Working Paper Series

# The Effect of Changes in Reserve Requirements on Investment and GNP

Prakash Loungani and Mark Rush

Working Papers Series
Issues in Macroeconomics
Research Department
Federal Reserve Bank of Chicago
December 1991 (WP-91-21)

FEDERAL RESERVE BANK
OF CHICAGO

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

by

Prakash Loungani*

and

Mark Rush**

University of Florida

October 1991

* University of Florida and Federal Reserve Bank of Chicago
** University of Florida

## 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 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

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

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

---

[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 ratios 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 signal to outsiders that the

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 while 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 in general, particularly aggregate investment. We find that changes in reserve requirements over the post-World War II period appear to have had a significant impact on real activity, particularly on aggregate investment.[5] We also provide evidence that the impact of reserve requirements on real activity occurs at least partly through it impact on credit activity, which we measure as commercial and industrial loans provided by banks.

---

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.

## 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 paid 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 Barro points out, 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 aggregate 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 D, and the required reserve ratio by T, the loan supply is

(1) $$L^s = f(R, i)D(1-T)$$

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

Loan demand is given by:

(2) $$L^d = g(R, i, y)$$

The loan market clears by equating supply and demand:

(3) $$g(R, i, y) = f(R, i)D(1-T)$$

As (3) makes clear, unanticipated and once-and-for-all-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. Whether or not these changes have a significant impact on macroeconomic variables is an empirical issue, which we address in a later section. We begin our empirical analysis by discussing ways of measuring T, the required reserve ratio.

## 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 6% increase in time deposits at all classes of banks. Additionally, changes in reserve requirements are often accompanied by other complicated policy decisions,

---

[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.

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 Figures 1(a) and 1(b), 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

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

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

(5) $$RAM = (T_0 - T_1)D$$

where D 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]

(6) $$F = AMB/B$$

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

(7) $$DF \approx \Delta\,(RAM/B)$$

The time series behavior of DF is shown in Figure 1(a) and 1(b) as well. 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.

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

## 4. Empirical Results

### A. Empirical Specification

Obviously, factors other than reserve requirements determine the evolution of real activity. Hence, we estimate reduced form OLS equations for investment and output as functions of changes in reserve requirements and other macroeconomic variables, which we specify below.

The two measures of reserve requirements that we use are (log) changes in T and F, denoted by DT and DF respectively. To capture one obvious source of macroeconomic fluctuations, we include the log of real federal purchases (LF) in the regressions for output. The impact of this variable on investment was never significant, so we excluded it from those regressions; no results hinge on this exclusion. We use four alternate measures of monetary policy: the growth rate of the monetary base (DB), the growth rate of M1 (DM), 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

[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.

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 include an additional independent variable that is motivated by the empirical findings of Barro (1989). Using reduced form equations similar to the ones we estimate, Barro found that the real stock market return has a strong impact on subsequent aggregate investment. Moreover, stock returns dominated both a Tobin's-q variable and cash-flow variables. We follow Barro by including in our regressions real stock return, called DS, where the stock market aggregate used is the Standard and Poor's 500.[11]

Finally, we also need to take account of the trend growth in output and investment. Deciding whether these variables are trend-stationary or difference-stationary is far from the focus of our paper; hence we explore both methods of detrending. In one set of regressions we include a time trend and lags of the dependent variable. In another set, we use first differences of the log of output and investment.

For all the variables, except the trend, we included lags. Clearly there is no theoretical basis for the number of lags to be included. Including more lags than justified lowers efficiency but including fewer biases the results. Hence, we were generous with the lags. In the trend stationary case, we included eight lags of the independent variables and two lags for LF and the lagged dependent variable; in the difference stationary regressions we reduced the dependent variable to one lag. To check the sensitivity of our results, we tried different lag structures. For

---

[11] In Loungani, Rush and Tave (1991), we have explored the impact of stock market dispersion on aggregate investment. Since the results to be presented below are robust to the inclusion of dispersion, we exclude it from the current specification.

instance, we increased the number of lags for the independent variables up to twelve; and changed the lags for the dependent variable up to four. We also estimated regressions omitting the stock return variable. Our conclusions were, in general, robust to these changes, and the added lags rarely attained standard levels of significance. The measure of output used is real GNP, while for investment we used gross private domestic investment plus consumer durable expenditures.

To summarize, our estimated trend-stationary equations are of the form:

(8) $LI = a + bt + C(L)DT \text{ [or } C(L)DF] + D(L)DB + E(L)DS + F(L)LI + \text{error}$

(9) $LY = a' + b't + C'(L)DT \text{ [or } C'(L)DF] + D'(L)DB + E'(L)DS + F'(L)LY + G'(L)LF + \text{error}$

where LI and LY are the log of investment and output, respectively, and the X(L)'s are polynomials in the lag operator. The difference-stationary regressions are similar, except that the first-differences of LI and LY are used and the trend term is omitted. For our intermediation variables, we expect the coefficients of C(L) and C'(L) to be negative when DT is used and positive when DF is used.

