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# THE MONETARY TRANSMISSION MECHANISM IN MEXICO

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ABSTRACT

An important question in macroeconomics has been how the transmission mechanism of monetary policy works. In particular, the question of whether there exists a credit channel for the transmission of monetary policy has been one of the central themes in the discussion of the effectiveness of monetary policy. If this channel exists, then shocks to credit markets, particularly to bank loans, can have real effects. This paper presents new evidence on the credit hypothesis for the case of Mexico after 1984. We present a simple variant of the open economy IS-LM model which includes a credit channel. The model has the following empirical implications which are absent from models which do not include a credit channel. We show that changes in the expectations of devaluation, the desired cash/deposit ratio, and measures of financial deregulation, will have real effects because they change the quantity of credit available in the economy. We explore these implications of the model through standard VAR techniques and find that the evidence strongly supports the credit view. We find that the impact on economic activity of credit and nominal depreciation rate shocks is very significant.

# The Monetary Transmission Mechanism in Mexico

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## I. INTRODUCTION

An important question in macroeconomics has been how the transmission mechanism of monetary policy works. In particular, the question of whether there exists a credit channel for the transmission of monetary policy has been one of the central themes in the discussion of the effectiveness of monetary policy. While these issues have been thoroughly studied for the U.S., there has been little work done on the credit hypothesis for developing countries. This paper provides new evidence on whether a credit mechanism for the transmission of monetary policy was present in Mexico during the 1984-1994 period.

The credit view focuses on financial market imperfections. The principal hypothesis of this view holds that shocks to credit markets, particularly to bank loans, have real effects. The theoretical underpinnings of the credit hypothesis are

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based on two basic assumptions. The first, is that loans are imperfect substitutes for other non-bank assets such as commercial paper for firms in the economy. The second, is that there exist shocks (for example, monetary policy ones) which affect the cost and availability of funds to banks.

The first of these assumptions, imperfect substitutability, arises due to imperfect information in credit markets. Banks provide credit to agents who, due to high screening and monitoring costs, cannot easily obtain funds through other means. The result is that if banks become unable or unwilling to extend credit (if banks simply cut back on the amount of credit), there will be a fall in spending by customers who depend on it, and therefore, in aggregate demand. The second assumption specifies that contractionary monetary policy will reduce the quantity of loans as well as the volume of reserves, thereby also inducing a fall in spending by those economic agents who depend on bank credit to carry out purchases or investments. Together, these two assumptions imply that "credit shocks" will have real effects on economic activity.

The Mexican experience during 1984-1994 presents a good test case for this hypothesis. During this period, the main goal of monetary policy was the determination of the exchange rate. The government followed a policy of depreciating the nominal exchange rate at a predetermined rate.[1] A change in the rate of depreciation during this period had an effect on the nominal interest rate which in turn affected the real quantity of money in the economy, thereby directly affecting the amount of loans the banking sector was able to extend.

We begin by presenting a simple variant of the open economy textbook IS-LM model in Section II.[2] This model allows us to examine different scenarios with respect to the effect of credit shocks on aggregate economic activity. Specifically, we see that changes in the rate of depreciation, which are fully reflected in the nominal interest rate, have real effects through their effect on the volume of credit in the economy. In addition, we look at the effect of financial deregulation on credit and aggregate demand. In Section III we test the predictions of the model for Mexico by evaluating whether different indicators of credit shocks have any predictive power for output and investment with the vector autoregression methodology.

The results show that the volume of credit is an important predictor for economic activity. Shocks to the nominal depreciation rate or the volume of credit to the private sector explain between 26 and 36 percent of the variance of

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[1] This presents us with a very clear case for identifying policy shocks. We can unambiguously identify the announced rate of depreciation as the policy variable.

[2] The closed economy version is in Bernanke and Blinder (1988).

economic activity. In addition, our evidence supports the contention that the principal source of variations in credit is changes in the nominal depreciation rate. The conclusions are presented in Section IV.

## II. THE MODEL

This section extends the credit channel model of Bernanke and Blinder (1988) to an open economy with predetermined exchange rates.[3] We model a financially backward economy where there are three assets: money, bonds, and loans. Unlike the typical IS-LM model, we abandon the perfect substitutability assumption between bonds and "loans"; we also discuss the effects of credit rationing. In this economy, there are two types of firms, those who are able to finance their needs issuing bonds in the open market, and an important fraction of firms who borrow from the banking system. For the latter type of firms, we assume that their demand for credit is a function of their desired investment which depends on the interest rate on loans and the level of activity (y). If $\rho$ is the nominal interest rate on loans, the demand for credit is:

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[3] Calvo and Kumar (1994) presents a similar model to explain how changes in the demand for money, and through it credit availability, affect aggregate output and employment in former socialist economies.

$$\underset{(-)}{L(\rho-\pi},\underset{(+)}{y)} \tag{1}$$

Where $\pi$ is the expected inflation rate, therefore $\rho-\pi$ is the real interest rate on loans faced by these firms.

Loan supply will be determined by the balance sheet of banks. Banks finance themselves from deposits, and total deposits in the banking sector are:

$$\frac{D}{P}=m\frac{M}{P}(i,y) \tag{2}$$

where m is the ratio of deposits to money which we assume is constant, i is the nominal interest rate in pesos, and M/P is real money balances. Assuming perfect capital mobility implies that uncovered interest parity (UIP) will hold so that, $i=i^{*}+\dot{e}$, where $i^{*}$ is the foreign interest rate on bonds, for example, the U.S. T-bill rate.

The quantity of loans in the economy will be supply determined, and the interest on loans will be determined in the credit market. Equilibrium in the loan market implies:

$$L(\rho-\pi,y)=m\frac{M}{P}(i,y)(1-\tau) \tag{3}$$

where $\tau$ is the required reserve ratio. From equation (3) we can solve for the equilibrium level of $\rho-\pi$. As we stated before, the quantity of loans is supply determined.

