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# THE EFFECT OF CHANGES IN RESERVE REQUIREMENTS ON INVESTMENT AND GNP

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## ABSTRACT

This paper provides evidence on the importance of the credit channel in the transmission of monetary policy. Changes in reserve requirements are used to measure "credit shocks." Reserve requirement changes are often made for regulatory reasons, and hence provide a more exogenous measure of credit shocks than the measures used in previous tests. To distinguish between the "money" and "credit" channels, the significance of the reserve requirements variable is studied in an empirical model that includes other monetary aggregates (either the monetary base or M1). We find that an increase in reserve requirements lowers aggregate investment, real GNP and commercial and industrial (C&I) loans made by banks.

The Effect of Changes in Reserve Requirements on Investment and GNP

Prakash Loungani and Mark Rush*

## 1. Introduction

There is a large literature that posits a link between the extent of financial intermediation performed by banks and aggregate real activity. While the specifics differ from model to model, the basic idea is that certain types of borrowers, mostly small firms, are unable to borrow directly by issuing securities on the open market. These borrowers are highly dependent on bank credit and their borrowing is sensitive to the terms on which it available. Shocks to the supply of bank credit can have adverse consequences for investment by depriving such borrowers of funds.[1] In a recent paper, Gertler and Hubbard (1988) state that "theoretical models which motivate these types of real-financial mechanisms are now in abundance. The main challenge remaining is to quantify their importance."

The main source of evidence for the adverse consequences of declines in intermediary credit comes from the Great Depression. Bernanke (1983) and Hamilton (1987) have argued that the collapse of intermediation was very important during the onset of the Great Depression. To determine if intermediation matters outside of such exceptional episodes, Bernanke (1986) and Friedman (1983) have used measures of credit to capture effects from intermediation, while Gordon and Veitch (1984), Rush (1985, 1986) and Manchester (1989) use the money multiplier

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between M2 and the monetary base. The credit and money multiplier variables have met with some success. However, a problem with both these variables is that they contain a large endogenous component: a fall in GNP reduces the demand for loans and hence causes a decrease in credit and in the money multiplier.[2] Thus, this evidence does not provide unambiguous support for the importance of financial intermediation.

We propose to investigate the impact of credit shocks by using a more exogenous "shifter" of intermediary activity. In particular, we focus on changes in reserve requirements. Over the post-WWII period, the majority of changes in reserve requirements have been carried out for bank regulatory reasons, rather than as part of counter-cyclical monetary policy.[3] Hence they can be regarded as exogenous changes in the excise tax on deposit services provided by banks. An increase in reserve requirements raises the effective tax rate on deposit services and, hence, lowers the amount of financial intermediation carried out by banks. If bank loans are special, as asserted in the financial intermediation literature cited earlier, the increase in reserve requirements should have adverse real effects.

There is suggestive evidence from the banking microstructure literature that these changes are important enough to have significant impacts on bank profitability.[4] Slovin, Sushka and Bendeck (1990) find that announcements of increases in reserve requirements depress bank stock returns, while raising stock returns in nonbank financial firms. Santoni (1985) studies the effects of the Monetary Control Act of 1980 which imposed uniform reserve requirements across all financial firms by lowering the requirements for member banks and raising them for non-members. He finds that this change raised the after-tax earning streams and stock prices of member banks, while lowering earnings and stock prices of non-member banks.

Where our work complements these studies is in showing that the impact of reserve regulation is felt not just on bank profitability, but on the amount of financial intermediation and on real activity, particularly aggregate investment.[5] We also provide evidence that the impact of reserve requirements on real activity occurs at least partly through its impact on credit activity, which we measure as commercial and industrial loans provided by banks.

## 2. Theoretical Framework

Several theoretical frameworks generate a correlation between changes in reserve requirements and real activity. One of these is outlined in Barro (1990). As stated in the introduction, a basic assumption is that banks are more efficient than households or nonfinancial firms at evaluating and collecting loans made to firms. For simplicity, assume that banks make only one kind of loan--on which the interest rate charged is R--and accept one kind of deposit--on which the interest rate is $R^d$. In order for the bank to engage in intermediary activity, the spread $R-R^d$ must cover the costs of intermediation, which include the costs of holding some noninterest-bearing reserves. As discussed by Barro, an increase in the required reserve ratio operates like a tax on this intermediary activity, as banks are required to hold more reserves and thus make fewer loans. To the extent that bank-dependent borrowers are unable to find alternate sources of funding, the reduction in loans translates into declines in investment and output.

Similar results can be derived from the model discussed by Bernanke and Blinder (1988).[6] To the two assets contained in the IS-LM model, money and bonds, Bernanke and Blinder add a third asset, loans. They assume that loans are imperfect substitutes for bonds, for the reasons outlined earlier. Denoting the interest rate on bonds by i, the interest rate on loans by R, the quantity of bank deposits by DEP, and the required reserve ratio by T, the loan supply is

$$L^s = f(R,i)\cdot DEP(1 - T) \tag{1}$$

Loan demand is given by:

$$L^d = g(R,i,y) \tag{2}$$

The loan market clears by equating supply and demand:

$$g(R,i,y) = f(R,i)\cdot DEP(1 - T) \tag{3}$$

As (3) makes clear, changes in the required reserve ratio, T, lower loan supply and hence the quantity of intermediation.[7] The decline in the quantity of intermediation causes output and investment to fall, under the maintained assumption that bonds are not perfect substitutes for loans.

## 3. Measures of the Reserve Requirements Tax

A history of changes in reserve regulations over our sample period is provided in Appendix A. One thing that is apparent is that these changes are frequently quite complex. For instance, the 1951 increase in the required reserve ratio actually breaks down into an increase from 22% to 24% on demand deposits held at central reserve banks; a 18% to 20% increase on demand deposits at reserve city banks; an increase from 12% to 14% on demand deposits at country banks; and a 5% to a 6% increase in time deposits at all classes of banks. Additionally, changes in reserve requirements are often accompanied by other complicated policy decisions, such as changes in which cities are deemed "country" or the massive rewriting of reserve requirement regulations in the 1980s, that affect banks' ability to create credit. These considerations preclude a strategy of simply "reading off" tax rate changes from the reserve requirements schedule and using these changes as an independent regressor.

Instead, we suggest two measures which represent attempts to summarize these complex changes in regulations in one number. The first variable is the ratio of "required reserves held by member banks" to "total member bank deposits subject to reserve requirements." We refer to this variable as *the* required reserve ratio (T). In theory, the behavior of T could be driven largely by shifts from one type of bank to another, or from one type of deposit to another; these shifts may be caused by factors other than reserve requirement changes. However a look at the time series behavior of log changes in T (DT), shown in Figure 1, should allay these fears. By matching this figure to the history given in Appendix A, one can verify that almost all of the "blips" in this series correspond fairly closely to dates of actual changes in reserve requirements.