## B. Benchmark Results

We estimated the regressions specified above for the period 1950:1 to 1987:4. To conserve space, the results of the estimation are summarized 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.[12]

Looking at the first row in 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 stock return coefficients are also highly significant. Declines in the extent of financial intermediation--as measured by either DT or DF--have the predicted negative impact on real activity. The short run impact is significant at 1% in three of the four equations and at 10% in the output regression with DT. The sum of the current and eight lagged coefficients is again significant at 1% in three equations but insignificantly different from zero in the output equation with DT.

Also reported in Table 1 are the results of estimating the regressions using the growth rates of output and investment as dependent variables. Estimating the regressions in first difference form modifies the interpretation of the estimated coefficients. This specification implies that when the sum of the DT (DF) coefficients is significantly negative (positive), then then a one-period change in the level of T or F has a permanent impact on the *level* of GNP and investment.[13]

---

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

[13] Since we measure these variables as growth rates, this may be appropriate. For instance, a permanent decrease in the required reserve ratio causes a one-period decrease in DT and a one-period increase in DF. But the fact that the change in the required reserve ratio is permanent may imply a permanent increase in GNP as the tax on credit creation is permanently lower. This sort of permanent effect on GNP and investment is not allowed in the trend stationary case, because with a finite number of lags for DT and DF, GNP must eventually return to its trend.

Clearly the sums of the DS coefficients are still strongly significant. However, the impact from the money supply as measured by the sums of the coefficients is sharply diminished. Most likely this suggests that money is neutral in the long-run (neutrality requires that the sum of the coefficients equal zero) and indeed, most of the longer lagged coefficients are negative. Our main interest, however, centers around the financial intermediation variables. It is clear that our intermediation variables, especially the shorter lagged variables, remain highly significant. In particular, the sums of the current and first four lagged coefficients fall a bit in absolute value but their overall level of significance is unaffected. Looking at the longer lags, it is interesting to note that the estimated sums all fall in size and significance relative to the trend-stationary specification. In the output regressions, the sum of the DT variables remains insignificant and the sum of the DF variables barely attains significance. The sums in the two investment remain quite significant, but are substantially smaller than in the trend stationary specifications. These qualitative results suggest that in the long-run, a change in the required reserve has no effect on the level of GNP and the effect on investment shrinks.[14]

[14] As pointed out by one of the referees, the fact that the last several lags of the DF variable tended to have negative coefficients suggested that including longer lags might further reduce the total sum of the coefficients. Thus, we also estimated regressions with 12 lags of our intermediation variables to examine this possibility. None of the lags attained anything close to conventional levels of statistical significance. Somewhat surprisingly to us, adding the extra lags did not have too much impact on the overall sums; however, the significance of the sums was reduced.

Overall, these results strongly support our main qualitative prediction 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.[15]

## 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 any 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 DT and DF 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 only large values for DT and DT, where we define large as being greater than 0.7 standard deviations away from the mean.[16] The sums and standard errors of the coefficients from regressions using these "large" values are reported in Table 2. Briefly, comparing these with the previous results, we see

---

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

[16] 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.

little effect in the investment regressions. In the output regressions the main impact is to lower the significance of the sums with all the lagged coefficients, though it slightly raises the significance of the sums with only four lagged coefficients.[17]

The second dimension along which we test our results is to consider the impact of using an alternate measure of monetary policy. It has been suggested that the impact of reserve requirements on real activity that we report may be 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 suggestion. 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

[17] To conserve space, we do not report the details of two other tests that investigate the robustness of our results to potential endogeneity problems. First, we estimate regressions that omit contemporaneous values of the independent variables. The results here are quite similar to what we obtained using only "large" values for intermediation: Little effect in the investment regressions and a general reduction in the significance of the longer lagged sums in the output regressions. Second, we estimate a VAR system with output, investment, DT (or DF), DB and DS. Here again, the impact of DT and DF on real activity emerges as statistically significant.

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.

Once again, we estimate both trend and difference stationary regressions over the same time period as our benchmark specification. The results from this are summarized in Table 4. In light of the issue discussed above, the intermediation variables perform quite well. In all cases, the sum of at least the current and first four lagged coefficients is significantly different from zero at the 10% level or better. And the qualitative results we obtained were identical to those obtained using the monetary base: Intermediation has a stronger effect on investment than on total GNP. Thus, we find these results to be quite supportive of a role for credit creation in influencing aggregate variables.

