economic variables are not measured more frequently than monthly. Often, these conditions and events in themselves enhance the credibility of policy announcements or convey information. If other factors are sometimes correlated with intervention, one might easily observe periodic, short-lived effects on exchange rates. Our ability to draw inferences about signaling from such correlations is limited.

Nonsterilized Intervention

Although sterilized intervention could temporarily affect exchange rates under some rather unusual circumstances, central banks must link their exchange-rate objectives with their monetary policies in order to influence rates regularly and permanently. Most central banks, including the Federal Reserve System, at times seem to operate in this fashion, either by not fully sterilizing their intervention or by occasionally adopting exchange-rate objectives for their monetary

■ **15** See Osterberg (1989) for a model of the risk premium that specifically introduces intervention.

■ **16** This paragraph reflects comments from Bonnie Loopesko.

policies. This section considers the possible conflicts that nonsterilized intervention can cause.[17]

Marston (1985) provides a comprehensive review of stabilization policy, indicating how different assumptions about the formulation of expectations, allowances for wage indexing, inclusions of wealth, and the extent of asset substitutability modify conclusions about exchange-rate policies drawn from small open-economy macroeconomic models. Although the qualifications and permutations are extensive, some general conclusions pertain to discussions of the appropriateness of nonsterilized intervention.

Most notably, Marston's survey shows that less exchange-rate flexibility promotes overall price stability only when temporary, domestic monetary (or financial) shocks predominate. In this case, using nonsterilized intervention to smooth exchange rates will not conflict with price stability, because monetary shocks raise or lower prices as they depreciate or appreciate a nation's currency.[18]

When real economic shocks predominate, however, greater exchange-rate flexibility promotes overall price stability, although the case seems weaker for supply shocks than for demand shocks.[19] Under such circumstances, attempting to smooth exchange rates might actually increase the price movements necessary to compensate for the shocks, because flexible rates aid price movements in eliminating excess supply or demand. Moreover, in responding to real shocks, intervention might reduce the credibility of a central bank's long-term commitment to price stability, by demonstrating that central banks would compromise that objective.

Marston's survey also weakens the argument that floating exchange rates insulate an economy from foreign shocks, by showing the large number of possible ways that exchange-rate changes might transmit these shocks. Nevertheless, his survey does not argue that fixed rates and intervention are superior to floating exchange rates on this score.

Given that no single exchange-rate regime promotes stability in all cases, a hybrid exchange-rate regime, with the degree of intervention contingent on the predominant nature of shocks, might seem optimal. Such would indeed be the case in a world where the central bank had perfect information about the nature of economic disturbances. Unfortunately, economists disagree on whether monetary or real shocks have been primarily responsible for the variation in real and nominal exchange rates since the early 1970s. Even in cases where monetary shocks predominate, the proper intervention response is not clear. Central banks should smooth exchange-rate movements in some cases and accentuate them in others.

The richness of Marston's survey suggests, whether intentionally or not, that economists do not agree on a specific variant of the open-economy macroeconomic model.[20] Consequently, one cannot reach an unequivocal conclusion about the benefits of targeting exchange rates with monetary policy. At best, the literature offers a qualified recommendation for nonsterilized intervention when a domestically produced disturbance is clearly monetary in nature. Such instances do occur and are sometimes readily discernible. In the 1977–79 period, for example, the dollar depreciated sharply as U.S. inflation accelerated relative to inflation abroad and as markets lost confidence in our willingness to eliminate it. A monetary contraction would have promoted a stronger dollar and stable prices.

III. The Implications for Policy

Economists have offered various theoretical arguments in support of sterilized intervention. Some researchers have found statistically significant and, at times, quantitatively important relationships between intervention and exchange rates. I have argued that this evidence does not endorse an active intervention policy, as the G3 countries have often conducted in recent years.

The empirical evidence generally does not find an economically significant relationship between the risk premium and intervention, as required by the portfolio-adjustment theory. This finding suggests that intervention, at least in volumes typically observed, cannot permanently alter exchange rates, independent of monetary policy. Central banks must weigh exchange-rate objectives in tandem with their inflation objectives.

Similarly, I question the idea that central-bank intervention provides a credible market signal of future policy intentions. Central banks do not generally seem to operate in this manner, and intervention does not have an obvious

■ **17** For an interesting discussion of nonsterilized intervention, expectations, and target zones, see Klein (1989) and Klein and Lewis (1991).

■ **18** Glick and Hutchison (1990) provide an easy-to-read exposition, which uses a simple model.

■ **19** See Glick and Hutchison (1990).

■ **20** See also Frankel and Rockett (1988).

comparative advantage over other methods of ensuring monetary policy credibility. Most important, such intervention cannot remain sterilized and effective; it does not constitute an independent policy instrument.

One might interpret the portfolio-adjustment and the monetary-signal arguments for intervention as requiring much larger magnitudes of intervention. The United States, for example, has built up its foreign-exchange reserves since the early 1980s to approximately $42 billion. While this might enhance our ability to intervene through these rather questionable channels, it also greatly increases our exposure to foreign-exchange losses.

Intervention, however, might play a role in international macroeconomic policy coordination, serving as a signal of continuing cooperation. Countries may not even intend such intervention primarily to influence exchange rates, although such an effect could be a desired side benefit. Although I know of no research specifically directed at this issue, the hypothesis is not inconsistent with recent patterns of intervention. It also may explain the interest in coordinated intervention, which other theories of intervention do not require, except to reduce the overall costs.

A recent body of literature suggests that foreign-exchange markets are at times informationally inefficient and that intervention, by improving market efficiency, could influence exchange rates. Indeed, some of the most interesting recent empirical support is consistent with this explanation. Nevertheless, how important are these inefficiencies? Do they obviously disrupt international commerce? Do central banks regularly meet the informational requirements to exploit this situation successfully? At best, this literature seems to support relatively small, secretive interventions under conditions of extreme market disorder.

Although the scope for affecting exchange rates through sterilized intervention seems narrow, nearly all economists recognize that countries can influence nominal exchange rates through their monetary policies. The literature indicates, however, that nonsterilized intervention can conflict with domestic price stability. Only when domestic monetary shocks create exchange-market disturbances will intervention remain consistent with price stability. Although this observation justifies targeting exchange rates with monetary policy under certain circumstances, it does not justify pursuing that policy through currency purchases in the exchange market, rather than through typical open-market operations. A small country lacking well-developed secondary markets in government bonds might find such intervention useful for conducting its monetary policy. The Swiss have traditionally conducted monetary policy through foreign-exchange purchases. Nevertheless, the benefits to larger countries, such as West Germany, Japan, and the United States, are not apparent.

Appendix: Studies of Recent G3 Intervention

This appendix summarizes recent empirical studies of U.S., West German, and Japanese intervention. One can interpret the results as broadly relating to a signaling approach, either because they incorporate high-frequency data or because their methodology suggests this approach. Edison (1990) presents a comprehensive survey of intervention literature, including earlier papers, research on the portfolio-adjustment mechanism, and research on intervention profits.

Humpage (1984) investigates dollar–mark interventions by the United States and other major developed countries for a one-year period following President Carter's November 1, 1978, intervention efforts. Using simultaneous Box–Jenkins techniques, he finds that both unanticipated U.S. intervention against marks and unanticipated foreign intervention against dollars were significantly correlated with the closing exchange rate. The results, however, suggest that official dollar purchases resulted in a dollar depreciation. The coefficients were economically insignificant. The reaction function suggests that central banks attempted to smooth exchange-rate movements, or leaned against the wind.

