Stanford
Center for International Development

Working Paper No. 111

Investment by Manufacturing Firms and the Transmission of Monetary Policy in Mexico

by

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November 2001

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Abstract

The behavior of investment by Mexican manufacturing firms is analyzed for the period 1984-1999, which can be characterized by several structural changes, i.e. financial liberalization, the re-privatization of commercial banks, significantly reduced the financing needs of the public sector, and an almost complete freezing of bank intermediation after the 1994 financial crisis. Standard investment equations are estimated with special attention paid to the relevant differences between the cost of internal versus external funds. This paper finds that internal funds, in the form of cash flow, have been significant in financing capital expenditures, especially by small firms. On the other hand, real interest rate movements also seem to have affected capital formation by firms throughout the period. Moreover, I find that capital expenditures by large firms are more responsive to real interest rate changes than investment by medium and small firms. This is evidence for the role of the credit channel of monetary policy. Finally, although I find that investment by small firms has become more responsive to changes in cash flow during the second half of the1990s, the interest rate elasticity of investment does not seem to have changed during the episodes that commonly characterized the evolution of credit markets in Mexico.

[*] Paper presented at the Conference on Mexican Credit organized by the Center for Research on Economic Development and Policy Reform at Stanford University, October 5-6, 2001. I thank A. Tornell, J.A. González, C. Woodruff, M. Messmacher, L. Martínez, A. Werner, G. Marrufo, L. Videgaray for comments, and S. L. Orozco for research assistance. All remaining errors are mine, and the views expressed here do not necessarily coincide with those of the Bank of Mexico. Comments welcome at: osanchez@banxico.org.mx.

I. Introduction

During the past twenty years, Mexico's financial system has undergone several structural changes. Financial liberalization, the re-privatization of commercial banks, and the reduction in the financing needs of the public sector caused domestic credit to expand during the early 1990s. However, the 1994 financial crisis almost caused all financial intermediations by banks to cease, which severely restricted the supply of funds to firms during the second half of the 1990s. Parallel to these developments, the economy went from a practically fixed exchange rate regime, during the 1980s and first half of the1990s, to a full-fledged floating exchange rate regime after the mid-1990s. Therefore, the greater flexibility of the exchange rate regime implied that investment flows to Mexico are now more stable, thus improving Mexican firms' ability to access foreign capital.

The evolution of Mexico's financial system, and macroeconomic framework at larger, influenced the access of Mexican firms to investment funds. On the other hand, how firms financed their investments also limited the effect of monetary policy changes on capital formation by firms. This study provides some empirical evidence on how the developments described above affected the way in which real interest rate changes impacted firms' investment behavior in Mexico throughout the 1980s and 1990s.

The analysis concentrates on the behavior of manufacturing firms during 1984-1999, a period that is characterized by the structural changes just mentioned. Standard investment equations are estimated with special attention paid to the relevant differences between the cost of internal versus external funds. This paper finds that internal funds, in the form of cash flow, have been significant in financing capital expenditures, especially by small firms. This result suggests credit market imperfections in the Mexican economy. On the other hand, real interest rate movements also seem to have affected capital formation by firms throughout the period. Moreover, I find that capital expenditures by large firms are more responsive to real interest rate changes than investment by medium and small firms. This is evidence for the role of the credit channel of monetary policy. If one takes into account the fact that fluctuations in domestic interest rates given international capital mobility are partly explained by changes in foreign interest rates, I find that foreign interest rates have significantly affected investment behavior by manufacturing firms in Mexico. Finally, although I find that investment by small firms has become more responsive to changes in cash flow during the second half of the1990s, the interest

rate elasticity of investment does not seem to have changed during the episodes that commonly characterized the evolution of credit markets in Mexico.

The paper is organized as follows. The next section gives an overview of the recent developments in the Mexican economy, and of how these developments have affected domestic credit markets during the past twenty years. Section III proposes the main hypothesis of the paper, and Section IV reviews the relevant literature. Section IV presents a simple empirical model. Section V describes the data. The main results are presented in Section VI, and Section VII offers some concluding remarks.