Therefore, total loans will be a function of i, y, and $m(1-\tau)$.[4]

$$C(\underset{(-)}{i},\underset{(+)}{y},\underset{(+)}{m(1-\tau)}) \tag{4}$$

Given that in this economy investment is done by two types of firms, those that react to the interest rate on bonds (i) and other firms whose investment depends on the amount of loans; these two variables will affect aggregate demand.[5] The analog to the IS curve will be:

$$y=Y(i-\dot{e},C(i,y),G) \tag{5}$$

where G includes all the other sources of demand such as government expenditure, the real exchange rate, etc... The effect of a change in the nominal interest rate on aggregate demand will be:

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[4] If there is credit rationing equilibrium in the credit market will be characterized by an excess demand for loans and a rate on loans of $\rho-\pi$, which is lower than the one that makes equation (3) hold with equality. In this case, when the supply of loans changes the loan rate, $\rho$, will remain constant, and $C(.)=m(1-\tau)M/P$.

[5] The quantity of loans is preferred to the real interest rate on loans because as discussed previously in footnote 4, if there is credit rationing in the economy the real rate on loans might not change and all the action will be captured by the quantity of loans.

$$\frac{dy}{di} = \underset{(-)}{y_i} + \underset{(+)}{y_C}\underset{(-)}{\frac{dC}{di}} < 0 \tag{6}$$

An open economy with a predetermined exchange rate and perfect capital mobility will have an LM curve which is completely elastic at the nominal interest rate $i=i^*+\dot{e}$. Figure 1 shows the equilibrium in the goods and money markets.

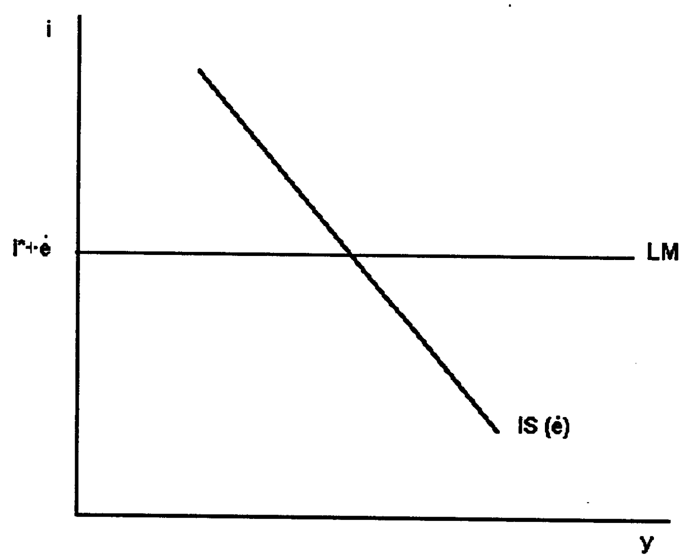


**Figure 1**

### II.1: COMPARATIVE STATICS

In this section, we use the model presented above to study two types of shocks which have been particularly important in Mexico. First, we look at the effect on aggregate demand of a fall in the expectations of devaluation. This could be due to a variety of reasons, but a particularly interesting one is due to the implementation of an exchange rate based stabilization plan such as the one which was introduced in Mexico in December 1987. Second, we look at the effect of an increase in the deposit to money ratio due to financial deregulation.

A fall in the expectations of devaluation will, given $i^*$, translate one for one into a fall in the nominal interest rate i. This means that the LM curve will shift by the amount $\Delta\dot{e}$. The IS curve, however, will shift downwards and to the left by less than $\Delta\dot{e}$. To see this we totally differentiate equation (5) which is the IS curve.

$$dy = Y_i\,(di - d\dot{e}) + Y_C\,(C_i\,di + C_y dy) \tag{7}$$

setting dy=0 and solving for di, we get

$$di = [\frac{Y_i}{Y_i + Y_C C_i}]\;d\dot{e} \tag{8}$$

Equation (8) shows that keeping output constant, the change in the nominal interest rate needed to equilibrate the goods market is smaller that the change in the expected devaluation (since $Y_i/Y_i+Y_cC_i < 1$). Since the LM curve will shift down by more than the IS curve, output will actually increase, as Figure 2 shows. [6]

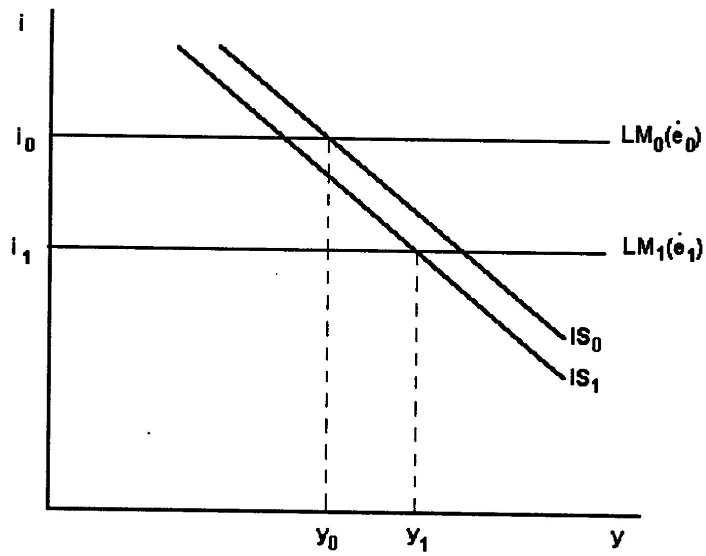


**Figure 2**

Where $i_0=i^*+\dot{e}_0$ and $i_1=i^*+\dot{e}_1$ and $\dot{e}_1<\dot{e}_0$. This outcome differs from the one which would result in a model without a credit channel. In an economy where all firms can borrow at i, $Y_C=0$,

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[6] This is assuming that output is demand determined. Under the more general case, this change in the rate of devaluation will shift the aggregate demand curve, and if the aggregate supply curve is upward sloping, output will also increase.

so $di = d\dot{e}$ and output will not change! We think this model helps to clarify the difference of opinion between those who claim that the reduction in nominal interest rates is expansionary, and those who think that given that this reduction in the nominal interest rate is driven by a fall in the expectations of devaluation, it should not have any real effects aside from the increase in the real quantity of money.