The second variable makes use of data from the St. Louis Federal Reserve Bank, which makes an adjustment to the monetary base to reflect changes in reserve requirements. In particular, the St. Louis Fed "adjusted monetary base" (AMB) is calculated as

$$AMB = B + RAM \qquad (4)$$

where B is the source base and RAM is the reserve adjustment magnitude. As an illustration of how RAM is computed, suppose that there is only class of deposits that are subject to reserve requirements. Then, if the required reserve ratio is changed from some initial base period value $T_0$ to $T_1$, RAM is computed as

$$RAM = (T_0 - T_1) \cdot DEP \quad (5)$$

where DEP is the current level of deposits that are subject to reserve requirements. An increase in reserve requirements ($T_1 > T_0$) absorbs reserves whereas a reduction "frees up" reserves. In practice, of course, the computation of RAM is quite complicated because of differences in requirements across types of deposits and types of banks.

We could use changes in RAM as an alternative summary measure of changes in reserve requirements. However, it is likely that the impact on real activity of, say, a $5 billion RAM would be greater if the source base was $6 billion than if it were $400 billion. To capture this effect, the variable we use, denoted F, is calculated as the ratio of the adjusted monetary base to the source base:[8]

$$F = \frac{AMB}{B} \quad (6)$$

Note that log differences of this ratio (DF) are approximately,

$$DF \approx \Delta\left(\frac{RAM}{B}\right) \quad (7)$$

As with the DT variable, major changes in this variable are associated with reserve requirements changes. Indeed, the simple correlation between DT and DF is -0.772. Increases in the required reserve ratio raise DT and lower DF. Hence, in keeping with the theory outlined above, we expect DT to have a negative correlation with economic activity and DF to have a positive correlation.

## 4. Empirical Results

### A. Empirical Specification

We estimate reduced form OLS equations for investment and output as functions of changes in reserve requirements and certain other macroeconomic variables. The measure of output used is real GNP, while for investment we use gross private domestic investment plus consumer durable expenditures.

The two measures of reserve requirements that we use are DT and DF. We use four alternate measures of monetary policy: chnages in the growth rate of the monetary base (DDB), the growth rate of M1 (DDM), the change in the 3-month Treasury bill rate, and the spread between the short-term T-bill rate and the short-term commercial paper rate.[9] Broadly speaking, all four measures of monetary policy were significantly correlated with real activity, and there was little reason to choose one measure over the other on empirical grounds.[10] More important, conclusions about the impact of changes in reserve requirements on real activity--which is our primary focus--do **not** depend crucially on the choice of the monetary policy measure. In the interests of brevity, therefore, we only report results based on the monetary base and M1 measures.

We follow Barro (1989) by including in our regressions the real stock return, called DS, where the stock market aggregate used is the Standard and Poor's 500. Using reduced form equations similar to the ones we estimate, Barro found that variations in stock returns have a strong impact on subsequent aggregate investment. Moreover, stock returns dominated both a Tobin's-q variable and cash-flow variables.

Before presenting the results, we discuss two issues that arise in most empirical studies.

*(i) Assumptions about stationarity:*

The controversy over whether output is trend-stationary or difference-stationary is far from being resolved. Hence, in a working paper version of this paper [Loungani and Rush (1991), available on request] we present results for a variety of specifications to show that our conclusions about the impact of reserve requirements on real activity are not unduly sensitive to assumptions made about stationarity. In the interests of brevity, the results reported here are for the following specification:

$$DY_t = \beta + \pi DY_{t-1} + \sum_{k=0}^{8} \delta_k DT_{t-k} + \sum_{k=0}^{8} \theta_k D^2 B_{t-k} + \sum_{k=0}^{8} \lambda_k DS_{t-k} \qquad \textbf{(8)}$$

A similar equation is estimated for investment; also, output and investment equations are estimated where F replaces T. This gives us a total of four regressions. Note that the specification above allows for changes in reserve requirements and changes in the real stock price to have permanent effects of the level of real activity, but changes in the monetary base are restricted to be neutral in the long run.

*(ii) Choice of lag length:*

As shown above, we include eight lags of the independent variables in all our specifications. To check the sensitivity of our results, we tried different lag structures. As one check on our results, we increased the number of lags for the independent variables up to twelve. Our conclusions were, in general, robust to these changes, and the added lags rarely attained standard levels of significance. As another check, we estimated regressions where the lag length was picked on the basis of the Akaike information criterion, subject to a maximum of twelve lags. Once again, we found that our qualitative results--and to a large extent even our quantitative results--were unaffected by these changes. Hence we only present the results based on the eight-lag specification.

## B. Benchmark Results

We estimated the four regressions specified above for the period 1950:1 to 1987:4. The results of the estimation are summarized in Table 1 as follows. First, for each independent variable, we report the sum of the current and eight lagged coefficients and the standard error of the sum. For the reserve requirements variables, we also provide some evidence on the short run impact of these variables on real activity by reporting the sum of the current and four lagged coefficients.[11] Second, we report values of the F-statistic for the null hypothesis that the current and lagged coefficients can be excluded from the regression.

Looking at the first row in the top panel of Table 1, we find a significant role for changes in the money supply: In both the output and investment regressions, the sum of the base money coefficients is highly significant. Next, in keeping with Barro's work, the sums of the real stock price coefficients and the F-statistics are generally significant.[12] Declines in the extent of financial intermediation--as measured by either an increase in T or a decline in F--have a negative impact on real activity, which is consistent with the theories presented above. The short run impact is significant at 5% or better in three of the four equations, but is insignificant in the output regression with T [column (1)]. The long run impact is estimated to be significantly different from zero in the equation with F, but not in the equations with T. The bottom panel in

Table 1 has the results from the F-tests. Except in the column (1) regression, the null hypothesis that the reserve requirement measures can be excluded is very strongly rejected.

Overall, the main qualitative finding is that increases in reserve requirements have an adverse impact on real activity, after controlling for the impact of standard macroeconomic variables, including measures of monetary policy.[13]

## C. Tests of Robustness

We undertook tests along a couple of dimensions to further examine the robustness of our results. First we wanted to ascertain how our results were affected by endogeneity. Given the sources in our regressions of possible endogeneity (e.g., endogenous Federal Reserve policy) it is difficult to think of variables that could legitimately be used as exogenous instruments in a conventional 2SLS regression. Hence, we employ the following strategy.