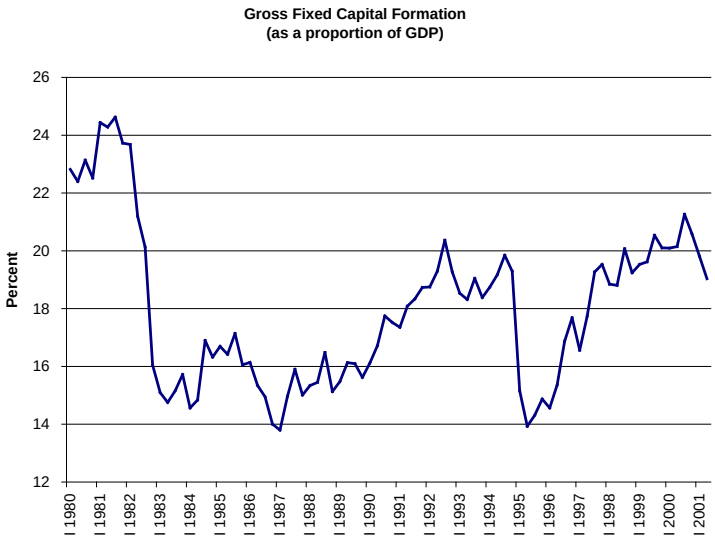
II. Evolution of the Mexican Economy and Its Impact on Credit Markets

Mexico became a net exporter of capital as a result of the 1982 debt crisis. During the period 1981-1985, net inflows of foreign resources fell from 7.4 percent of GDP to –5.8 percent. After the devaluation of 1982, the main priority of the government was to control inflation and reestablish the external balance, with a substantial reduction in the fiscal deficit being the policy focus. Exchange rate depreciation was controlled with the intention of containing price increases, resulting, however, in a significant appreciation of the real exchange rate. During 1985, the recessionary effects of the real exchange rate appreciation, the lack of external credit, combined with the Mexico City earthquake, contributed to slower economic growth. In 1986, the fall in oil prices further dampened investment and growth. Consequently, the government adopted a more aggressive exchange rate policy in 1987, by allowing the real exchange rate to depreciate at a higher (constant) rate. The resulting improvement in international competitiveness favored the manufacturing exports sector, while other sectors of the economy deteriorated because of the contracting domestic demand. As a result of the nominal depreciation, the rate of inflation rose to 159 percent in 1987.

In order to avoid previous price stabilization programs, the government led a concerted effort -- with businesses, workers and farmers -- to reduce nominal wage and price inertia, to maintain a conservative monetary policy, to accelerate trade liberalization, and to further reduce the public sector deficit by undertaking an important privatization program. A fixed exchange rate regime was adopted, later followed by a crawling peg. As a result of these measures, the inflation rate fell to 19.7 percent in 1989, and the primary fiscal surplus reached 8 percent of

GDP. Although the 1985 level was re-attained, investment was still discouraged by high nominal interest rates and a limited access to international capital markets (Figure 1).

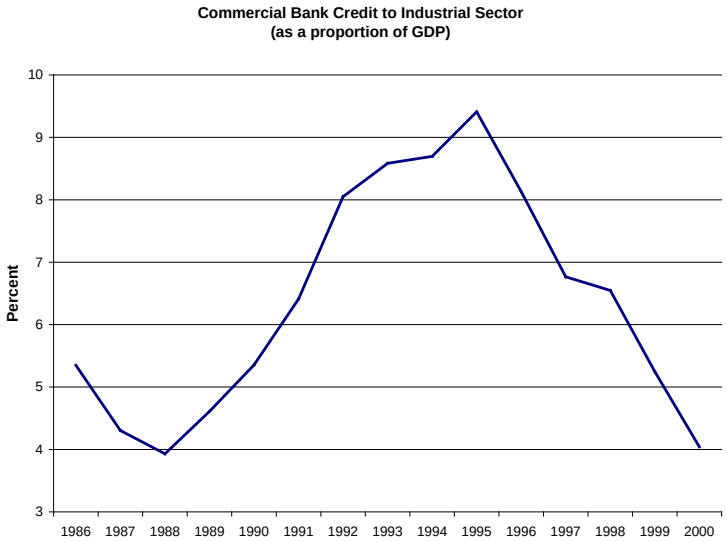
Figure 1



The financial liberalization, which started in 1988, consisted of interest rate liberalization, the elimination of credit quotas and forced loans, and the abolition of obligatory reserves. Almost completed by 1990, financial liberalization was achieved with the complete privatization of commercial banks in 1992. From then on the government entered the financial markets mainly to issue domestic bonds (Cetes). This, together with a significant reduction in the public sector's financing needs, led to an important "crowding in" effect for the private sector. The latter's access to credit increased significantly, especially as domestic savings were further complemented by foreign capital inflows during the first half of the 1990s (Figure 2).