## D. Dynamic Response of Output and Investment

Having established the statistical significance of our results, we now assess their quantitative importance by tracing out the dynamic response of output and investment to changes in reserve requirements. For this we use the estimated coefficients from the trend-stationary regressions reported in Table 1. As a baseline forecast, we set all the future values of DB, DS, DT, DF, and LF 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, DS and LF at their mean values, but assume that reserve requirements are lowered for two successive quarters and then return to their mean value. We picked the magnitude of the reduction to equal the actual change in reserve requirements that occurred in 1958:1 and 1958:2.[18]

The response of output and investment over a 20-quarter period is shown in Figure 2, using estimates from the DF regression. The policy change raises output above the baseline forecast, with the peak impact occurring after six quarters--the impact at this point is $120 billion, or about a 3% increase. The impact on investment is much stronger--about $60 at the peak, representing a 15% increase. The impact on output and investment dies out fairly slowly over the succeeding quarters. In Figure 3, we show the estimated impact using the DT regression. This reduces the estimated impact of the policy change, with the peak impact dropping to 1% and 10% for output and investment, respectively.

To check the sensitivity of our quantitative results, we retain DT as the policy measure but use estimates from Table 3. Recall that in this regression M1 growth was used as the measure of monetary policy rather than base growth. As shown in Figure 4, the quantitative impact of this change is fairly small. For instance, the size of the peak impact on output falls slightly below 1%, whereas the impact on investment is now about 7.5%.

---

[18] That is, we set the values of DT and DF in the first quarter equal to their value in 1958-1 and in the second quarter equal to their 1958:2 value.

## E. Extensions of the Basic Results[19]

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 a difference-stationary equation for commercial and industrial loans (DL), specified in a fashion similar to the investment equation:

(10) $DL = \alpha + \beta(L)DT \text{ [or } \beta(L)DF] + \Gamma(L)DB + \gamma(L)DS + \delta(L)DL + \text{error}$

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. 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.[20]

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.[21] It is easy to show that MIX is inversely related to both

[19] We are grateful to the referees for suggesting these extensions.

[20] 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.

[21] Kashyap, Stein and Wilcox (1990) 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.

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.[22]

## 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.

[22] 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.

## REFERENCES


Barro, Robert J. "The Stock Market and Investment." Unpublished University of Rochester working paper # 185, December, 1989.

Barro, Robert J. Macroeconomics. New York, John Wiley and Sons, Inc, 1990.

Barro, Robert J. and Mark Rush. "Unanticipated Money and Economic Activity" in Rational Expectations and Economic Policy, ed. 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, June 1983, 257-276.

Bernanke, Ben. "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.

Bernanke, Ben 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, 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, ed. 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, September 1987, 693-703.

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

Gertler, Mark 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.

Haslag, Joseph and Scott Hein. "Macroeconomic Activity and Alternative Monetary Policy Actions: Some Preliminary Actions." Working paper, 1991.

James, Christopher. "Some Evidence on the Uniqueness of Bank Loans." Journal of Financial Economics, 19, 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, Working Paper, December 1990.

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

Loungani, Prakash, Mark Rush and William Tave. "Allocative Disturbances and Economic Fluctuations." Working Paper, April 1991.

Manchester, Joyce. "How Money Affects Real Output." Journal of Money, Credit and Banking, 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, May 1985, 309-321.

Rush, Mark. "Unexpected Money and Unemployment: 1920 to 1983." Journal of Money, Credit, and Banking, 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, January 1990, 3-19.

## Appendix A: Changes in Reserve Requirements

| | Net demand deposits: Central reserve city banks | Net demand deposits: Reserve city banks | Net demand deposits: Country banks | Time deposits (all classes of banks) |
|---|---|---|---|---|
| 1941 | 26 | 20 | 14 | 6 |
| 1948:1 | 22 | | | |
| 1948:2 | 24 | | | |
| 1948:3 | 26 | 22 | 16 | 7½ |
| 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 | 16½ | | |
| 1960:3 | 17½ | | | |
| 1960:4 | 16½ | | 12 | |
| 1962:4 | | | | 4 |

| | Net demand deposits | | | | Savings | Other time | |
|---|---|---|---|---|---|---|---|
| | Reserve city 0-5m. | Reserve city Over 5m. | Other banks 0-5m. | Other banks Over 5m. | | 0-5m. | Over 5m. |
| 1966:3 | | | | | 4 | 4 | 6 |
| 1967:1 | | | | | 3 | 3 | |
| 1968:1 | 16½ | 17 | 12 | 12½ | | | |
| 1969:2 | 17 | 17½ | 12½ | 13 | | | |
| 1970:4 | | | | | | | 5 |