Loopesko (1984) finds that lagged, cumulative intervention was related to changes in ex-post arbitrage profits in 11 out of 24 cases. The strongest evidence is for Canadian dollars, West German marks, Japanese yen, and French francs in sample periods extending from late 1978 through 1981. This supports the portfolio-adjustment channel. Moreover, lagged exchange rates or profits were significant in about 21 of the cases, implying less-than-perfect market efficiency. In some cases for West Germany (when passive intervention was eliminated from the data), the effect of coordinated intervention was different from the effect of uncoordinated intervention.

In a unique and interesting paper, Dominguez (1988) studies the ability of intervention to signal monetary policy intentions between January 1977 and February 1981. She regresses

intervention on unanticipated money, which she calculates using survey data, and also regresses exchange-rate changes on intervention. Following the Volcker shift in operating procedures in October 1979, intervention signaled the Fed's intention to offset unanticipated fluctuations in money. This intervention bore a significant and correctly signed relationship to the exchange rate, suggesting that the market believed the signal. The results for the Carter–Miller anti-inflation period, beginning in November 1978, and for the Carter–Volcker credit control period, beginning in March 1980, do not support the signaling hypothesis.

Humpage (1989) looks at U.S. intervention, measured with dummy variables, from August 1984 through August 1987 and finds only three instances when intervention clearly affected exchange rates. In all cases, the association was with the first official transaction after a period of no intervention and followed an unusual event or announcement. This intervention also tended to lean *with* the wind. The impact seemed short-lived and not associated with subsequent official transactions following the initial intervention. Using actual intervention data instead of dummy variables over similar time periods, Humpage (1989) reexamines these findings. The only difference is that initial intervention sometimes appeared significant even if not associated with an unusual event or policy announcement. A distinction between coordinated and unilateral intervention was not important. These coefficient estimates could contain a simultaneity bias.

Dominguez and Frankel (1989) estimate a two-equation simultaneous system that considers both signaling and portfolio-adjustment channels over two subperiods: November 1982 to October 1984 and October 1984 to December 1987. The models use survey data for values of expected future exchange rates. The portfolio equation considers intervention both in absolute terms and relative to wealth. The researchers either cumulated intervention over the expectations horizon or from the start of the sample, or entered the individual intervention prior to the survey measure. The evidence offers support to the portfolio channel.

A second equation models expectations as extrapolations from past exchange-rate changes, but includes a dummy variable for reported "news" of any official actions to affect the exchange rate and a measure of reported intervention (the intervention series times the news dummy). Both of these intervention variables often prove significant, but the news dummy does so more often. The authors' quantitative analysis of the results suggests that intervention that has only a portfolio effect is quantitatively insignificant, but intervention that also alters expectations can be quantitatively significant.

Dominguez and Frankel focus on U.S. and West German intervention to affect dollar–mark exchange rates, because Japanese intervention data were not available. Dominguez (1990a) extends this work by including U.S. and Japanese intervention to affect the dollar–yen exchange rate from January 1985 to December 1988. The results were broadly similar.

Dominguez (1990b) investigates intervention and ex-post arbitrage profits from January 1985 to December 1987. Various subperiods show different results with respect to the significance and the sign of the coefficients for unilateral and coordinated intervention. Overall, however, coordinated intervention is more apt to show a significant and correctly signed coefficient than is unilateral intervention. Sometimes, notably in the G5 period (September through December 1985), the coefficient on coordinated intervention appears to exert an economically significant effect.

Although these conclusions hold for overnight transactions, they appear more often over one-month and three-month investment horizons. When the results hold only for the longer horizons, intervention dollar sales (purchases) must raise (lower) domestic interest rates, lower (raise) foreign interest rates, or appreciate (depreciate) the future exchange rate, but do not affect the spot exchange rate.

Humpage and Osterberg (1990), using a generalized autoregressive conditional heteroscedasticity (GARCH) model, examine the effects of daily U.S., West German, and Japanese intervention on ex-post arbitrage profits from January 3, 1983, to February 19, 1990. Following Loopesko (1984), they find cumulative intervention associated with a very small, significant increase in the mark–dollar risk premium, but find cumulative intervention in the yen–dollar market to be insignificant. The variance equation does not include cumulative intervention. Following Dominguez (1988), they differentiate between coordinated and unilateral intervention, and do not cumulate the data. Coordinated intervention was not significant in any mean or variance equations, nor was unilateral West German intervention. Unilateral Japanese intervention was significant in the mean with the wrong sign, and in the variance with a positive coefficient. Unilateral U.S. intervention was not significant in the mark–dollar equations, but was

significant in the yen–dollar, conditional-variance equation with a negative coefficient.

Building on theoretical arguments for intervention when noise trading persists, Hung (1991b) investigates the impact of U.S. intervention on both the level and volatility of exchange rates. She regresses unexpected exchange-rate changes on net intervention cumulative up to the realization of the expectation, and on four common news variables: unanticipated trade deficits, unemployment results, producer-price inflation, and changes in interest-rate differentials. Hung measures volatility by the standard deviation of exchange rates over two-week intervals and regresses unexpected exchange-rate volatility on the news variables and on cumulative gross intervention. (Hung estimates expected exchange-rate volatility from option prices.) The tests span two subperiods: December 1984 to December 1986, and January 1987 to December 1989. The results are mixed. U.S. intervention affects the yen exchange rate in both subperiods and influences the mark in the second period. U.S. intervention lowers exchange-rate volatility in the first period, but otherwise raises volatility. Hung interprets the disparate results as indicating that the effectiveness of intervention depends on market conditions and on the skill of those intervening.

Klein and Rosengren (1991) consider intervention from the September 1985 Plaza agreement to the October 1979 stock-market crash, proxying official transactions with dummies based on newspaper accounts. Interventions did *not* precede monetary policy changes with sufficient frequency to suggest that the United States or West Germany intended them as a signal of future monetary policy changes. Nevertheless, coordinated intervention did have a statistically significant and correctly signed impact on daily exchange-rate changes between the Plaza and Tokyo (May 1986) summits. Unilateral U.S. intervention influenced the exchange rate between the Tokyo and Louvre summits. Klein and Rosengren conclude that the market initially thought of intervention as a policy signal, but soon learned that central banks were not using it as such.

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A Regional Perspective on the Credit View

by Katherine A. Samolyk

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Introduction

Although the last decade ushered in the longest peacetime expansion of the modern era, it also saw a precipitous rise in the number of bank failures. More than half of the banks that have been declared insolvent since the Federal Deposit Insurance Corporation was founded in 1933 failed during the 1980s. Given the current trend toward deregulation, the structure of the financial services industry has come under intense scrutiny. More recently, the Federal Reserve System has been concerned about how the poor health of the banking industry may be affecting the supply of credit and thereby depressing economic activity.