Finally, we look at the effect of a different type of shock, one brought on by financial deregulation. This type of shock is particularly relevant for the case of Mexico where starting in 1988, a series of steps where taken to deregulate financial markets and to privatize the banking system. Financial deregulation would lead to an increase in m, the ratio of deposits to money, that individuals want to hold. From equation (3), we see that when $m(1-\tau)$ increases, then for any nominal interest rate i, the quantity of loans will rise. This will shift the IS curve to the right and given a horizontal LM curve at $i=i^{*}+\dot{e}$, this shift in the IS curve will imply an expansion in output.[7]

In summary, this model presents the following empirical implications which are absent in an open economy IS-LM model without a credit channel.

i) Changes in the expectations of a devaluation have real effects because they change the quantity of loans in the

[7] If the shock was due to a decline in the reserve coefficient $\tau$, the results are exactly the same.

economy. If there is credit rationing the interest rate on loans might not change.

ii) Changes in the desired cash/deposit ratio and/or the reserve requirement also have real effects when we include a credit channel.[8]

iii) Other measures of financial deregulation that permit banks to have additional sources of financing will also have real effects.

## III. EMPIRICAL RESULTS

The model developed in the previous section highlights some interesting results. In this section, we evaluate the empirical evidence for the credit hypothesis in Mexico from 1984 to 1994. Previous studies for the U.S. economy, particularly by King (1985) find that the evidence runs contrary to the credit view. He uses standard VAR techniques to show that credit, which he measures as commercial and industrial loans by commercial banks, has little predictive power for GNP. Although this evidence seemed particularly damaging, Bernanke(1986) and Bernanke and Blinder (1989) show that using a structural VAR improves the importance of credit significantly. Loungani and Rush (1995) show that an increase

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[8] Loungani and Rush(1995) show that for the U.S., an increase in reserve requirements affects real activity through its impact on credit, which they measure as commercial and industrial loans provided by banks.

in reserve requirements has real effects on output because of a fall in credit extended by banks.

Our approach is to test our model's predictions in two steps. First, if the depreciation rate is a good indicator of monetary policy in Mexico during the period 1984-1994, and if policy shocks to this variable affect the real economy through a credit channel, then these variables (the depreciation rate and credit) should be important reduced-form predictors of economic activity. In Section III.1 we demonstrate that the level of credit is by far the most important variable for forecasting the level of real activity using both Granger causality tests and a standard VAR analysis. Each VAR we ran has one measure of economic activity (industrial production or investment), the real exchange rate, the real interest rate, and a variable that measures the credit channel (credit or the depreciation rate). We used the actual depreciation rate because it is the policy variable that we propose is mostly responsible for a large fraction of the variation in credit.[9] Our results show that the volume of credit contains very strong predictive power for economic activity. Innovations to the level of credit can account for as much as 36 percent of the variance in industrial production. We did not find

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[9] In 1991 a crawling target zone was introduced to allow for some flexibility in the exchange rate. After this date we used the announced depreciation for the central parity.

evidence, however, of predictive power for the rate of depreciation.

This result poses the question of whether all the shocks to credit are due to changes (contemporaneous and past) in the depreciation rate, or whether they are exogenous. To answer this question we estimate a set of VARs that include both the nominal depreciation rate and the volume of credit together, and interpret the estimated dynamic responses of the economy to shocks to these policy measures as reflecting the structural effect of monetary policy in Mexico during this period. The results show that the credit view of the monetary transmission mechanism is quite relevant for the case of Mexico. We find that the shocks to credit are mostly due to changes in the nominal depreciation rate, and that shocks to the depreciation rate have the expected negative effect on output, and work mostly through the credit channel.

### III.1 REDUCED FORM EVIDENCE

The model of Section II, shows that changes in the expectations of devaluation and financial regulation can affect aggregate demand through a credit channel. It is well known that monetary aggregates aid in the prediction of the future behavior of output. Our first step in examining the credit view for the case of Mexico is to see whether credit is also a good reduced form predictor for economic activity.

We use as our measure of credit, total loans to the non-financial private sector given by commercial and development banks. In addition, the model suggests that due to following a policy of predetermined exchange rates, the rate of depreciation will affect aggregate demand through its effect on the quantity of credit in the economy. Therefore, changes in the rate of depreciation of the peso will be negatively related to the quantity of credit in the economy. As we mentioned in the introduction, because the monetary authority was following a policy of a preannounced rate of depreciation, this is unambiguously the monetary policy variable. We use two separate measures of economic activity. One is an index of industrial production, and the other is an index of gross fixed investment. The data are monthly from 1984:01 to 1994:05. All the variables (except the depreciation rate) are seasonally adjusted and with the exception of the interest rates and the depreciation rate, they are also in logs. The following is a list of all the variables used. [10]

1) CRED is the real quantity of credit. (see text)
2) DEP is rate of depreciation of the peso
3) CPP is the real interest rate
4) RER is the real exchange rate
5) IP is an index of real industrial production

[10] CPP is the average cost of funds + 5% - $\pi_t$; given that 5% is the average premium for commercial paper over the reference rate that is used. CRED is as described in the text. All the data are from the Banco de Mexico.

6) INV is an index of real gross fixed investment.