To start, recall that both intermediation variables can be affected by the public's (endogenous) actions in shifting between deposit types. However, as we noted earlier, most of the pronounced blips in the T and F series correspond to policy actions by the Fed. This suggests that focusing on "large" changes in these series is one way to alleviate the potential bias caused by shifting between deposit types. Hence, we estimate regressions that use alternate series for T and F which are constructed by using only large values for DT and DF. We define large as being greater than 0.7 standard deviations away from the mean.[14] We then contructed a series for T and F that reflected only these large changes. The sums and standard errors of the coefficients from regressions using these alternate series for T and F are reported in Table 2. Comparing these with the previous results, we see that the long run impact of a change in T on both output and investment is now negative, as hypothesized by the theory, but it is not measured very precisely. When F is used, the estimates of both the short run and the long run impacts continue to have the "right" sign, but the effect is dampened, particularly in the investment equation. Even so, as shown in the bottom panel of Table 2, the results of the F-tests suggest that, as in the benchmark case, the null hypothesis that the reserve requirement variables can be excluded from the regression is very strongly rejected in six out of the eight cases.

The second dimension along which we test our results is to consider the impact of using an alternate measure of monetary policy. Reserve requirements could appear to affect real activity if they are partially "proxying" for a correlation between M1 and real activity. It would appear that re-estimating our regressions with the monetary base replaced by M1 would be a test of this conjecture. While we do follow this route below, it is useful to keep in mind that this procedure suffers from a potential pitfall: In this paper, we are interested in studying the effect on aggregate real variables from exogenous changes in bank intermediation, that is, exogenous fluctuations in bank loans. Now, consider the following hypothetical scenario. Suppose that all investment is financed by bank loans and bank loans finance only investment. Then, due to the endogenous correlation between bank loans and investment, the inclusion of bank loans in a reduced form regression will eliminate the impact of other variables that influence investment through impacts on bank loans. Further, assume that funds for all banks loans are obtained through banks' intermediation from demand deposits and that M1 fluctuates only because of the demand deposit component. Then, including M1 in the regression will have the same impact as including loans: No other variables would emerge as significant determinants of investment. Obviously, in reality the correlations between investment and bank loans, between bank loans and demand deposits, and between demand deposits and M1 are not perfect. Nonetheless, these endogenous correlations exist and they reduce the likelihood of isolating a separate impact from changes in reserve requirements, once a broader monetary aggregate is included in the regression. Hence we would argue that finding *any* relationship between our intermediation measures and aggregate variables from such a regression is very strong evidence in favor of theories that stress a role for credit creation.

The results from this exercise are summarized in Table 4. In light of the issue discussed above, the intermediation variables perform quite well. In two of the four cases, the sum of at the current and first four lagged coefficients is significantly different from zero at the 10% level or better, and is close to significance at the 10% level in the investment regression with F. As for the long run effects, we find as before that intermediation has a long run effect when F is used as the measure but not when T is used. Moreover, we continue to see that six out of eight F-tests find that the intermediation variables should not be eliminated from the regressions.Thus, we find that our qualitative results are not substantially altered when M1 is used.

## D. Dynamic Response of Output and Investment

We next assess the quantitative importance of our results by tracing out the dynamic response of output and investment to changes in reserve requirements. For this we use the estimated coefficients from the regressions reported in columns (3) and (4) of Table 1. Before we present these "impulse responses," it is useful to keep in mind that the estimated equation [equation (8), which we reproduce below] contains two lags of the dependent variable:

$$Y_t = \alpha + \beta t + \sum_{j=1}^{2} \pi_j Y_{t-j} + \sum_{k=0}^{8} \delta_k T_{t-k} + \sum_{k=0}^{8} \theta_k DB_{t-k} + \sum_{k=0}^{8} \lambda_k S_{t-k}$$

Hence the response of output to reserve requirement changes depends not just on the estimated $\delta$ coefficients but also on the estimates of the $\pi_1$ and $\pi_2$, the coefficients on the lagged dependent variables. In particular, small changes in the estimates $\pi_1$ and $\pi_2$ can translate into large changes in the point estimates of the long run multiplier, which is given by $\Sigma\delta/(1-\pi_1-\pi_2)$.

As a baseline forecast, we set all the future values of DB, S, and F equal to their mean over our sample period, while the trend variable is allowed to grow at its usual rate. Then, to determine the impact of changes in reserve requirements, we retain DB and S at their mean values, but assume that reserve requirements are lowered. We picked the magnitude of the reduction to equal the actual change in reserve requirements that occurred in 1958:1 and 1958:2, which was approximately a 10% reduction.

The response of output and investment over a 20-quarter period is shown in Figure 2. The policy change raises output above the baseline forecast, with the peak impact occurring after five quarters--the impact at this point is \$90 billion, or about a 2% increase. The impact declines fairly slowly over the succeeding quarters towards its long run value. For instance, the impact on output after twenty quarters is still two-thirds as large as the peak impact. The impact on investment is relatively much stronger; it levels off at \$50 billion, representing a 10% increase.

We next investigate whether these dynamic responses are sensitive to the use of a particular monetary aggregate. In Figure 3, we show the response of output and investment to the same policy shock using estimates from columns (3) and (4) in Table 3. Recall that in these regressions M1 growth was used as the monetary aggregate rather than base growth. Comparing

Figures 2 and 3, the quantitative impact of this change on investment is fairly small; the long run impact falls from $50 billion to $40 billion. For output, the short run impact looks fairly similar in Figures 2 and 3. For instance, the impact on output after eight quarters falls from $80 billion in Figure 2 to $68 billion in Figure 3. But the long run impact is dramatically different. Even though the sum of estimated $\delta$ coefficients is not very different in the two cases [the F(8) estimate in Table 1 is 0.489 versus 0.554 in Table 3], the estimates of the coefficients on the lagged dependent variables are slightly different; these small differences translate into a big difference in the estimate of the long run multiplier.

Thus far we have shown that using the F measure of reserve requirements, the reduction in reserve requirements raises the long run level of output and investment, regardless of the monetary aggregate used. As a final check on the economic significance of our results, we consider how these conclusions would be altered if the T measure of reserve requirements is used. Using the estimates from columns (1) and (2) of Table 1, we show the dynamic responses in Figure 4. Again, we use Figure 2 as a basis for comparison. It is clear that using T reduces the estimated impact of the policy change, with the peak impact dropping to slightly less than 1% for output and about 5% for investment. The impact then dies fairly rapidly, but as the estimates in Table 1 suggest, the long run impact is not very precisely measured when T is used as the reserve requirements measure. Nonetheless, we still find that a permanent reduction in required reserves permanently raises investment.