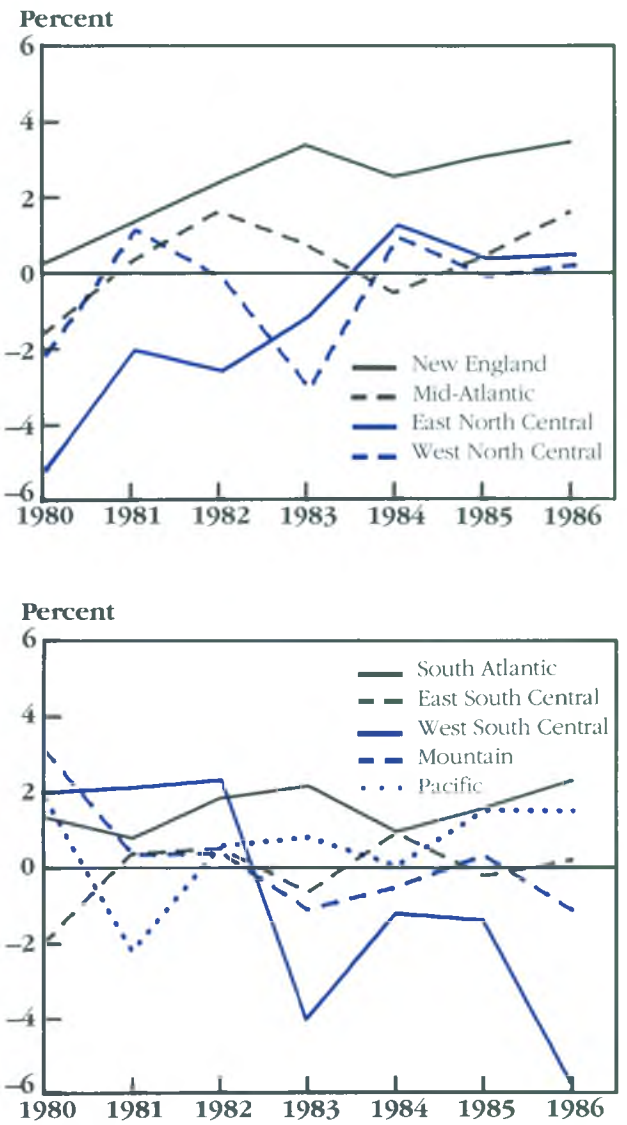
Concerns about a credit crunch are paralleled by macroeconomists' increasing interest in understanding the relationship between the financial sector and the real sector. The notion that credit-market activity may affect real economic activity has come to be known as the *credit view*. According to this view, credit markets are important in determining the allocation of resources in an economy for two simple reasons. First, individuals with profitable investment projects may not have the financial resources to fund their ventures themselves. Investors with financial capital do not have complete information about these investment projects and face costs associated with monitoring their performance. Consequently, investors will impose more stringent credit terms, such as higher interest rates or higher collateral requirements, on less creditworthy borrowers to compensate for expected monitoring costs.

Second, this view also posits that financial intermediaries (hereafter referred to as banks) improve the efficiency of credit markets by identifying, funding, and monitoring the performance of profitable investment projects. However, much of the information produced by banks is confidential, so they must be monitored as well. This implies that the ability to fund risky ventures is affected by the creditworthiness of banks, as measured by the financial health of their balance sheets. Because a less creditworthy bank is more likely to require monitoring, depositors will (and regulators should) impose more stringent credit requirements on the institution. Thus, the credit view posits that financial factors, such as the health of bank balance sheets, can affect the allocation of resources and the level of real economic activity.

The credit view may have important implications for nations that are characterized by

FIGURE 1

The Growth Rate of Real GSP Minus the Growth Rate of Real GNP



SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis.

diverse regional economies, such as the United States. When it is more costly to monitor the performance of risky ventures in regions outside the local sphere, credit markets may segment along regional dimensions. Thus, because local banks play an important role in funding local borrowers, the health of a region's banking sector may affect its ability to intermediate credit to local projects. In addition, features of state and federal financial regulatory systems, such as interstate banking restrictions, tend to magnify the effect of factors that impede the interregional flow of funds.

The regional dimensions of credit flows may be important in assessing the performance of regional economies. Credit markets may be a channel by which regional economic conditions can be propagated into the future. This credit view suggests that regional recessions may be prolonged because of the effect of poor economic performance on the creditworthiness of both local banks and nonbank borrowers and, hence, on the region's ability to attract the external finance needed to fund local investment activity. For example, capital-poor Boston banks may be unable to lend to a profitable-but-risky local biotechnology firm, while healthy Cleveland banks may choose not to invest in it because monitoring the firm is too costly. In the extreme case, the venture is not undertaken at all. Instead, resources in Cleveland are channeled to local investment projects with lower real returns — albeit projects with lower information costs.

Regional disparities in economic performance have been stark in recent years. Figure 1 depicts the difference between the growth rate of real gross state product (GSP) and the growth rate of real gross national product (GNP) for nine regions from 1980 to 1986. Likewise, credit problems, especially those impacting on the banking industry, have also varied considerably across regions. Failures of depository institutions have been concentrated in economically distressed areas. The most stark examples are the depressed farm belt and oil-producing regions in the mid-1980s, and more recently the Northeast. The credit view suggests that financial problems associated with regional recessions may make it more difficult for these areas to fund a recovery.

Despite the sharp disparities in regional economic conditions, most empirical studies have looked for a link between credit and economic activity at the national level. A significant credit channel at the regional level, however, may be obscured in tests that aggregate data across regions. Specifically, regional information costs may cause the relationship between financial-sector conditions and economic activity to be different for states experiencing economic difficulties than for those in an economic boom; thus, a cross-sectional approach may be better suited to testing for a credit channel in the United States.

This paper provides a first step in testing for whether there is a link between regional credit

markets and regional economic performance. State-level data between 1980 and 1986 are used to examine the relationship between state output growth (relative to national output growth) and several measures of regional credit health, including failed business liabilities, commercial bank loan-loss reserves, and the return on commercial bank equity. A pooled cross-sectional time-series approach is used to examine whether the relationship between financial conditions and economic performance differs for low-growth versus high-growth states.

The results yield evidence of a regional credit channel. Regional bank balance-sheet conditions are significantly related to the performance of regional economies. Moreover, there is a different relationship between credit health and economic growth in states experiencing slow output growth compared with those that are doing well.

I. A Regional Credit View

The regional credit view presented here examines the implications of an asymmetric distribution of information among investors and entrepreneurs for a regional economy.[1] It assumes that investors with financial capital do not have good information about entrepreneurs seeking funding. Thus, the creditworthiness of these borrowers — as measured by their collateral, the underlying project risks, and the costs of monitoring their contracts — affects the terms of credit and subsequently the mix of investments that are funded.[2] The credit view also assumes that banks improve the efficiency of capital markets by reducing the information costs associated with credit flows. Banks specialize in identifying and monitoring investment projects. They also diversify across many projects, thus reducing the costs that depositors must incur to monitor bank portfolios (in an unregulated financial system).[3] However, when banks cannot completely diversify portfolio risks that are costly to monitor, the creditworthiness of these institutions — as measured by their equity capital and the credit quality of their loan portfolios — affects their ability to fund risky investments.[4] An important implication of this view is that changes in bank creditworthiness can affect economic activity. Specifically, a deterioration of the internal wealth of banks (bank equity capital) can make it more costly for them to fund projects and thus can depress investment activity.

In a previous paper, Samolyk (1989), I present a formal model of how imperfect information can underlie a regional credit channel between local credit conditions and local investment activity. The model emphasizes the role of banks in funding investments and assumes that banks possess a specialized information technology that allows them to identify and monitor investment projects more efficiently than other individuals in credit markets. Unlike much theoretical literature that uses imperfect information to motivate financial structure, however, this analysis assumes that the economy is made up of regional economies that have different production technologies. The local production technologies have a random return, and the distribution of returns on local investment activity is assumed to exhibit diminishing marginal returns.