We ran a series of Granger causality tests to see whether our "credit channel" variables (i.e. CRED and DEP) contain information about the behavior of our economic activity measures (i.e. IP and INV). Table 1 contains marginal significance levels for the test that 6 lags of CRED or DEP significantly aid in the prediction of the output measure after controlling for a constant and 6 lagged values of the output variable itself. Each row of the table represents an equation that forecasts some measure of economic activity by 6 lags of itself, 6 lags of the real interest rate (CPP), 6 lags of the real exchange rate (RER), 6 lags of each of the "credit channel" variables in turn, and a set of dummy variables for the months when a discrete devaluation took place.[11] [12]

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[11] This lag length was chosen by running F-tests for omitted lags with 6, 7, 8, 12, and 18 lags.

[12] During the period under investigation, two discrete devaluations took place July 1985, and December 1987. Given that we want to control for these crisis episodes, we included dummies for them and we also included 6 lags of the dummy variables to account for the dynamic response of the economy to the beginning of the crisis.

**TABLE 1: GRANGER-CAUSALITY TESTS**

| Economic Activity Measure | RER | CPP | DEP | CRED |
|---|---|---|---|---|
| IP | 0.94 | 0.53 | 0.69 | --- |
| INV | 0.74 | 0.32 | 0.93 | --- |
| IP | 0.18 | 0.54 | --- | 0.08 |
| INV | 0.07 | 0.50 | --- | 0.14 |

Each entry in the table shows the marginal significance levels for the hypothesis that all lags of the column variable can be excluded from the equation predicting a row variable. Therefore, a small value indicates that the column variable is important for predicting the row variable. The results of Table 1 shows that credit "Granger causes" industrial production at the ten percent level. In fact, the results show that credit is by far the best predictor of industrial production and investment. It is interesting to note that the depreciation rate is not significant at all for either measure of economic activity. This may be due to the long lags required for a change in the depreciation rate to affect economic activity (however, it might be acting through a change in credit). This shows that credit is an important predictor of economic activity, suggesting that there is an additional channel, other than the traditional one, for the transmission of monetary policy.

Granger causality tests are not necessarily the best way to assess "predictive power," since the right hand variables are not orthogonal. To address this issue, we estimate some vector autoregressions (VARs) with orthogonalized residuals in order to capture the joint time series behavior of these series. The percentage of the variance of the forecasted variable attributable to alternative right-hand side variables at different horizons gives a better way of measuring predictive power. Each four variable VAR contains one of the measures of economic activity (IP or INV), one of the "credit channel" variables (CRED or DEP), and both the real exchange rate and the real interest rate. Each equation was estimated using a constant, 6 lags of each variable, and the set of dummies used in the Granger causality tests.

We estimated the VARs using a standard approach, that is one that uses the Cholesky decomposition to orthogonalize the residuals.[13] The variance decomposition results for each four variable VAR are presented in Table 2. Each entry in the table is the percentage of the variance of the row variable attributable to each of the column variables at a 12, and 24

[13] We ran our VARs in levels to capture any existing co-integrating relationship between the variables. Fuller (1976) and Hamilton (1994) show that running VARs in levels is best since differencing throws information away and produces no asymptotic efficiency in an autoregression, even if it is appropriate.

month horizon. The results presented are for the ordering listed in the table, however, the results for two other orderings (Y-CPP-X-RER, and Y-X-CPP-RER) were almost identical.[14] This suggests that the information contained in the shocks to the different variables is nearly orthogonal. We believe this model to be the correct structural one for the innovations. This is because in a small open economy with perfect capital mobility, the domestic real interest rate differs from the foreign interest rate by the expected real appreciation of the currency (see Dornbusch (1983)). So, with a fixed exchange rate and a sticky price level, any transitory shock to the real exchange rate (RER) will generate an immediate change in the real interest rate. Therefore, in our model the real exchange rate should be before the real interest rate in the ordering. Finally, we handicap the predictive power of credit (CRED) and the depreciation rate (DEP) by placing it last in the ordering.[15]

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[14] Y refers to either IP or INV, and X refers to CRED or DEP.

[15] Given that DEP is a policy variable, there are reasons to place it first in the ordering due to the unavailability of the information when the policy decision is implemented. Because of this, we also ran a VAR placing DEP first in the ordering, however, the results did not change.

**TABLE 2: 4 VARIABLE VAR VARIANCE DECOMPOSITIONS OF ECONOMIC ACTIVITY**

| Economic Activity Measure (Y) [a] | IP OR INV | RER | CPP | CRED | DEP |
|---|---|---|---|---|---|
| 1.IP/12 | 57.6 | 13.0 | 3.46 | 26.0 | --- |
| 2.IP/24 | 46.0 | 10.9 | 7.22 | 35.9 | --- |
| 3.INV/12 | 53.4 | 28.4 | 3.09 | 15.1 | --- |
| 4.INV/24 | 44.2 | 23.9 | 6.04 | 25.9 | --- |
| 5.IP/12 | 89.7 | 0.81 | 4.56 | --- | 5.0 |
| 6.IP/24 | 85.5 | 1.22 | 4.02 | --- | 9.3 |
| 7.INV/12 | 86.6 | 3.03 | 7.01 | --- | 3.3 |
| 8.INV/24 | 84.8 | 2.41 | 6.12 | --- | 6.6 |

a: The numbers following the / refer to the horizon (i.e. 12 is 12 months ahead). Entries show the percentage of forecast variance of (Y) at different horizons attributable to innovations in column variables.

The results in Table 2 are quite favorable to the credit hypothesis. Innovations to credit explain up to 36 percent of the variation in industrial production, and 26 percent of the variation in investment. On the other hand, the depreciation rate does not explain much of the variation in either industrial production or investment (but neither does any variable other than itself). Furthermore, it is almost always the case that the "credit channel" variable (CRED or DEP) is the most important variable in explaining the variation in economic activity (however measured) following innovations to itself. It is interesting to note, that just as with the Granger causality tests before, the level of credit seems to be the most important variable in explaining the variations in both output and investment.