## E. Extensions of the Basic Results

We present some auxiliary evidence to support the hypothesis that changes in reserve requirements affect aggregate investment through their impact on bank loans. First, we show that increases in reserve requirements have an adverse impact on the quantity of bank loans, in particular, commercial and industrial loans. We estimate an equation for the (log) change in commercial and industrial loans (DL), specified as:

$$DL_t = \beta' + \pi DL_{t-1} + \sum_{j=0}^{8} \delta_k DT_{t-k} + \sum_{j=0}^{8} \theta_k DB_{t-k} + \sum_{j=0}^{8} \lambda_k DR_{t-k} \tag{10}$$

The sample period is restricted by the availability of the loan data and starts in 1959:1. The results of the estimation are reported in Table 4. In the interests of brevity only the sums of the DT and DF coefficients are reported. We see that for both DT and DF measures, the sums of the current and lagged coefficients are significantly different from zero. Hence, the results strongly support the hypothesis that increases in reserve requirements have a negative impact on the quantity of bank loans.[15]

Finally, we conduct a more direct test of the hypothesis that bank credit contains "information" that is not contained in other types of credit. We do so by constructing a variable denoted MIX which is the ratio of bank credit to total credit, where the total is lending by depository institutions plus the Fed.[16] It is easy to show that MIX is inversely related to both the required reserve ratio and the currency/deposit ratio. Increases in MIX therefore correspond to increases in intermediation and should lead to increases in aggregate investment. To test this we regress investment on current and eight lagged values of the growth rate of the mix, the growth rate of the monetary base and stock returns. As shown in Table 5, the results support the hypothesized positive impact of the MIX variable on aggregate investment.[17]

## 6. Conclusions

To study the effects of financial intermediation on real activity, some exogenous "shifter" of intermediary activity is needed. The variable considered in this paper is changes in reserve requirements. As discussed in the paper, these changes are often made for bank regulatory reasons, and hence appear to be far more exogenous with respect to macroeconomic developments than the credit variables used in earlier tests. If intermediation has real effects, then an increase in reserve requirements ought to be followed by declines in output and investment. We find that changes in reserve requirements have statistically significant and quantitatively important impacts on real activity. Furthermore, even after we control for the correlation between M1 growth and real activity, changes in reserve requirements continue to exert an independent influence on real activity. This result provides support for theories that emphasize the credit channel of monetary transmission.

## REFERENCES


Barro, Robert J. "The Stock Market and Investment." Rochester Center for Economic Research Working Paper # 185, December 1989.

__________. Macroeconomics, 3rd ed. New York: John Wiley and Sons, 1990.

__________ and Mark Rush. "Unanticipated Money and Economic Activity." In Rational Expectations and Economic Policy, edited by Stanley Fischer. Chicago: University of Chicago Press, 1980.

Bernanke, Ben. "Non-Monetary Effects of the Financial Collapse in the Propagation of the Great Depression." American Economic Review 73 (June 1983), 257-276.

__________. "Alternative Explanations of the Money-Income Correlation." Real Business Cycles, Real Exchange Rates and Actual Policies, Carnegie-Rochester Conference Series on Public Policy (Autumn 1986), 49-100.

__________ and Alan Blinder. "Credit, Money and Aggregate Demand." NBER Working Paper No. 2534, March 1988.

Blinder, Alan S. and Joseph E. Stiglitz. "Money, Credit Constraints, and Economic Activity," American Economic Review 73 (May 1983), 297-302.

Fama, Eugene F. "What's Different About Banks?" Journal of Monetary Economics 15, (January 1985), 29-40.

Friedman, Benjamin. "The Roles of Money and Credit in Macroeconomic Analysis." in Macroeconomics, Prices and Quantities, edited by James Tobin, Washington, D.C.: Brookings, 1983.

Friedman, Milton and Anna J. Schwartz. A Monetary History of the United States 1867-1960. Princeton, N.J.: Princeton University Press, 1963.

Frydman, Roman and Peter Rappoport. "Is the Distinction Between Anticipated and Unanticipated Money Growth Relevant in Explaining Aggregate Output?" American Economic Review 77 (September 1987), 693-703.

Gertler, Mark. "Financial Structure and Aggregate Economic Activity: An Overview." Journal of Money, Credit and Banking 20 (August 1988), 559-588.

__________ and R. Glenn Hubbard. "Financial Factors in Business Fluctuations." National Bureau of Economic Research, Working Paper No. 2758, November 1988.

Gordon, Robert J. and John M. Veitch. "Fixed Investment in the American Business Cycle, 1919-1983." NBER Working Paper No. 1426, August 1984.

Hamilton, James. "Monetary Factors in the Great Depression." Journal of Monetary Economics 19 (March 1987), 145-170.

Haslag, Joseph and Scott Hein. "Reserve Requirements, the Monetary Base and Economic Activity." Federal Reserve Bank of Dallas Economic Review (March 1989), 1-15.

__________ . "Macroeconomic Activity and Monetary Policy Actions." Journal of Money, Credit and Banking 24 (November 1992), 431-446.

James, Christopher. "Some Evidence on the Uniqueness of Bank Loans." Journal of Financial Economics 19 (March 1987), 217-235.

Jefferson, Philip. "Money in the Theory of Financial Intermediation." Unpublished University of Virginia Manuscript, September 1989.

Kashyap, Anil, Jeremy Stein and David Wilcox. "Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance." Forthcoming, American Economic Review, 1993.

King, Robert and Charles Plosser. "Money, Credit and Prices in a Real Business Cycle Model." American Economic Review 74 (June 1984), 363-80.

Loungani, Prakash and Mark Rush. "The Effects of Changes in Reserve Requirements on Investment and GNP." Federal Reserve Bank of Chicago Working Paper No. WP-91-21, December 1991.

Manchester, Joyce. "How Money Affects Real Output." Journal of Money, Credit and Banking 21 (February 1989), 16-32.

Plosser, Charles. "Money and Business Cycles: A Real Business Cycle Interpretation." Proceedings of the 14th Economic Policy Conference of the St. Louis Fed, 1991.

Rush, Mark. "Unexpected Monetary Disturbances During the Gold Standard." Journal of Monetary Economics 15 (May 1985), 309-321.

__________. "Unexpected Money and Unemployment: 1920 to 1983." Journal of Money, Credit, and Banking 18 (August 1986), 259-274.

Santoni, G.J. "The Monetary Control Act, Reserve Taxes and the Stock Prices of Commercial Banks." Federal Reserve Bank of St. Louis Review (June/July 1985), 12-20.

Slovin, Myron, Marie Sushka, and Yvette Bendeck. "The Market Valuation Effects of Reserve Regulation." Journal of Monetary Economics 25 (January 1990), 3-19.