In each productive sector there are two types of individuals: bankers and lenders. Bankers possess an information technology for locating and monitoring specific real investment projects; lenders do not. Bankers obtain external finance to fund their portfolios of projects, produce information in locating and monitoring projects, and provide lenders with access to additional investment opportunities. As explained in Bernanke and Gertler (1987), local banks cannot perfectly diversify portfolio risk because the scale of an individual bank project is large relative to the size of a bank's portfolio. Therefore, the ability of banks to fund local investments is related to their financial health.

The model also assumes that monitoring costs are lower for local investments than for investments in other regions.[5] Thus, credit markets are regional because banks can use their technology most efficiently in making local investments. Banks can invest in other regions, but they face higher monitoring costs in doing so. These conditions imply that the cost of credit to local banks depends on their relative credit-

■ **1** See Gertler (1988) for a review of asymmetric information models of credit markets.

■ **2** The information costs associated with credit risks may even lead to the credit rationing of borrowers with profitable investment projects (see Williamson [1986]).

■ **3** In the extreme, when a bank can completely diversify individual credit risks, the amount of the bank's capital and the dispersion of its individual asset returns do not affect the ability to fund its portfolio (see Diamond [1984]).

■ **4** Bernanke and Gertler (1987) formally model the relationship between bank creditworthiness and the funding of specialized investment projects.

■ **5** These costs include the cost of monitoring both the ex ante distribution of investments and the ex post returns to projects undertaken.

worthiness as well as on the profitability of their investment projects.

Since expected monitoring costs rise as leveraged investment increases, while expected project returns exhibit diminishing marginal returns, an upper bound exists on the capacity of a region to fund risky investments externally, given its stock of internal financial capital. Regional balance-sheet conditions and the distribution of investment opportunities are therefore related to a region's financial capacity.

In this model, disparities in regional economic performance can be exacerbated by the impact of regional economic conditions on the creditworthiness of local banks. In areas experiencing a local recession, the resulting erosion in bank capital can prevent banks from funding profitable, albeit privately monitored, local projects that would be financed if information were costless. For example, consider an economy comprised of regions with independent but identical production possibilities. If half of the regions receive a poor investment return while the other half receive an above-average return, banks in ailing regions may find it more difficult to attract external finance to fund profitable new investment projects, even though banks in other regions are flush with funds. Thus, poor regional economic performance can be propagated into the future as the associated decline in creditworthiness hinders the ability of banks to fund a recovery.[6] This occurs because poor regional credit health precludes the use of local information about profitable investment opportunities.

Moreover, capital-rich sectors will invest in lower-yielding local projects as long as the return is greater than the cost-adjusted return associated with funding capital-poor regions. As a result, although national bank capital may not have changed, disparate regional credit health can cause the return from investment activity in the overall economy to be lower.[7] The impact of regional disparities in bank capital is greater than the impact of regional differences in other sources of funds because of banks' comparative efficiency in producing information about local investments.[8] Thus, this credit view also suggests that a link between credit conditions and economic activity at the regional level could be obscured in examining data aggregated at the national level.

II. Identifying a Financial Transmission Mechanism through Disaggregation

The notion that the financial system propagates economic fluctuations depends on how financial structure affects the allocation of resources. The imperfect-information view of a credit channel suggests that changes in the costs of supplying credit-market services can affect investment expenditures and output; thus, financial-sector performance can feed back to the real sector and exacerbate output fluctuations. However, empirical tests for a macroeconomic link between financial structure and economic activity have yielded inconclusive evidence of the existence of such a channel.[9]

The mixed evidence of the importance of financial performance for business fluctuations in studies using national-level data may reflect the difficulties inherent in finding proxies for financial services associated with the information costs that underlie the credit view. Tests for a credit channel to output often use credit flows and interest-rate measures to proxy for financial performance. These measures, however, are a reflection of financial capacity as well as expectations about future economic activity and hence about the profitability of real investment opportunities. Expectations about the distribution of future investment opportunities would affect credit flows even in a world of perfect information, where financial structure is irrelevant to the level and mix of investment activity.

Thus, concluding that these variables help to predict economic activity does not imply that they also cause economic activity. For example, the determination that lower growth in bank lending tends to precede a decline in economic activity may merely reflect a decrease in the profitability of investment opportunities (and, hence, a decrease in loan demand). Likewise, evidence of an increase in perceived credit risks, in the

■ 6 See Bernanke and Gertler (1989) for a theoretical model in which credit effects are strongest in distressed economies.

■ 7 In Samolyk (1989), I demonstrate how, when there is short-run immobility in information technology, regional imbalances both in entrepreneurial wealth and in the distribution of investment opportunities can affect the aggregate allocation of credit and aggregate future output relative to the allocation that would be feasible if regional information asymmetries did not exist.

■ 8 This result generalizes to any firm that produces information in funding local ventures, including other types of financial intermediaries as well as local entrepreneurs who have access to direct credit markets.

■ 9 See Gertler (1988) for a survey of these studies.

form of larger default-risk premiums, is not unambiguously indicative of financial-market frictions, because it is difficult to identify whether the premium is associated with higher monitoring costs or with a change in the underlying distributions of returns on risky real investment projects.

In a previous paper (Samolyk [1990]), I argue that it is the higher cost of finance associated with credit failures and reduced internal capital for future financing that may "cause" real activity to the extent that it magnifies output fluctuations. Debt default, because it reduces the entrepreneurial capital of both primary borrowers and financial intermediaries, may be a relevant channel by which financial-market performance can feed back and affect economic activity. I find that, controlling for monetary conditions and lagged economic activity, past insolvencies are significantly related to real output.[10]

The regional credit view presented here has implications for empirically testing for a credit channel. First, because it implies that the allocation of credit is affected by a region's creditworthiness, it recommends the use of variables related to the health of regional financial balance sheets (such as debt in default) as financial proxies. In addition, because a region's relative creditworthiness can affect its access to funds, the regional credit view suggests that there may be an asymmetric relationship between credit conditions and economic activity for creditworthy regions versus those that are poor credit risks; regional credit problems may constrain regional growth more than healthy credit markets may stimulate it. Thus, regional credit conditions may be significantly related to differences in regional economic performance in a way that would be obscured in examining data aggregated at the national level. To the extent that credit markets may be regional—whether a vestige of regulation or a feature of optimal industrial organization—a cross-sectional time-series approach may be better suited in testing for a credit channel.[11]

The Empirical Model

I estimate two types of reduced-form models of relative state output growth using annual state-level data from 1979 to 1986 (which span the most recent business cycle). Relative state output growth, y_t, the difference between the growth rate of real GSP and that of real GNP, is regressed on its own lagged value and on various lagged measures of state credit conditions. The first type of model specifies a log-linear relationship between credit conditions and relative state output growth of the general form

$$(1) \quad y_{i,t} = B_o y_{i,t-1} + \sum_{i=1} B_i \, CREDIT_{i,t-1} + e,$$

where all explanatory variables are lagged one year and *CREDIT* is the set of proxies for state credit conditions included in the regression.

The second type of model includes interactive dummy variables for all explanatory variables to test whether there is a significantly different relationship between credit conditions and output in low-growth versus high-growth states. Regressions of this type are of the general form

$$(2) \quad y_{i,t} = C_o(H_o)\, y_{i,t-1} + \sum_{i=1} C_i\,(H_i)\, CREDIT_{i,t-1} + D_o(L_o)\, y_{i,t-1} + \sum_{i=1} D_i(L_i)\, CREDIT_{i,t-1} + e,$$

where H_o and H_i are dummy variables that equal one when $y_{i,t}$ is positive, and D_o and D_i are dummy variables that equal one when $y_{i,t}$ is strictly negative. This specification effectively splits the pooled sample into low-growth and high-growth observations.