| | Net demand deposits | | | | | Sav. | Other time | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0-2 | 2-10 | 10-100 | 100-400 | 400+ | | 0-5 <6 mths. | 0-5 <4 yrs. | 0-5 >4 yrs. | 5+ <6 mths. | 5+ <4 yrs. | 5+ >4 yrs |
| 1972:4 | 8 | 10 | 12 | 13 | 17½ | 3 | 3 | 3 | 3 | 5 | 5 | 5 |
| 1973:3 | | 10½ | 12½ | 13½ | 18 | | | | | | | |
| 1974:4 | | | | | 17½ | | | | | 6 | 3 | 3 |
| 1975:1 | 7½ | 10 | 12 | 13 | 16½ | | | | 1 | | | 1 |
| 1975:4 | | | | | | | | | | | | |
| 1976:1 | | | | | | | | 2½ | | | 2½ | |
| 1976:4 | 7 | 9½ | 11¾ | 12¾ | 16¼ | | | | | | | |

***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

## TREND STATIONARY

| | DT REGRESSIONS | | | DF REGRESSIONS | |
|---|---|---|---|---|---|
| | OUTPUT | INVESTMENT | | OUTPUT | INVESTMENT |
| DB(8) | 0.78*** | 2.31*** | DB(8) | 1.37*** | 3.15*** |
| | (.30) | (.62) | | (.42) | (.80) |
| DS(8) | 0.134*** | 0.349*** | DS(8) | 0.123*** | 0.348*** |
| | (.040) | (.088) | | (.038) | (.090) |
| DT(4) | -0.148* | -0.720*** | DF(4) | 7.19*** | 17.22*** |
| | (.079) | (.192) | | (1.95) | (5.04) |
| DT(8) | -0.121 | -0.626*** | DF(8) | 6.95*** | 20.45*** |
| | (.084) | (.204) | | (2.35) | (5.55) |

## DIFFERENCE STATIONARY

| | DT REGRESSIONS | | | DF REGRESSIONS | |
|---|---|---|---|---|---|
| | OUTPUT | INVESTMENT | | OUTPUT | INVESTMENT |
| DB(8) | 0.26* | 0.50* | DB(8) | 0.30** | 0.73** |
| | (.14) | (.28) | | (.15) | (.33) |
| DS(8) | 0.146*** | 0.321*** | DS(8) | 0.130*** | 0.284*** |
| | (.038) | (.091) | | (.037) | (.091) |
| DT(4) | -0.125* | -0.717*** | DF(4) | 5.14*** | 13.79*** |
| | (.074) | (.184) | | (1.66) | (4.25) |
| DT(8) | -0.046 | -0.363** | DF(8) | 2.46* | 11.45*** |
| | (.063) | (.156) | | (1.53) | (3.89) |

The top numbers are the sums of the current and lagged coefficients in the specified regression. An (8) indicates it is the sum of the current and eight lagged coefficients; (4) indicates the sum of the current and four lagged coefficients. The number in parentheses beneath the estimate of the sum is the standard error of the sum. *** indicates significance at the 1% level, ** at the 5% level and * at the 10% level.

TABLE 2: REGRESSIONS USING ONLY "LARGE" VALUES FOR DT AND DF

## TREND STATIONARY

| | DT REGRESSIONS | | | DF REGRESSIONS | |
|---|---|---|---|---|---|
| | OUTPUT | INVESTMENT | | OUTPUT | INVESTMENT |
| DB(8) | 0.64** | 2.35*** | DB(8) | 1.21*** | 3.58*** |
| | (.30) | (.63) | | (.39) | (.79) |
| DS(8) | 0.120*** | 0.328*** | DS(8) | 0.097*** | 0.312*** |
| | (.039) | (.084) | | (.038) | (.083) |
| DT(4) | -0.156** | -0.634*** | DF(4) | 7.09**** | 13.05*** |
| | (.077) | (.185) | | (1.81) | (4.23) |
| DT(8) | -0.087 | -0.524*** | DF(8) | 7.27*** | 20.97*** |
| | (.083) | (.200) | | (2.45) | (5.41) |

## DIFFERENCE STATIONARY

| | DT REGRESSIONS | | | DF REGRESSIONS | |
|---|---|---|---|---|---|
| | OUTPUT | INVESTMENT | | OUTPUT | INVESTMENT |
| DB(8) | 0.20 | 0.51* | DB(8) | 0.23 | 0.71** |
| | (.13) | (.28) | | (.14) | (.31) |
| DS(8) | 0.127*** | 0.297*** | DS(8) | 0.112*** | 0.249*** |
| | (.037) | (.088) | | (.037) | (.087) |
| DT(4) | -0.130* | -0.670*** | DF(4) | 4.69*** | 10.49*** |
| | (.072) | (.178) | | (1.52) | (3.80) |
| DT(8) | -0.025 | -0.286* | DF(8) | 2.37 | 10.58*** |
| | (.060) | (.151) | | (1.60) | (3.98) |

The top numbers are the sums of the current and lagged coefficients in the specified regression. An (8) indicates it is the sum of the current and eight lagged coefficients; (4) indicates the sum of the current and four lagged coefficients. The number in parentheses beneath the estimate of the sum is the standard error of the sum. *** indicates significance at the 1% level, ** at the 5% level and * at the 10% level.