Given the evidence presented above, we can safely say that credit is one of the most important variables in the prediction of real economic activity. Figures 3 and 4 show the dynamic response of all the variables in the VAR to a unit shock in the estimated equations associated with the credit variables (CRED and DEP) in Table 2 along with their 2 standard error confidence bands.[16] Each row in the figures represents the dynamic response of each column variable to a shock in the row variable, for example, the last row of each figure shows the dynamic response of all the variables in the system to a shock in the "credit channel" variable (CRED or DEP). The last row in Figure 3 shows the effect of a positive shock to the level of credit on all the variables in the VAR.[17] Shocks to the level of credit tend to be permanent. A positive shock to the level of credit has a positive and significant effect on both industrial production and investment, reaching a peak after approximately five months, and is still present after two years. As expected, a shock to the volume of credit leads to a real exchange rate

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[16] The contemporaneous month is designated as January (J).

[17] The impulse response functions for the VARs containing Investment are nearly identical and are available upon request.

appreciation as aggregate demand increases raising the prices of non-tradeables.

The last row of Figure 4 shows the impulse response functions for a shock to the nominal depreciation rate. We also observe that these shocks are relatively permanent. A positive shock to the depreciation rate (i.e an increase in the depreciation rate) leads to a decline in industrial production, although the result is only significant after the eighth month. In the model of the previous section, an increase in the depreciation rate leads to a decrease in the volume of credit and therefore, to a decrease in the level of aggregate demand and a fall in the prices of non-tradeables leading to a significant and permanent real depreciation. This is exactly what we find in Figure 4.

Although these results are encouraging because they do not depend on the ordering of the variables, they don't tell us whether the principal source of the shocks to credit are exogenous or induced by changes in the nominal depreciation rate; as we think is the case in Mexico where monetary policy concentrated on exchange rate targeting. To determine this, we estimate a set of five variable VARs that include both the nominal depreciation rate and the volume of credit together and interpret the estimated dynamic responses of the economy to shocks to this policy measure as reflecting the structural effect of monetary policy in Mexico during this period.

Table 3 shows the Granger causality tests for a set of regressions that contain both the nominal depreciation rate and the volume of credit. As before, each row of the table represents an equation that forecasts some measure of economic activity by 6 lags of itself, 6 lags of the real interest rate (CPP), 6 lags of the real exchange rate (RER), 6 lags of the announced rate of depreciation (DEP), 6 lags of the volume of credit (CRED), and the same set of dummy variables for the months when a discrete devaluation took place.

**TABLE 3: GRANGER-CAUSALITY TESTS**

| Economic Activity Measure | RER | CPP | DEP | CRED |
|---|---|---|---|---|
| IP | 0.30 | 0.55 | 0.72 | 0.11 |
| INV | 0.37 | 0.34 | 0.41 | 0.04 |

Table 3 shows that the volume of credit is by far the most important variable in predicting economic activity measured either as investment or as industrial production, even when the depreciation rate is included in the equation. The insignificance of the depreciation rate in the previous Granger causality tests might be because the depreciation rate affects output by changing the volume of credit in the economy, so multicolinearity between these two variables will be a problem. This is apparent in the granger causality tests for the volume of credit, where the depreciation rate is highly significant.

Just as before, we estimate a set of five variable VARs in order to asses if we can explain the shocks to credit by shocks to the depreciation rate and to analyze the effect of these shocks on industrial production and investment. Table 4 shows variance decompositions for both the VARs with industrial production and the one with investment. The results show that once we account for nominal depreciation rate innovations, exogenous shocks to credit are not very important for predicting the variation in either output or investment. Innovations to the rate of depreciation account for as much as 26.5 percent of the variations in economic activity. More importantly, the results show that variations in the depreciation rate can account for up to 76 percent of the variation in the volume of credit. These results are invariant to placing credit before the nominal depreciation rate in the ordering.

**TABLE 4**: 5 VARIABLE VAR VARIANCE DECOMPOSITIONS OF ECONOMIC ACTIVITY

| Economic Activity Measure (Y) [a] | IP OR INV | RER | CPP | DEP | CRED |
|---|---|---|---|---|---|
| 1.IP/12 | 75.3 | 1.53 | 6.74 | 14.4 | 2.10 |
| 2.IP/24 | 52.3 | 9.84 | 15.6 | 20.4 | 1.79 |
| 4. INV/12 | 70.9 | 3.23 | 9.03 | 15.9 | 0.92 |
| 5. INV/24 | 49.0 | 8.40 | 14.7 | 26.5 | 1.14 |
| 6.CRED/12 (IP) | 1.62 | 2.35 | 10.2 | 54.3 | 31.5 |
| 7.CRED/24 (IP) | 1.61 | 1.76 | 11.1 | 76.0 | 9.52 |
| 8.CRED/12 (INV) | 3.75 | 2.05 | 10.9 | 54.5 | 28.8 |
| 9.CRED/24 (INV) | 1.38 | 1.91 | 14.3 | 74.1 | 8.3 |

a: The numbers following the / refer to the horizon as in Table 2.
Entries show the percentage of forecast variance of (Y) at different horizons attributable to innovations in column variables. Order is as shown.

Figures 5 shows the dynamic response of all the variables to a unit shock in all the variables in the system. The last two rows of the figure show the response of all the variables to a shock in the depreciation rate and the volume of credit respectively. An increase in the depreciation rate leads to a permanent fall in industrial production.