The Credit Variables

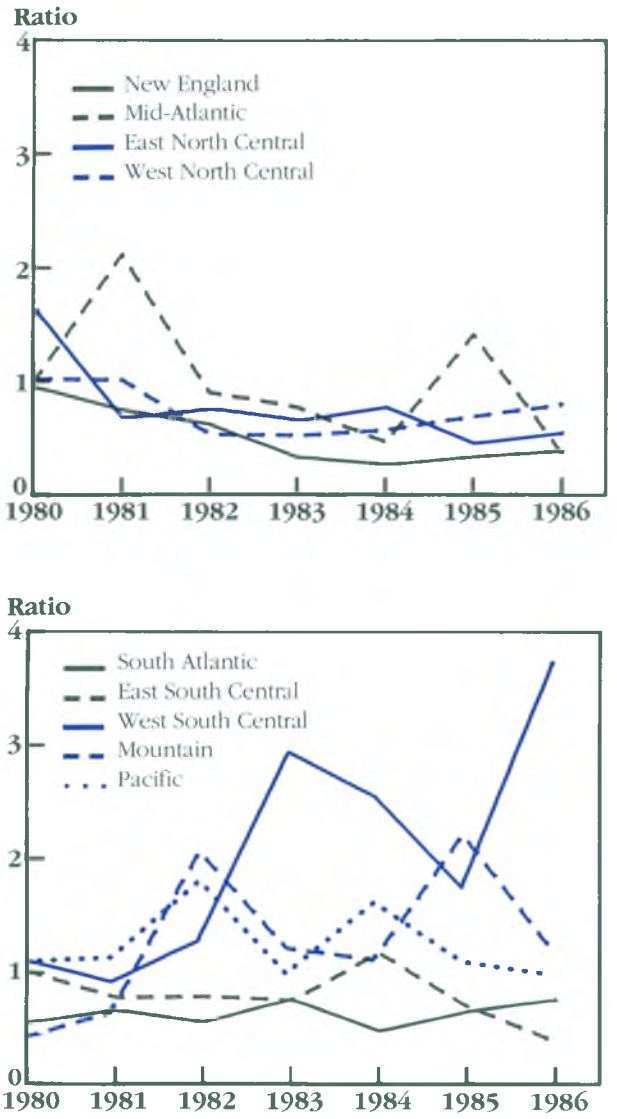
The credit view suggests that credit flows—while inherently reflecting expectations about the profitability of current real investment opportunities—may also be affected by the information costs associated with supplying external finance. I have not identified whether agency costs or underlying investment fundamentals drive financial flows. However, I attempt to control for expectations about future economic performance by including the growth rate of the constant-dollar volume of bank lending (*GLOAN*) as a credit proxy that is relatively forward-looking, as opposed to balance-sheet measures that capture the quality of existing credit. State-level data on the nominal stock of end-of-year bank loans outstanding were obtained from the Federal Finan-

■ **10** This study is related to Bernanke's (1983) study of the Great Depression.

■ **11** Although this asymmetry implies that regional credit imbalance could be a drag on aggregate economic growth, this paper tests for a regional credit channel rather than for whether regional credit imbalances can, in fact, help to explain aggregate economic activity.

FIGURE 2

Ratio of Failed Business Liabilities to GSP (Scaled by the National Ratio)



SOURCES: Dun and Bradstreet Corporation; and U.S. Department of Commerce, Bureau of Economic Analysis.

cial Institutions Examination Council's Reports of Condition and Income (call reports) and were deflated by the GSP deflator.

Other financial proxies, more directly related to the ex post creditworthiness of both bank and nonbank business borrowers as a result of past financial decisions, are included in each specification. I include these proxies to test whether, when controlling for real loan growth (expectations about the future) and past relative output growth, they significantly help to explain the relative growth of state output.

I use Dun and Bradstreet state-level annual data on the volume of failed liabilities associated with business failures to measure the overall creditworthiness of business borrowers. Business failures that occur in a given year are related to the flow of credit in default; thus, their numbers are related both to bankruptcy costs and to changes in the stock of entrepreneurial capital. The business failure series does not include firms that voluntarily discontinued operations with no loss to creditors, but only those that are legally insolvent.[12] A higher level of business liabilities in default should increase the cost of credit to entrepreneurs and reduce future economic activity.

To control for differences in the size of state economies, the volume of failed business liabilities was scaled by GSP.[13] The log of this ratio was included in all regressions. Figure 2 illustrates the regional differences in this variable, depicting the ratio of failed business liabilities to GSP (deflated by the national ratio) for nine regions. During the 1980s, the volume of bad credit relative to income increased for the U.S. economy as a whole. For regions such as the oil-producing states, however, credit problems were reflected in a substantially greater deterioration in business balance sheets.

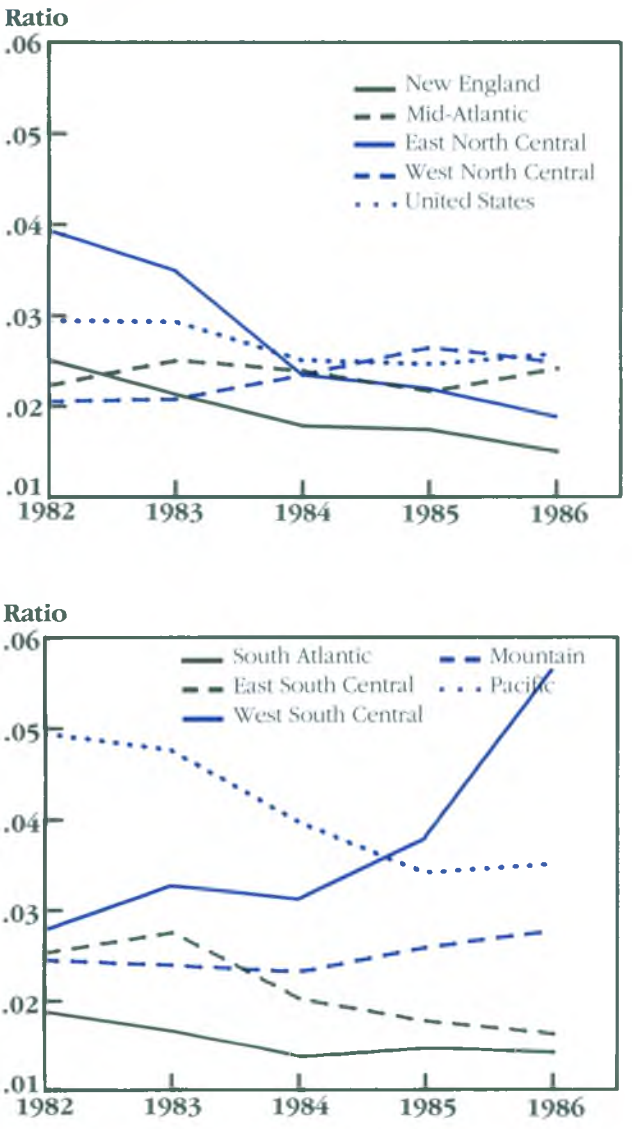
A regional credit view that emphasizes the role of banks in funding local projects implies that bank equity capital reflects bank creditworthiness because it is the buffer between the performance of bank loan portfolios and insolvency. However, bank equity capital is a poor proxy for bank creditworthiness because, like capital on any corporate balance sheet, it is not a market valuation of the present value of firm ownership. Such a valuation would reflect expectations about the quality of the current loan portfolio, including the return on the loan portfolio, the volume of loans in default, and the degree of default on bad loans. Instead, the measures of the creditworthiness of local banking sectors came from state-level call report data on loan quality and bank profitability. These include loan loss reserves, nonperforming loans (defined as loans 90 days past due and still accruing, plus nonaccruing loans) as a share of total loans, and the ratio of net income to bank equity

■ **12** It should be noted, however, that legal insolvency — the inability to service debt liabilities — may reflect balance-sheet illiquidity rather than economic insolvency. The inability to obtain credit may reflect expectations about the profitability of future local investment opportunities.