## Appendix A: Changes in Reserve Requirements

| | Net demand deposits | | | Time deposits |
|---|---|---|---|---|
| | Central reserve city banks | Reserve city banks | Country banks | (all classes of banks) |
| 1941 | 26 | 20 | 14 | 6 |
| 1948:1 | 22 | | | |
| 1948:2 | 24 | | | |
| 1948:3 | 26 | 22 | 16 | 7 1/2 |
| 1949:2 | 24 | 21 | 15 | 7 |
| 1949:3 | 22 | 18 | 12 | 5 |
| 1951:1 | 24 | 20 | 14 | 6 |
| 1953:3 | 22 | 19 | 13 | |
| 1954:2 | 21 | | | 5 |
| 1954:3 | 20 | 18 | 12 | |
| 1958:1 | 19 | 17 | 11 | |
| 1958:2 | 18 | 16 1/2 | | |
| 1960:3 | 17 1/2 | | | |
| 1960:4 | 16 1/2 | | 12 | |
| 1962:4 | | | | 4 |

| | Net demand deposits | | | | Savings | Other time | |
|---|---|---|---|---|---|---|---|
| | Reserve city | | Other banks | | | | |
| | 0-5m. | Over 5m. | 0-5m. | Over 5m. | | 0-5m. | Over 5m. |
| 1966:3 | | | | | 4 | 4 | 6 |
| 1967:1 | | | | | 3 | 3 | |
| 1968:1 | 16 1/2 | 17 | 12 | 12 1/2 | | | |
| 1969:2 | 17 | 17 1/2 | 12 1/2 | 13 | | | |
| 1970:4 | | | | | | | 5 |

| | Net demand deposits | | | | | Sav. | Other time | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0-2 | 2-10 | 10-100 | 100-400 | 400+ | | 0-5 | | | 5+ | | |
| | | | | | | | <6 mths. | <4 yrs. | >4 yrs. | <6 mths. | <4 yrs. | >4 yrs |
| 1972:4 | 8 | 10 | 12 | 13 | 17 1/2 | 3 | 3 | 3 | 3 | 5 | 5 | 5 |
| 1973:3 | | 10 1/2 | 12 1/2 | 13 1/2 | 18 | | | | | | | |
| 1974:4 | | | | | 17 1/2 | | | | | 6 | 3 | 3 |
| 1975:1 | 7 1/2 | 10 | 12 | 13 | 16 1/2 | | | | 1 | | | 1 |
| 1975:4 | | | | | | | | | | | | |
| 1976:1 | | | | | | | | 2 1/2 | | | 2 1/2 | |
| 1976:4 | 7 | 9 1/2 | 11 3/4 | 12 3/4 | 16 1/4 | | | | | | | |

***Reserve Requirements established under the Monetary Control Act (MCA) of 1980***

| Net transactions accounts | | Nonpersonal time deposits | | Eurocurrency liab. | |
|---|---|---|---|---|---|
| 0-25 million | 3 | Less than 4 yrs. | 3 | All types | 3 |
| over 25 million | 12 | 4 yrs. or more | 0 | | |

See Santoni (1985) for information on the phase-in periods and other details of the 1980 MCA.

## TABLE 1: BENCHMARK REGRESSIONS

**Panel A: Sums of coefficients and standard errors**

| | Col. (1) Output | Col. (2) Investment | Col. (3) Output | Col. (4) Investment |
|---|---|---|---|---|
| DB(8) | 1.267*** | 1.722*** | 1.498*** | 2.867*** |
| monetary base growth | (0.321) | (0.513) | (0.391) | (0.750) |
| S(8) | 0.008*** | 0.011* | 0.001 | -0.006 |
| stock prices (S&P 500) | (0.003) | (0.006) | (0.004) | (0.007) |
| T(4) [or F(4)] | -0.011 | -0.498*** | 2.266*** | 4.526** |
| reserve requirements | (0.066) | (.162) | (0.830) | (2.268) |
| T(8) [or F(8)] | 0.007 | 0.002 | 0.489** | 1.398*** |
| reserve requirements | (0.010) | (.021) | (0.226) | (0.577) |

In columns (1) and (2) T is used as the measure of reserve requirements, whereas F is used in columns (3) and (4). In each row, the numbers reported are the sums of the current and lagged coefficients in the specified regression, with associated standard errors in parentheses. X(8) indicates the sum of the current and eight lagged coefficients of the explanatory variable; X(4) indicates the sum of the current and four lagged coefficients. A "***" indicates significance of the sum at the 1% level, ** at the 5% level and * at the 10% level.

**Panel B: F-tests**

| | Col. (1) Output | Col. (2) Investment | Col. (3) Output | Col. (4) Investment |
|---|---|---|---|---|
| DB(8) | 3.096*** | 3.796*** | 2.465*** | 3.407*** |
| S(8) | 2.456*** | 3.913*** | 1.217 | 3.249*** |
| T(4) [or F(4)] | 0.881 | 4.587*** | 3.653*** | 4.300*** |
| T(8) [or F(8)] | 1.190 | 3.060*** | 2.233** | 2.600*** |

The numbers shown are values of the F-statistic; the null hypothesis is that the current and lagged values of the relevant variables can be excluded from the regression. A "***" indicates that the null hypothesis can be rejected at 1%, ** at the 5%, * at the 10%.

TABLE 2: REGRESSIONS WITH "LARGE" VALUES OF T AND F

**Panel A: Sums of coefficients and standard errors**

| | Col. (1) Output | Col. (2) Investment | Col. (3) Output | Col. (4) Investment |
|---|---|---|---|---|
| DB(8) | 1.254*** | 1.732*** | 1.330*** | 1.935*** |
| monetary base growth | (0.319) | (0.611) | (0.364) | (0.748) |
| S(8) | 0.008*** | 0.009 | 0.001 | 0.000 |
| stock prices (S&P 500) | (0.003) | (0.006) | (0.003) | (0.007) |
| T(4) [or F(4)] | -0.002 | -0.520*** | 1.442* | 2.169 |
| reserve requirements | (0.057) | (.139) | (0.776) | (2.092) |
| T(8) [or F(8)] | -0.012 | -0.010 | 0.464* | 0.690 |
| reserve requirements | (0.010) | (.019) | (0.256) | (0.631) |

In columns (1) and (2) T is used as the measure of reserve requirements, whereas F is used in columns (3) and (4). In each row, the numbers reported are the sums of the current and lagged coefficients in the specified regression, with associated standard errors in parentheses. X(8) indicates the sum of the current and eight lagged coefficients of the explanatory variable; X(4) indicates the sum of the current and four lagged coefficients. A "***" indicates significance of the sum at the 1% level, ** at the 5% level and * at the 10% level.

**Panel B: F-tests**

| | Col. (1) Output | Col. (2) Investment | Col. (3) Output | Col. (4) Investment |
|---|---|---|---|---|
| DB(8) | 3.467*** | 4.044*** | 2.700*** | 2.701*** |
| S(8) | 2.277** | 3.700*** | 1.156 | 2.509*** |
| T(4) [or F(4)] | 1.156 | 5.444*** | 3.644*** | 3.696*** |
| T(8) [or F(8)] | 1.644 | 3.488*** | 2.143** | 2.196** |

The numbers shown are values of the F-statistic; the null hypothesis is that the current and lagged values of the relevant variables can be excluded from the regression. A "***" indicates that the null hypothesis can be rejected at 1%, ** at the 5%, * at the 10%.