TABLE 3: REGRESSIONS USING M1

## TREND STATIONARY

| | DT REGRESSIONS | | | DF REGRESSIONS | |
|---|---|---|---|---|---|
| | OUTPUT | INVESTMENT | | OUTPUT | INVESTMENT |
| DM(8) | 0.34 | 1.72** | DM1(8) | 0.41 | 2.01** |
| | (.29) | (.78) | | (.31) | (.85) |
| DS(8) | 0.087** | 0.165 | DS(8) | 0.060 | 0.110 |
| | (.045) | (.104) | | (.044) | (.104) |
| DT(4) | -0.118* | -.455*** | DF(4) | 2.53*** | 5.34* |
| | (.067) | (.166) | | (1.26) | (3.06) |
| DT(8) | -0.034 | -.329* | DF(8) | 1.86 | 6.56 |
| | (.077) | (.195) | | (1.67) | (4.23) |

## DIFFERENCE STATIONARY

| | DT REGRESSIONS | | | DF REGRESSIONS | |
|---|---|---|---|---|---|
| | OUTPUT | INVESTMENT | | OUTPUT | INVESTMENT |
| DM1(8) | 0.17 | 0.37 | DM1(8) | 0.14 | 0.49 |
| | (.15) | (.31) | | (.14) | (9.32) |
| DS(8) | 0.103*** | 0.269*** | DS(8) | 0.083** | 0.216** |
| | (.035) | (.091) | | (.034) | (.089) |
| DT(4) | -0.112* | -.510*** | DF(4) | 2.13** | 6.20** |
| | (.060) | (.149) | | (1.06) | (2.52) |
| DT(8) | -0.016 | -.323** | DF(8) | 1.11 | 6.60** |
| | (.064) | (.165) | | (1.33) | (3.37) |

The top numbers are the sums of the contemporaneous and lagged coefficients in the specified regression. (8) indicates all 8 lags are summed; (4) indicates the sum of the first 4 lags. The number in parentheses beneath the estimate of the sum is the standard error of the sum. *** indicates significance at the 1% level, ** at the 5% level and * at the 10% level.