■ **13** This ratio measures the flow of bad debt relative to the flow of income available for debt service.

FIGURE 3

Ratio of Nonperforming Loans to Total Loans



SOURCE: Board of Governors of the Federal Reserve System.

capital. The latter measure — the ex post return on bank equity (*ROE*) — is positively related to bank creditworthiness, as it represents the potential growth of internally generated bank capital.[14]

Provisions for loan loss reserves should reflect assessments of the degree of default on the current portfolio and thus on the credit quality of current loans outstanding. Given the promised yields on existing loans, larger loan loss reserves correspond to a lower return on existing assets. Therefore, the growth rate of loan loss reserves deflated by the GSP deflator (*GLOANLOSS*) was included in the regressions as a proxy for expected default losses on existing loan portfolios.

Nonperforming loans should reflect the share of the loan portfolio that is currently in default, but do not necessarily indicate the degree of default. Nonperforming loans, like failed business liabilities, reflect realizations of credit performance rather than expectations about future loan performance. The log of the ratio of nonperforming loans to total loans (*SNONPERF*) was included in some specifications as a proxy for the default rate on bank loans. Unfortunately, data on nonperforming loans are available only after 1981, so regressions using this series span only 1983 to 1986.

These problem-loan variables are important because they are related to the market values of both bank assets and bank capital—and hence to the creditworthiness of banks as borrowers today. The credit view presented here suggests that these variables may affect the characteristics of future credit extended and the use of intermediation technology in making new loans. In addition, bad loans can also cause banks to abrogate existing credit relationships; therefore, banks must expend resources in seeking out new investment opportunities. The disparities in bank-credit problems across regions are shown in figure 3, which depicts the share of nonperforming loans to total loans by region, as well as the national share. Although the national share was flat over the sample period of 1983 to 1986, there were substantial differences in both the level and the trend across regions.

III. Empirical Evidence

Results were derived from pooled regressions using cross-sectional state data over the sample period of 1980 to 1986. Regressions including the nonperforming loan series had a sample period of 1983 to 1986.[15] The variables are

14 In choosing measures of financial distress for a state's banking sector, obvious choices are data on the number of and liabilities of failed banks. However, because many failed banks are merged, their balance sheets are included in call report data. Data on bank failures will be included in future extensions of this study.

15 The pooled cross-sectional time-series regressions were estimated using the Shazam statistical package, with the autocorrelation coefficient, *rho*, constrained to be zero for all states. Pooled regressions that did not restrict the autocorrelation coefficient to be zero (but also did not adjust estimates for the inclusion of lagged dependent variables) yielded near-zero estimates of *rho* and no significant difference in the results.

BOX 1

Notes on Statistical Tables[a]

GSPDIF: The growth rate of real gross state product minus the growth rate of real gross national product.
LGSPDIF: *GSPDIF*(–1) if *GSPDIF* < 0.
HGSPDIF: *GSPDIF*(–1) if *GSPDIF* ≥ 0.

GLOAN: The growth rate of commercial bank loans deflated by the GSP deflator.
LGLOAN: *GLOAN*(–1) if *GSPDIF* < 0.
HGLOAN: *GLOAN*(–1) if *GSPDIF* ≥ 0.

FLIAB: The log of the ratio of failed business liabilities to GSP.
LFLIAB: *FLIAB*(–1) if *GSPDIF* < 0.
HFLIAB: *FLIAB*(–1) if *GSPDIF* ≥ 0.

GLOANLOSS: The growth rate of loan loss reserves deflated by the GSP deflator.
LGLOANLOSS: *GLOANLOSS*(–1) if *GSPDIF* < 0.
HGLOANLOSS: *GLOANLOSS*(–1) if *GSPDIF* ≥ 0.

ROE: The ratio of net income to equity capital of commercial banks.
LROE: *ROE*(–1) if *GSPDIF* < 0.
HROE: *ROE*(–1) if *GSPDIF* ≥ 0.

SNONPERF: The log of the ratio of nonperforming loans to total loans for commercial banks.
LSNONPERF: *SNONPERF*(–1) if *GSPDIF* < 0.
HSNONPERF: *SNONPERF*(–1) if *GSPDIF* ≥ 0.

a. The term (–1) indicates a one-year lag.

defined in box 1. The relative growth rate of real GSP was regressed on its own lagged value and on the lagged values of the proxies for state balance-sheet conditions. To control somewhat for expectations about the profitability of local investment opportunities, all regressions include the lagged value of the growth rate of bank loans. Also, dummy variables testing for economywide fixed effects by year were included in each regression specification.

Estimates of equation (1) are presented in panel A of table 1. In these regressions, the relationship between credit conditions and output is restricted to be the same for low-growth and high-growth observations.

Panel B of table 1 presents the results for symmetric regressions including interactive dummies that allow the coefficients on the explanatory variables to be different for states experiencing low growth and high growth. These dummies split the sample and help to detemine whether there is a structurally different relationship between lagged credit conditions and current relative output growth for low-growth and high-growth observations.

In all regressions, the lagged dependent variable explains most of the current relative growth of state output. Interestingly, controlling for lagged credit conditions, the relationship is not significantly different for low-growth versus high-growth observations in any of the specifications estimated.

Alternatively, there is a significantly different relationship between lagged credit conditions and current relative output growth in every specification. This indicates that the financial balance-sheet conditions inherited from the past are related to real economic activity differently for states experiencing a relative boom than for those experiencing relatively low growth. Thus, comparing the results in panel A with those in panel B indicates that restricting the relationship between financial factors and economic activity to be the same across states independent of relative conditions — a restriction implicitly imposed in tests using macroeconomic data — may obscure a significant link between credit and output.

The split sample results yield some evidence that financial factors matter in a way that is consistent with the credit view discussed here. The structural differences are in the relationship of output to the lagged variables that proxy for inherited financial balance-sheet conditions.

The ratio of failed business liabilities to state output is a significant predictor of negative output growth primarily in low-growth states (table 1, specifications 2.A and 2.A′). However, when nonperforming loans and the return on bank equity capital are included, this asymmetric relationship is no longer evident. At the same time, reverse causality tests (table 2) indicate that there is a different relationship among failed business liabilities, the return on bank equity capital, and nonperforming loans in low- versus high-growth states. These results suggest that bank credit quality and bank earnings may reflect the impact of broader business financial conditions in low-growth states.