## TABLE 3: REGRESSIONS WITH M1 REPLACING MONETARY BASE

**Panel A: Sums of coefficients and standard errors**

| | Col. (1) Output | Col. (2) Investment | Col. (3) Output | Col. (4) Investment |
|---|---|---|---|---|
| DM1(8) | 0.923*** | 1.734*** | 1.005*** | 3.218*** |
| M1 growth | (0.375) | (0.628) | (0.362) | (0.941) |
| S(8) | 0.007** | 0.018** | 0.001 | 0.007 |
| stock prices (S&P 500) | (0.003) | (0.007) | (0.004) | (0.007) |
| T(4) [or F(4)] | -0.059 | -0.232* | 1.767*** | 2.324 |
| reserve requirements | (0.052) | (0.132) | (0.525) | (1.482) |
| T(8) [or F(8)] | 0.012 | 0.019 | 0.554*** | 1.233** |
| reserve requirements | (.011) | (0.022) | (0.239) | (0.610) |

In columns (1) and (2) T is used as the measure of reserve requirements, whereas F is used in columns (3) and (4). In each row, the numbers reported are the sums of the current and lagged coefficients in the specified regression, with associated standard errors in parentheses. X(8) indicates the sum of the current and eight lagged coefficients of the explanatory variable; X(4) indicates the sum of the current and four lagged coefficients. A "***" indicates significance of the sum at the 1% level, ** at the 5% level and * at the 10% level.

**Panel B: F-tests**

| | Col. (1) Output | Col. (2) Investment | Col. (3) Output | Col. (4) Investment |
|---|---|---|---|---|
| DM1(8) | 2.116** | 2.089*** | 1.897* | 2.022** |
| S(8) | 1.316 | 2.701*** | 0.730 | 1.247 |
| T(4) [or F(4)] | 0.785 | 3.794*** | 3.487*** | 3.897*** |
| T(8) [or F(8)] | 0.813 | 4.207*** | 2.211** | 4.035*** |

The numbers shown are values of the F-statistic; the null hypothesis is that the current and lagged values of the relevant variables can be excluded from the regression. A "***" indicates that the null hypothesis can be rejected at 1%, ** at the 5%, * at the 10%.

TABLE 4: COMMERCIAL AND INDUSTRIAL LOANS REGRESSIONS

| DT REGRESSIONS | | DF REGRESSIONS | |
|---|---|---|---|
| DT(4) | -0.322** | DF(4) | 7.77*** |
| DT(8) | -0.469** | DF(8) | 11.80*** |

TABLE 5: INVESTMENT REGRESSION WITH "MIX" VARIABLE

| | |
|---|---|
| GMIX(4) | 3.75** |
| GMIX(8) | 3.36** |

Numbers reported are the sums of current and lagged coefficients. A *** indicates that the null hypothesis that these variables can be excluded from the regression can be rejected at the 1% level, and ** indicates rejection at the 5% level.

## FOOTNOTES

1. See Gertler (1988) for a thorough review of this literature. Blinder and Stiglitz (1983) discuss the importance of bank loans in credit creation.

2. See King and Plosser (1984) for a model of this process and Plosser (1991) for empirical evidence. Manchester controls for at least part of the endogeneity by including some components of the multiplier, such as the currency/deposit ratio and the excess reserve to demand deposit ratio, in a VAR system. She finds that there is still a significant correlation between the multiplier and real GNP.

3. As pointed out by Haslag and Hein (1989) and others, the Federal Reserve generally offsets changes in reserve requirements by movements in the source base. This suggests that reserve requirement changes are generally *not* undertaken with the objective of fine-tuning the economy--the offsetting change in the source base would be counter-productive if that were the objective.

4. This literature builds on the work of Fama (1985). He points out that bank loans are more costly than other sources of external funds, such as commercial paper, since banks face a deposit tax: they must keep part of their deposits as non-interest bearing reserves. Why are firms willing to borrow from what may be a relatively more expensive source of funds? The answer, suggested by Fama and others, is that bank loans are a form of inside debt that signals to outsiders that the firm's expected prospects are good. This hypothesis has received empirical support in an important paper by James (1987). He finds that announcements of bank credit agreements boost the borrowers' stock returns while announcements of other kinds of debt have no such impact.

5. For the pre-WWII period, Friedman and Schwartz (1963) attribute the sharpness of the 1937 recession to the Fed's doubling of reserve requirements in 1936-37. However, as discussed in Friedman and Schwartz, there was disagreement among commentators on whether the Fed's action represented a shock to the financial intermediation process (a "credit" shock) or a "nominal" disturbance, a shock to the stock of money.

6. A related model that generates a negative correlation between investment and changes in the required reserve ratio is presented in Jefferson (1989).

7. In contrast to our work, the focus of the Bernanke and Blinder paper is on "exogenous" shocks to the f(...) function. The two examples that they provide of such shocks are the collapse of credit during the Great Depression and the credit controls of March-July 1980. As with changes in T, shocks to the f(...) function lower the quantity of intermediation and output.

8. The potential explanatory power of this variable for real activity was suggested to us by Milton Friedman (in correspondence with Mark Rush).

9. We did not pursue a decomposition of money growth into anticipated and unanticipated components in view of the conclusions of Barro and Rush (1980) and Frydman and Rappoport (1987) that, with quarterly data, both components of the money supply matter for output.

10. We also tried specifications in which two of the policy measures were entered simultaneously: the base and M1, the base and interest rates, M1 and the interest rate. Again, no clear "winner" emerged. This may seem somewhat surprising since several studies find that interest rates dominate monetary aggregates in explaining real activity. Two factors may explain our results. First, many of the studies do not use the monetary base. Second, and perhaps more important, our sample period starts in 1947 whereas these studies typically focus on the post-1959 period.

11. The data used in the estimation and the complete set of results are contained in an appendix available from the authors.

12. In the regression reported in column 4, though the sum of the current and four lagged coefficients is 0.056, with an associated standard error of 0.031.

13. Two recent papers, Plosser (1991) and Haslag and Hein (1992), use bivariate and multivariate VAR's, respectively, and find that the reserve adjustment component of the base is significantly correlated with output.

14. We used 0.7 standard deviations because this range captures about 50% of observations from a normal distribution. We did not experiment with other ranges--0.7 is the *only* range we used.

15. By splicing our loans series with a series on C&I lending by weekly reporting banks, we were able to estimate a loans regression starting in 1950. The results from this exercise were equally supportive. The marginal significance level was .015, .067, .008 and .061 for DT(4), DT(8), DF(4) and DF(8), respectively.

16. Kashyap, Stein and Wilcox (1993) also construct a mix variable which is the ratio of bank lending to total lending, where the total is defined as bank lending plus commercial paper. They find this mix variable to be negatively correlated with investment, particularly, with inventories.