## TABLE 4: COMMERCIAL AND INDUSTRIAL LOANS REGRESSIONS

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

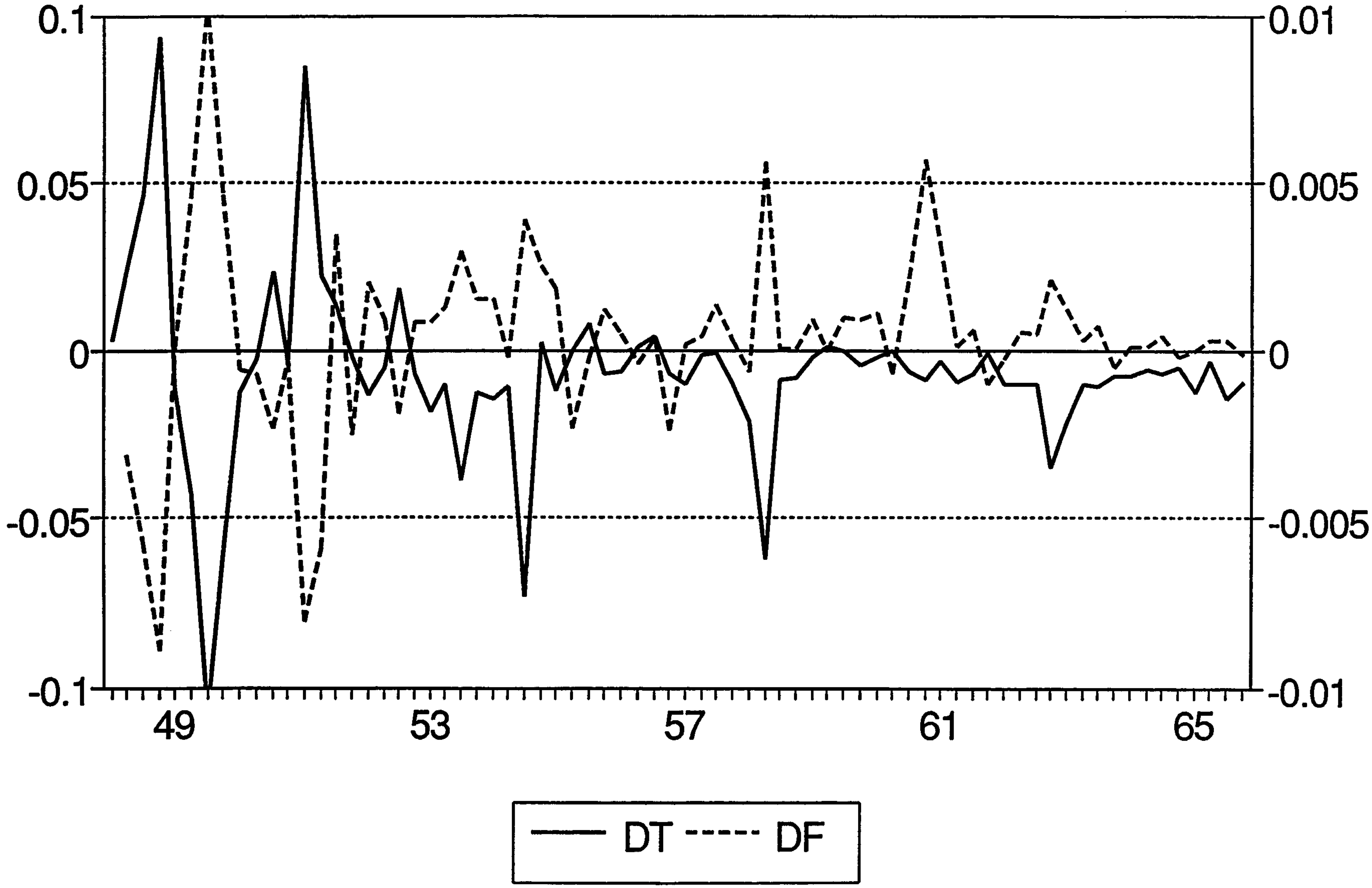
## TABLE 5: INVESTMENT REGRESSION WITH "MIX" VARIABLE

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

*** indicates significance at the 1% level and ** at the 5% level.

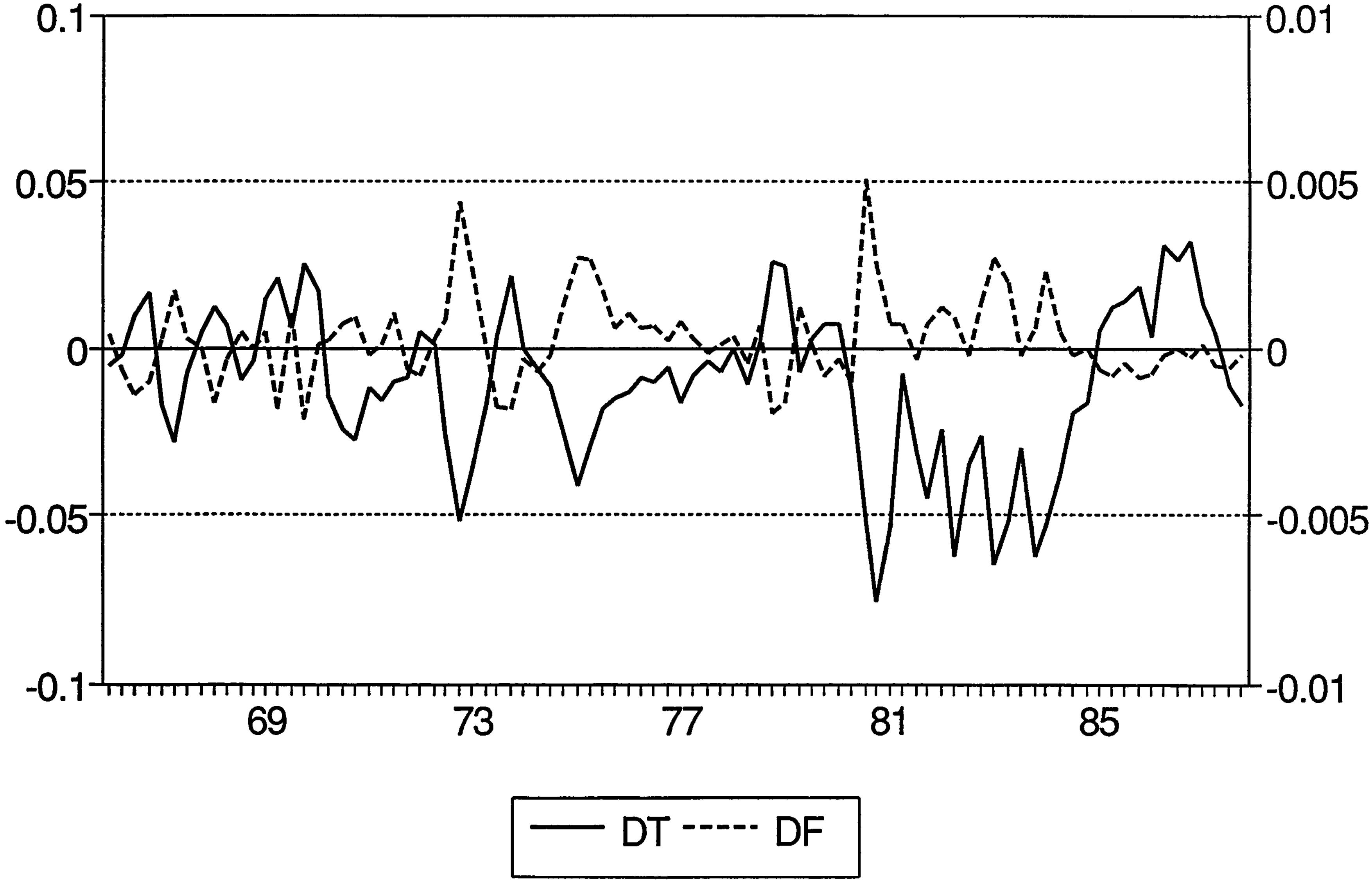
# Figure 1(a)