Lagged loan loss reserves are negatively related to output growth only in low-growth states. The coefficients on loan loss reserves are generally insignificant in high-growth states. This can be interpreted to indicate that past provisions for loan losses may be constraining credit availability in states experiencing low relative growth. Interestingly, reverse causality tests between loan loss reserves and the return on

TABLE 1

Results for Regressions Explaining Relative State Output Growth—Dependent Variable: *GSPDIF*

Panel A: Pooled Sample Results

	(1.A)	(1.B)	(1.A′)	(1.B′)	(1.C)	(1.D)
No. of observations	336	336	192	192	192	192
R^2	.3705	.3744	.4345	.4296	.3864	.3882
Log of likelihood function	846.925	847.081	500.824	500.479	497.797	498.195
GSPDIF(–1)	.515 (11.06)[a]	.513 (10.82)[a]	.429 (8.09)[a]	.433 (7.98)[a]	.449 (7.92)[a]	.442 (7.73)[a]
GLOAN(–1)	.008 (2.29)[b]	.008 (2.18)[b]	.013 (2.65)[a]	.013 (2.42)[a]	.013 (1.83)[b]	.012 (1.64)
FLIAB(–1)	–.006 (–4.97)[a]	–.006 (–4.86)[a]	–.006 (–6.99)[a]	–.005 (–5.81)[a]	–.005 (–4.55)[a]	–.005 (–4.49)[a]
GLOANLOSS(–1)	.003 (0.37)	.002 (0.30)	–.006 (–1.38)	–.007 (–1.45)	–.006 (–0.80)	–.006 (–0.71)
ROE(–1)	—	.011 (0.58)	—	.022 (0.89)	—	.027 (0.87)
SNONPERF(–1)	—	—	—	—	–.001 (–0.36)	–.0003 (–0.01)
Year dummies	Y80–Y86[a]	Y80–Y86[a]	Y83–Y86[a]	Y83–Y86[a]	Y83–Y86[a]	Y83–Y86[a]

Panel B: Split Sample Results

	(2.A)	(2.B)	(2.A′)	(2.B′)	(2.C)	(2.D)
No. of observations	336	336	192	192	192	192
R^2	.5096	.6960	.6255	.7388	.7310	.7392
Log of likelihood function	886.669	946.573	537.563	554.651	560.402	560.040
HGSPDIF	.476 (8.81)[a]	.293 (6.55)[a]	.349 (5.73)[a]	.252 (4.81)[a]	.270 (5.28)[a]	.260 (5.03)[a]
HGLOAN	–.001 (–0.30)	.002 (0.57)	–.004 (–0.33)	–.009 (–0.70)	–.027 (–2.02)[b]	–.023 (–1.72)[b]
HFLIAB	.0003 (0.09)	–.003 (–2.45)[a]	.001 (1.06)	–.001 (–0.45)	–.001 (–1.14)	–.001 (–1.08)
HGLOANLOSS	.025 (2.84)[a]	.0005 (0.06)	.011 (1.29)	.001 (0.07)	–.003 (–0.47)	.003 (0.45)
HROE	—	.081 (4.48)[a]	—	.133 (5.23)[a]	—	.026 (0.76)
HSNONPERF	—	—	—	—	–.010 (–3.81)[a]	–.009 (–2.80)[a]
LGSPDIF	.349 (4.87)[a]	.272 (4.63)[a]	.349 (4.06)[a]	.419 (5.69)[a,d]	.429 (5.66)[a,d]	.432 (5.73)[a,d]
LGLOAN	–.005 (–0.59)	–.008 (–0.96)	–.021 (–3.46)[a]	–.004 (–0.54)	.005 (0.70)[d]	.004 (0.53)[d]
LFLIAB	–.008 (–5.46)[a,c]	–.005 (–3.52)[a]	–.010 (–6.10)[a,c]	–.002 (–0.87)	.003 (1.64)[d]	.003 (1.33)[d]
LGLOANLOSS	–.048 (–3.05)[a,c]	–.018 (–1.40)	–.040 (–3.40)[a,c]	–.022 (–1.87)[b]	–.016 (–1.40)	–.021 (–1.75)[b]
LROE	—	–.114 (–6.01)[a,c]	—	–.082 (–3.94)[a,c]	—	–.037 (–1.42)
LSNONPERF	—	—	—	—	.001 (0.46)[c]	–.001 (–0.28)[c]
Year dummies	Y80–Y86[a]	Y80–Y86[b]	Y83–Y86[a]	Y83–Y86[b]	Y83–Y86[a]	Y83–Y86[a]

a. Coefficient (or sum of coefficients) is significant at the 1 percent level.
b. Coefficient (or sum of coefficients) is significant at the 5 percent level.
c. Slope coefficients are significantly different for $GSPDIF < 0$ and $GSPDIF \geq 0$ at the 1 percent significance level.
d. Slope coefficients are significantly different for $GSPDIF < 0$ and $GSPDIF \geq 0$ at the 5 percent significance level.

NOTE: *T*-statistics are in parentheses. The sample period is indicated by the year dummies. The means of the dependent variable are .003 and –.002 for the sample periods 1980–86 and 1983–86, respectively.

SOURCE: Author's calculations.

TABLE 2

Reverse Causality Tests for Credit Variables

	(3.A)	(3.B)	(4.A)	(4.B)	(5.A)	(5.B)	(6.A)
No. of observations	336	192	336	192	336	192	192
R^2	.6660	.6663	.6249	.3578	.7810	.8671	.9219
Log of likelihood function	–293.820	–149.546	417.654	225.174	834.776	470.437	111.726
Dependent variable	*FLIAB*	*FLIAB*	*GLOANLOSS*	*GLOANLOSS*	*ROE*	*ROE*	*SNONPERF*
HGSPDIF	–5.332 (–3.67)[a]	–2.651 (–1.54)	–.199 (–1.11)	–.471 (–2.20)[b]	.131 (2.49)[a]	.156 (2.09)[b]	–1.235 (–2.58)[a]
HGLOAN	–.397 (–1.84)[b]	.827 (1.31)	.020 (0.62)	.039 (0.55)	.010 (0.96)	–.022 (–0.89)	.333 (1.79)[b]
HFLIAB	.599 (11.49)[a]	.528 (6.79)[a]	–.001 (–0.24)	.005 (0.61)	–.001 (–1.07)	–.002 (–0.91)	–.009 (–0.60)
HGLOANLOSS	.174 (0.62)	–.118 (–0.26)	.222 (3.44)[a]	.341 (4.20)[a]	–.044 (–3.78)[a]	–.048 (–3.17)[a]	.188 (1.84)[b]
HROE	–.974 (–1.49)	–4.231 (–2.95)[a]	.228 (2.54)[a]	.541 (3.14)[a]	.860 (26.14)[a]	.824 (13.76)[a]	–.083 (–0.24)
HSNONPERF	—	.180 (1.16)	—	.023 (1.00)	—	–.027 (–5.56)[a]	1.009 (26.39)[a]
LGSPDIF	–1.228 (–0.61)[d]	–3.589 (–1.94)[b]	.292 (1.55)[d]	.188 (0.65)[d]	.151 (2.46)[a]	.126 (2.29)[b]	–1.211 (–3.18)[a]
LGLOAN	.264 (0.51)	.644 (1.02)	–.066 (–1.79)[b,d]	–.109 (–2.99)[a,d]	–.020 (–1.47)[d]	.016 (0.82)	–.140 (–1.15)[d]
LFLIAB	.580 (10.27)[a]	.676 (8.98)[a]	–.0001 (–0.01)	–.001 (–0.06)	–.006 (–3.43)[a,c]	–.011 (–4.15)[a,c]	.041 (2.79)[a,c]
LGLOANLOSS	.339 (0.70)	.610 (1.07)	.375 (4.56)[a,d]	.317 (2.80)[a]	.012 (0.74)[c]	–.003 (–0.13)	.183 (1.62)
LROE	–1.044 (–1.70)[b]	–.475 (–0.47)[d]	.157 (1.62)	.363 (1.78)[b]	.803 (22.90)[a,c]	.652 (7.92)[a,d]	.961 (3.87)[a,c]
RSNONPERF	—	.383 (2.64)[a,c]	—	.011 (0.49)	—	–0.33 (–6.22)[a]	1.037 (29.76)[a]
Year dummies	Y80–Y86[a]	Y83–Y86[a]	Y80–Y86[a]	Y83–Y86[a]	Y80–Y86[a]	Y83–Y86[a]	Y83–Y86[a]