In addition, we see that a shock to the depreciation rate leads to a permanent real depreciation of the peso. More important, however, is the fact that an increase in the depreciation rate leads to a substantial and permanent fall in the quantity of credit.[18] Lines 6-9 of Table 5 show that innovations to the depreciation rate are by far the most important factor in explaining the variations in the volume of credit, even including variations in credit itself. Shocks to the depreciation rate can account for up to 76 percent of the variation in credit when either industrial production or investment is used. This shows clearly that most of the variations in credit are due to changes in the depreciation rate. The last row of the figure shows that once the depreciation rate is taken into account, innovations to credit do not have a significant impact on either investment or industrial production. We also notice that the effect of an increase in the rate of depreciation on credit is sufficiently permanent while innovations to credit are more transitory.

This analysis leads to two important conclusions. First, we find that the credit hypothesis is very important for the case of Mexico. The impact on aggregate demand of credit and nominal depreciation shocks is larger than that of the real interest rate or the real exchange rate. Second, we find that shocks to the depreciation rate are the principal source of fluctuations in credit as opposed to exogenous shocks to credit . This is in accordance with the fact that financial intermediation increased greatly following the stabilization

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[18] Although the imperfect credibility story might generate similar output dynamics when a shock to the depreciation rate takes place, it would imply a sudden increase in credit and not a gradual build up of loans.

plan introduced in December of 1987 when the peso was devalued and then fixed and nominal interest rates dropped from an average of 96% in 1987 to 15.6% in 1992 (for a description of the Mexican experience see Dornbusch and Werner (1994)).

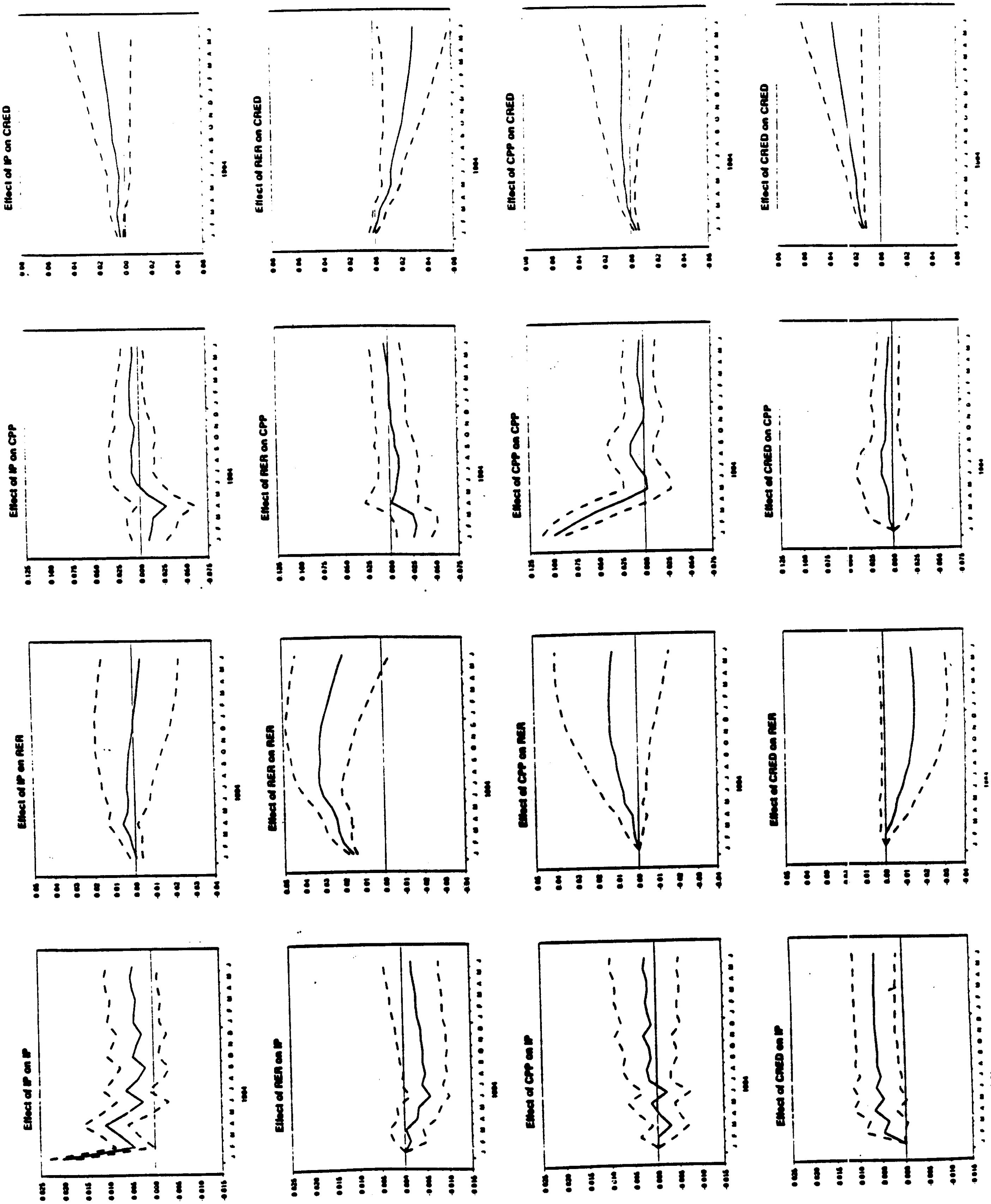
These empirical results support the conclusions drawn from the model we presented in Section I of the paper. The credit channel is an important one for Mexico. In particular, increases in the quantity of loans in the economy, whether directly or caused by a fall in the expectations of devaluation, have a positive effect on real economic activity. For the Mexican case, the evidence presented here shows that the most important source of changes in credit were the reductions in the depreciation rate.

## IV. CONCLUSIONS

Although there have been some theoretical models which include a credit channel for the transmission of monetary policy, the empirical evidence has been mixed. In this paper we first developed a simple variant of the open economy IS-LM model in which shocks to credit markets have effects on real output. We then tested the model's implications empirically for the Mexican economy during the period 1984 to 1994.