## Changes in reserve requirements,1948-65



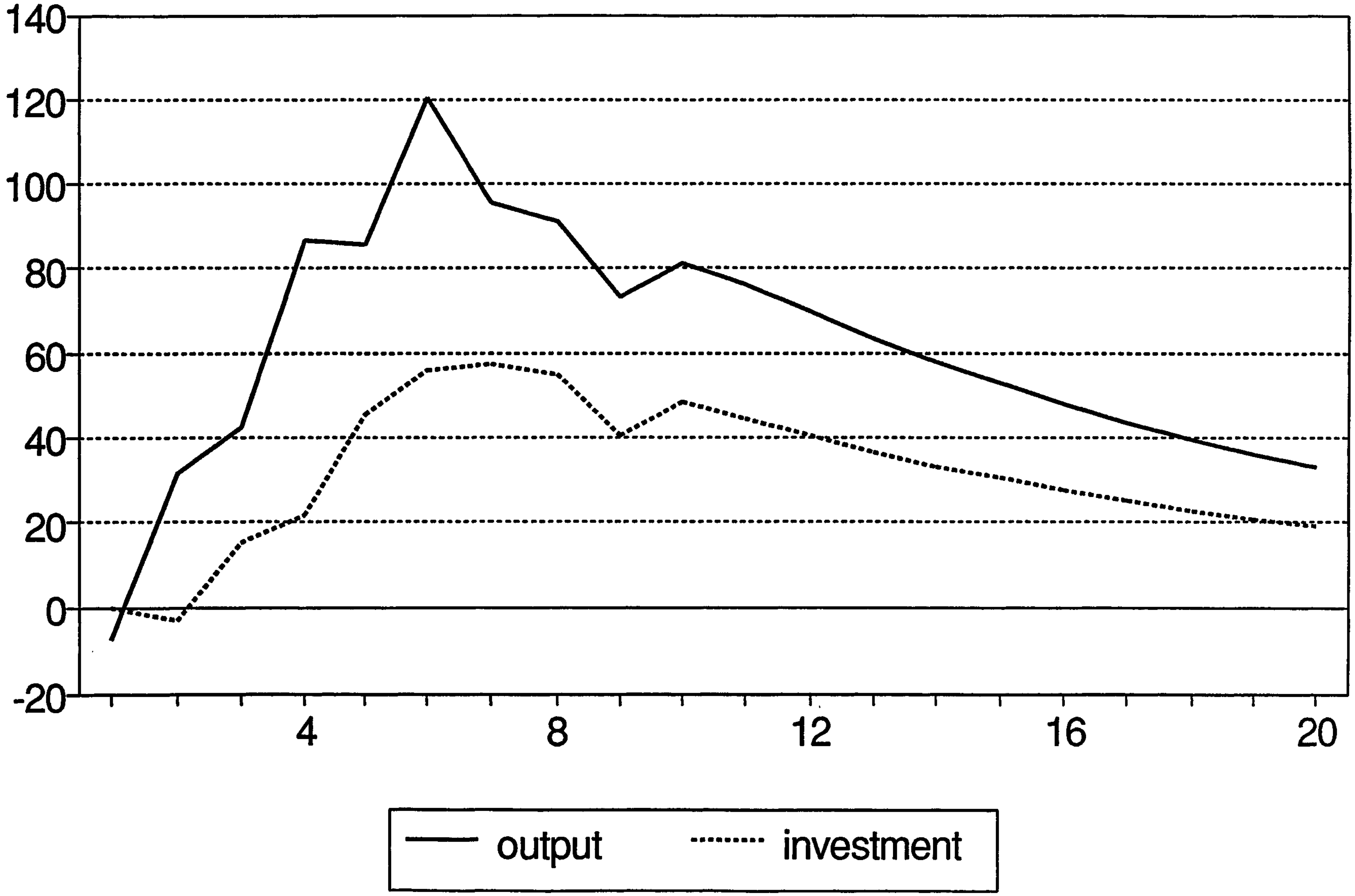
# Figure 1(b)