a. Coefficient (or sum of coefficients) is significant at the 1 percent level.
b. Coefficient (or sum of coefficients) is significant at the 5 percent level.
c. Slope coefficients are significantly different for $GSPDIF < 0$ and $GSPDIF \geq 0$ at the 1 percent significance level.
d. Slope coefficients are significantly different for $GSPDIF < 0$ and $GSPDIF \geq 0$ at the 5 percent significance level.
NOTE: *T*-statistics are in parentheses. The sample period is indicated by the year dummies.
SOURCE: Author's calculations.

bank equity capital (table 2) yield evidence that banks in high-growth states may be using loan loss reserves to smooth income. These results are consistent with the notion that financial capacity is more important for ailing economies than for healthy ones.

A somewhat puzzling result is that, in the regressions that exclude nonperforming loans, the lagged return on bank equity capital is positively related to output growth in high-growth states, but negatively related to output growth in low-growth states. The credit-health view implies that if the return on bank capital merely captures the potential flow of internally generated funds and hence increased financial capacity, it should be positively related to local relative growth. Alternatively, there is evidence that the negative relationship between bank profitability and output may be capturing tighter lending practices by loan officers. Thus, the asymmetry

between low- and high-growth states is consistent with the notion that creditworthiness may affect credit availability and economic activity.[16] When nonperforming loans are included (table 1, specification 2.D), the lagged return on equity is no longer significantly related to output growth for either group. In addition, reverse causality tests (table 2, specification 6.A) yield evidence in favor of the tighter-lending interpretation of the asymmetry; in states experiencing low growth, the lagged return on equity is positively related to the share of nonperforming loans, while this credit-quality variable negatively impacts future profitability.

Finally, although lagged loan growth is significantly related to relative output growth in the pooled sample regressions (table 1, panel A), the split sample regressions (table 1, panel B) yield little evidence that real loan growth is positively related to output growth when state financial balance-sheet conditions are included as explanatory variables.

These results are not meant to be interpreted as identifying the exact nature or magnitude of a regional credit channel. As with all tests of whether financial variables cause real variables, the fact that lagged financial variables "Granger cause" economic activity does not mean that inherently forward-looking financial decisions do not reflect expectations about future economic conditions. Thus, decisions to extend credit as well as to default or to mark down the valuation of bank assets reflect, to some degree, the present valuation of the expected payoff on financial claims as related to expectations about future economic conditions. The evidence that financial factors may exacerbate output fluctuations is the significantly different relationship between inherited credit conditions and economic performance in healthy regions versus those experiencing poor relative economic growth.

IV. Conclusion

Current concerns about financial-market fragility are forcing policymakers to face the issue of whether monetary policy should be used to confront credit-quality problems in the financial sector. However, opinions and interpretations differ on what the evidence of a credit channel implies for policymakers. The regional dimension of current financial conditions further complicates the problem, because its solution depends on what is causing credit markets to be regional, as well as on the sources of regional credit disparities.

This paper presents evidence that regional economic performance is related to regional creditworthiness. State financial balance-sheet conditions, inherited from the past, have a significant relationship to current state output growth for states that are experiencing low relative growth; the relationship is consistent with the credit-health view and is significantly different from the relationship in states experiencing high growth. The empirical tests presented here, however, are a joint test of whether banking markets are regional and whether there is a credit link between these markets and the relative performance of state economies. Thus, the implications of these results for policymakers depend on why credit markets are regional.

The model of regional credit markets discussed here captures some of the features of banking in an economy that is regional because of information costs. To the extent that entrepreneurs must rely on regional credit markets to originate specialized investments, the health of these borrowers and of the local banking sector that provides intermediation services can affect regional economic activity when there is asymmetric information between borrowers and investors supplying external finance.

The regional nature of U.S. credit markets may also be a reflection of the historically unique regulatory structure of the banking industry. Regulations, such as interstate branching restrictions, limit the ability of banks to diversify across regions. If credit markets are regional because regulations are binding, then the benefits of regulation should be weighed against the costs of less diversification. When it is costly to monitor borrowers — whether financial or nonfinancial — the ability to diversify is related to the ability to avoid bad outcomes that can make it more costly to obtain credit in the future. Likewise, limits on the scale of banks that impede their ability to raise capital may exacerbate regional output fluctuations, as poor bank profitability may constrain future lending when local real economic conditions improve.

Because the regional dimensions of credit markets in an economy that is inherently regional are not likely to be merely artifacts of regulatory policies, the implications of a regional credit view for the conduct of stabilization policy will not disappear with deregulation. Thus, even in a deregulated environment, it is likely that financial flows will be sensitive to the health of regional entrepreneurs to the degree

■ **16** In addition, states with a lower capital-to-asset ratio (and hence lower bank creditworthiness) will have higher returns on equity, all else be equal.

that these borrowers write contracts that are not fully contingent on the random return on their investments. But the credit view recognizes that this financial structure may also be the most efficient way of dealing with information costs inherent in financial contracts. Currently, we do not observe large banks divesting themselves of what can be defined as "aggregate risks." This may be the result of disincentives in the current regulatory environment. Alternatively, bank contracting may reflect the highly specialized characteristics of bank investments that make these risks difficult to assess, but at the same time may reflect one reason that financial intermediaries exist: to fund portfolios of specialized investment opportunities (Fama [1980, 1985]).

To the extent that information costs make financial markets inherently regional, financial conditions may be an unavoidable propagation mechanism to relative regional performance. In this scenario, it is hard to argue from a pure efficiency criterion that policymakers should "do anything" in response to a regional credit imbalance, such as that plaguing New England, because the malaise may be an unavoidable outcome of the market mechanism, however information intensive. General stabilization policies aimed at alleviating a regional credit problem are likely to have redistributional effects that are not justifiable according to a pure efficiency standard. Indeed, an expectation of this policy response — to the extent that it amounts to a monetary bailout — may distort the incentives to diversify ex ante and may exacerbate the potential problem.

In assessing the policy implications of the events of the past decade, it is therefore important to distinguish between microeconomic policies affecting financial market structure and macroeconomic policies aimed at promoting economic stability and growth. The interdependence of structural policies and stabilization policies allows the distinction to be easily blurred. The unfortunate outcome is often that macroeconomic tools are used to try to remedy the ills that result from microeconomic banking regulations and structural changes in the financial sector. If the current regional financial crisis is to some degree the result of regulatory policies, then the crisis represents an opportunity to foster a sentiment for regulatory change. To use regional financial fragility as a rationale for a general macroeconomic easing without addressing whether regulatory policies are part of the problem may mean losing an opportunity for structural reform that could ameliorate the problem in the long run.

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