The model we present has the following empirical implications which are absent from the standard open economy IS-LM model. The first is that changes in the expectations of devaluations (which translate one for one to changes in the nominal interest rate), have real effects because they change the quantity of credit available in the economy. Secondly, changes in the desired cash/deposit ratio or the reserve requirement will also have real effects. Finally, we find that other measures of financial deregulation which allow banks to have additional sources of financing will also have real effects. These implications are particularly interesting for Mexico where an exchange rate based stabilization plan lowered expectations of devaluation, and financial deregulation has been progressive.

The empirical evidence strongly supports the credit view. Shocks to credit can explain as much as 36 percent of the variation in economic activity. The results show that the credit view of the monetary transmission mechanism is quite relevant for the case of Mexico. We find that the shocks to credit are mostly due to changes in the nominal depreciation rate, and that shocks to the depreciation rate have the expected negative effect on output. We find that the impact on aggregate demand of shocks to the volume of credit and the nominal depreciation rate is larger, than that of the real exchange rate and the real interest rate.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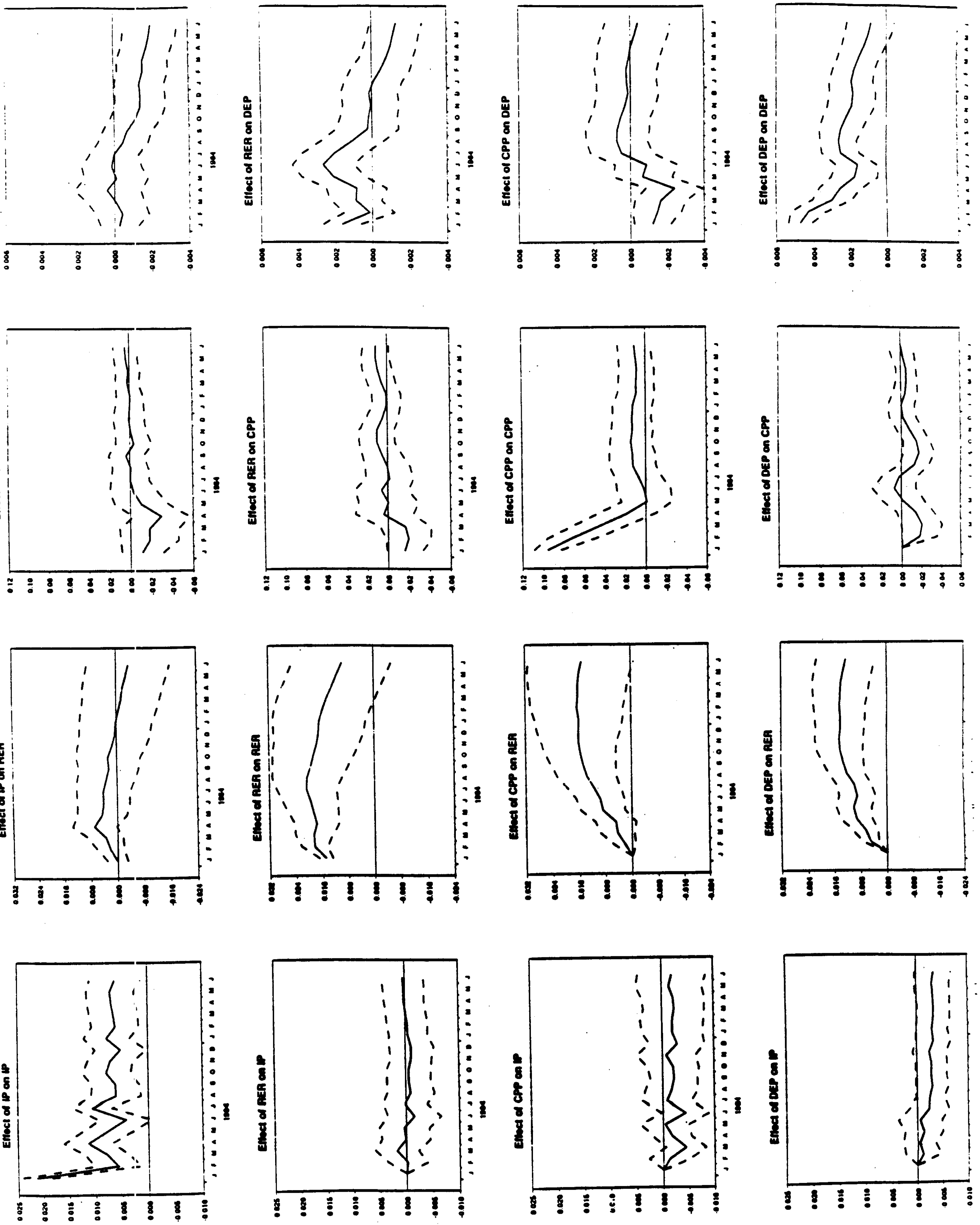
Effect of CRED on CRED