## Changes in reserve requirements,1966-87



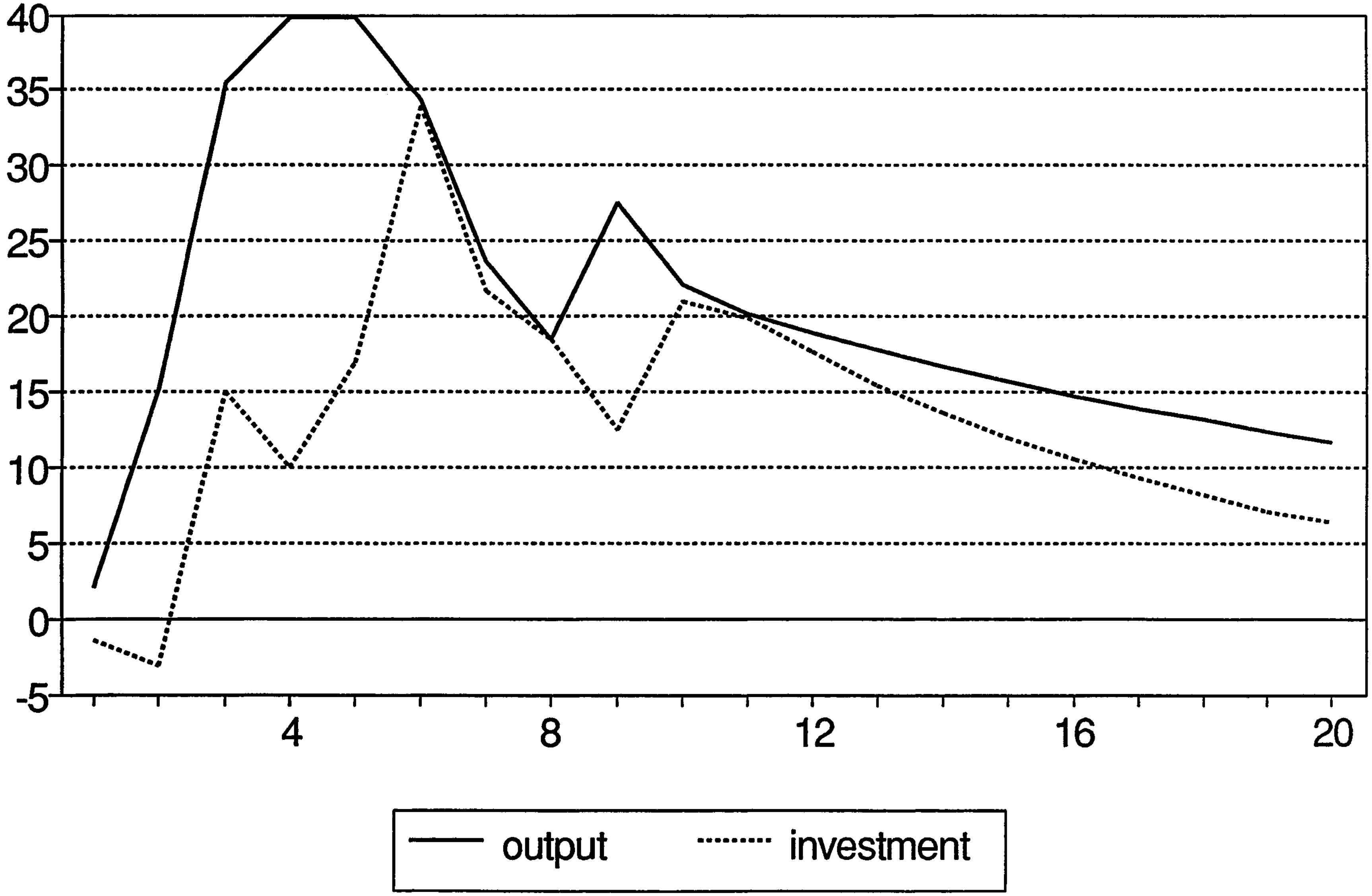
# Fig. 2: Output and Investment Response

## Using DF and Monetary Base Growth



# Fig. 3: Output and Investment Response

## Using DT and Monetary Base Growth



# Fig. 4: Output and Investment Response

Using DT and M1 Growth