17. If investment is regressed on the two underlying components of the mix, the required reserve ratio and the currency/deposit ratio, only the former is significant.

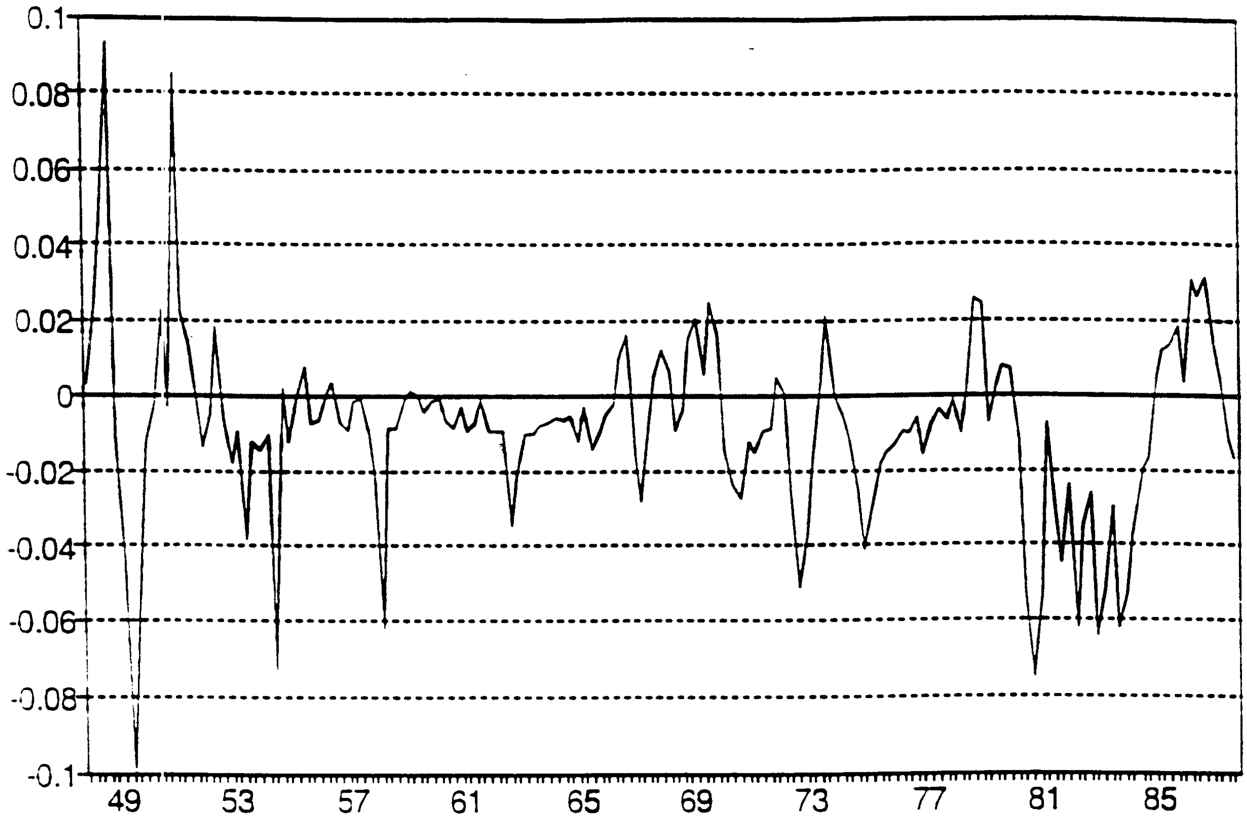


Figure 1: Changes in reserve requirements [DT measure].

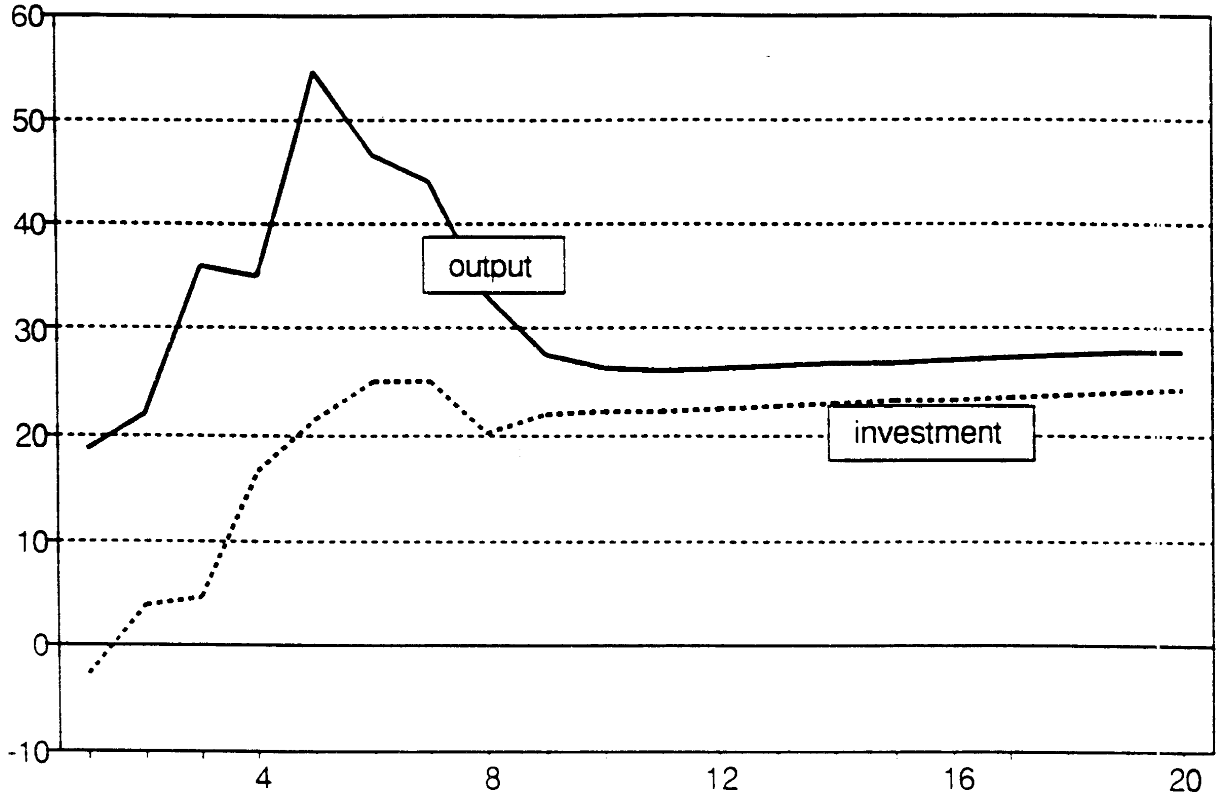


Figure 2: Impact of changes in reserve requirements [with DF measure and monetary base growth].