-FIGURE 3-

- FIGURE 4 -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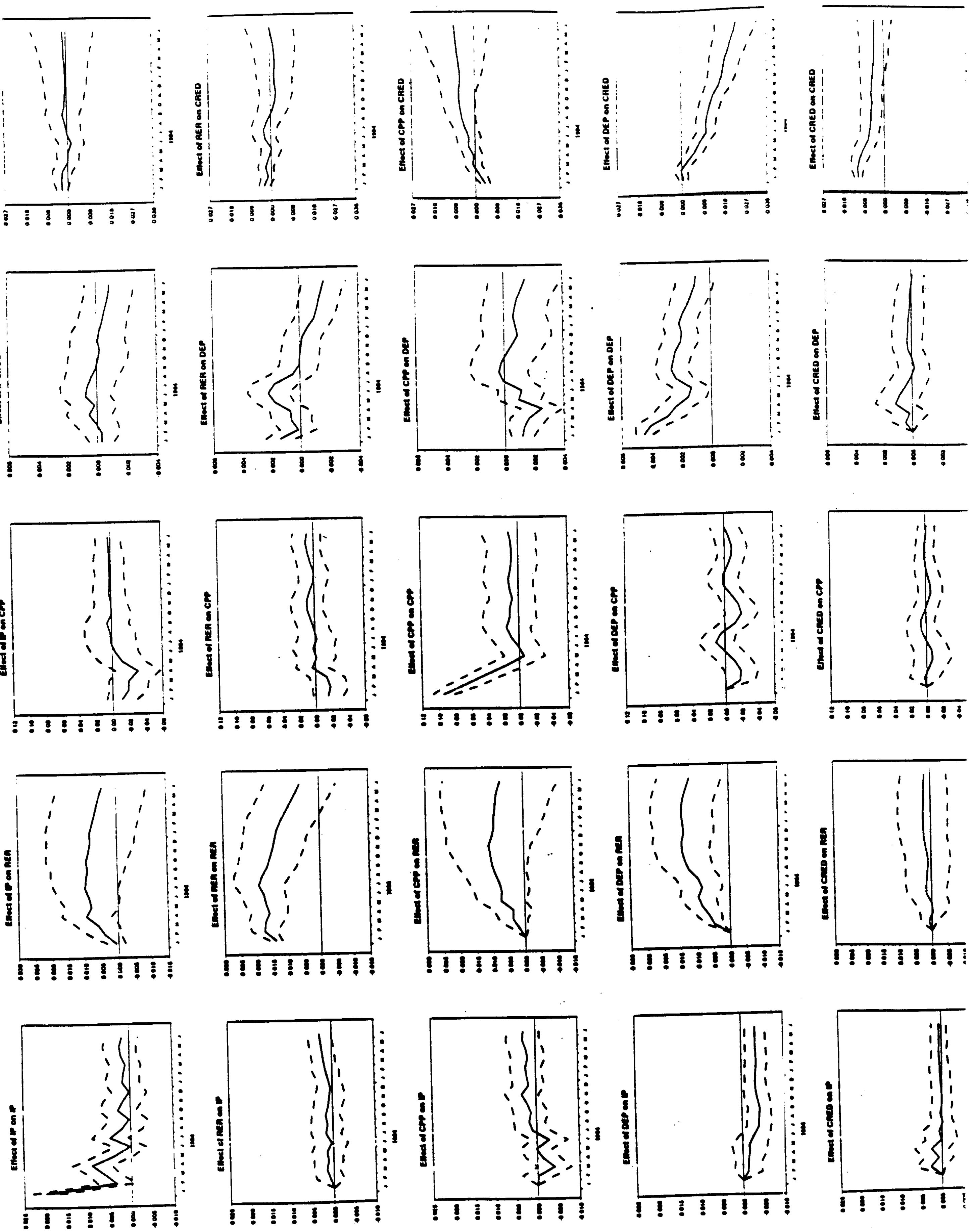
1984

- FIGURE 5 -



Effect of IP on CRED
Effect of RER on CRED
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Effect of DEP on CRED
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Effect of IP on DEP
Effect of RER on DEP
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Effect of DEP on DEP
Effect of CRED on DEP
Effect of IP on CPP
Effect of RER on CPP
Effect of CPP on CPP
Effect of DEP on CPP
Effect of CRED on CPP
Effect of IP on RER
Effect of RER on RER
Effect of CPP on RER
Effect of DEP on RER
Effect of CRED on RER
Effect of IP on IP
Effect of RER on IP
Effect of CPP on IP
Effect of DEP on IP
Effect of CRED on IP

**BIBLIOGRAPHY**

Bernanke, S. Ben. (1986) "Alternative Explanations of the Money-Income Correlation", in K.Brunner and A. Meltzer, eds., Real Business Cycles, Real Exhange Rates and Actual Policies. *Carnegie-Rochester Conference Series on Public Policy* 25 p.49-100

Bernanke, S.Ben and Blinder, S.Alan. (1988) "Is it Money or Credit, or Both, or Neither?: Credit, Money and Aggregate Demand." *American Economic Review, Papers and Proceedings* 78 May 1988 p.435-439.

Bernanke, S.Ben and Blinder, S.Alan (1982) "The Federal Funds Rate and the Channels of Monetary Transmission". *American Economic Review, Papers and Proceedings* 82, Sept 1992.

Blinder, A.S., and Stiglitz, J.E. (1983) "Money, Credit Constraints, and Economic Activity." *American Economic Review* 73 May 1983 p.297-302.

Calvo, A.Guillermo and Kumar, S.Manmohan (1994) "Money Demand, Bank Credit, and Economic Performance in Former Socialist Economies." *IMF Staff Papers* v.41:2, June 1994.

Copelman, M. (1994) "The Role of Credit in Post-Stabilization Consumption Booms." *MIT thesis*, May 1994.

Dornbusch, R. (1983) "Real Interest Rates, Home Goods, and Optimal External Borrowing," *Journal of Political Economy* vol91 N1. February 1983. p.141-153.

Dornbusch, R. and Werner, A.M., (1994) " Mexico: Stabilization, Reform And No Growth," *Brookings Papers on Economic Activity*. Vol 1 1994.

Gali, J. (1992) "How Well Does the IS-LM Model Fit Postwar U.S. Data." *Quarterly Journal of Economics 1992.*

Kashyap, A.K, Stein, J.C, and Wilcox, D.W. (1991) "Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance." *Manuscript* March 1991.

King, S.R. (1986) "Monetary Transmission: Trough Bank Loans or Bank Liabilities?" *Journal of Money, Credit, and Banking*, 18:3 August 1986 p.290-303.

Loungani, P. and Rush, M. (1995) "The Effects of Changes in Reserve Requirements on Investment and GNP." *Journal of Money, Credit, and Banking*, May 1995. p.512-525.2

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