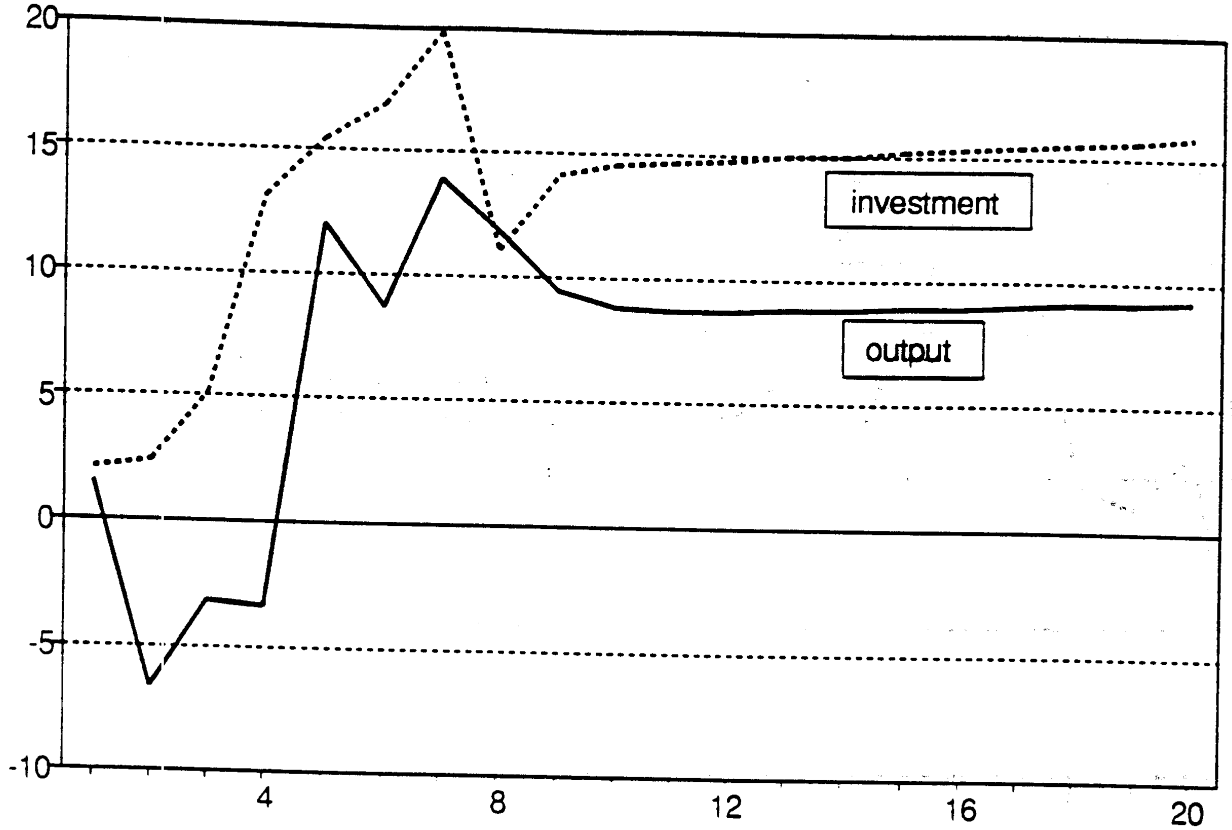


Figure 3: Impact of changes in reserve requirements [with DF measure and M1 growth].

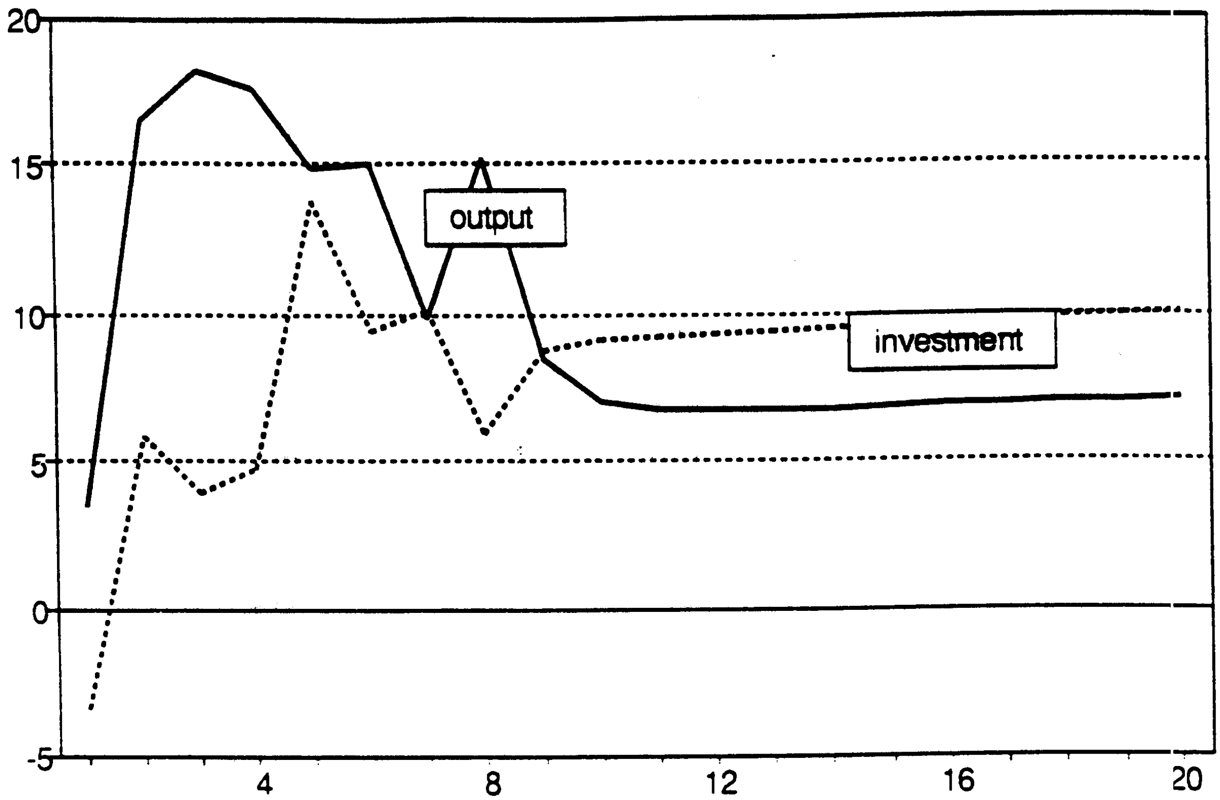


Figure 4: Impact of changes in reserve requirements
[with DT measure and monetary base growth].

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