During the period 1988-90, the economy recovered, with GDP growing at average rate of 3.5 percent annually. In 1990, the government renegotiated foreign debt under the Brady plan, resulting in a significantly reduced debt-service-to-GDP ratio, capital repatriation, and lower domestic interest rates. Contrasting with the rise in investment and consumption during 1991-1992 due to financial liberalization, economic growth was a mere 0.6 percent in 1993 as the economy slowed down that year.

Figure 2



Despite a higher growth in 1994, the problems accumulated during the years of large capital inflows and financial liberalization, combined with the negative external and domestic shocks to the economy, led to a balance of payments and financial crisis at the end of the year.[1] Tight monetary policy was implemented again in order to contain the inflationary effects of the devaluation. To make this policy credible, it became necessary to spell out the specific programs that would resolve the banking sector problems, and the costs that would be borne through fiscal adjustments. So, a key element in the new floating exchange regime was a monetary policy that serves as the nominal anchor with sole objective to stabilize inflation. Fiscal policy was tightened also, with a doubling of the primary surplus in 1995. Moreover, additional revenues were needed to start absorbing some of the costs of the banking sector rescue package.

During the years following the crisis, economic activity and employment suffered considerably because of falling domestic demand, reduced government spending, increased tax rates, high real interest rates, and vanishing credit. As the exchange rate stabilized, interest rates fell, and international financial markets resumed lending to Mexico. Thanks to the broad restructuring that the economy had undergone in the previous decade, especially the closer economic ties with the US, economic activity recovered rapidly as growth in the US started to

peak. Thus, consumption and investment in Mexico recovered strongly after 1995, with GDP growing at an average annual rate of 5.5 percent during 1996-2000. Moreover, the inflation rate dropped rapidly from 51.7 percent in 1995 to 9.6 percent in 2000.

Once the worst moment of the crisis passed, the floating exchange rate regime, together with the market-determined interest rates, contributed to a substantial reduction of speculative pressures in financial markets. A relevant feature of the floating regime was that it curbed the inflow of short-term capital, because now investors have to bear the foreign exchange risks. The proportion of the current account deficit financed by long-term capital inflows rose significantly.

During 1995-2000, Mexico continued to gear its industrial sector towards exports. Thus, during the second half of the 1990s, the share of exports in GDP doubled. Economic growth and price stability also eased the labor market, with average annual growth of formal employment reaching 6.3 percent from 1996 on. On the other hand, the rate of open unemployment, which reached 7.6 percent in august 1995, fell to 1.9 percent in October 2000, the lowest since the statistic is published. Finally, investment and consumption recovered with GDP growth averaging 5.5 percent from 1996 to 2000, and the inflation rate fell from 51.7 percent in 1995 to 8.9 percent in 2000.

As to the financial system, the government followed a comprehensive strategy to deal with the weaknesses that became evident during the crisis, where the over-indebtedness by firms and households almost caused a run on the banking system. The government implemented programs with the main objectives to combat moral hazard and minimize distortions, to strengthen regulation and supervision, and to reduce the need for the Central Bank to act as lender of last resort. Based on these objectives, credit lines denominated in foreign currency were opened at a penalty rate, so that commercial banks now find it easier to fulfill their external obligations. Moreover, the government initiated a program to recapitalize the banking system and legal reforms to allow greater foreign participation. Despite all these measures, Mexico's banking system experienced a pronounced contraction between 1995 and 2000, with credit to the industrial sector falling to the level prior to financial liberalization (Figure 2). Nonetheless, after the financial crisis in 1995, fixed capital formation rate recovered relatively quickly, remaining close to 20 percent from late 1998 on (Figure 1).

[1] To honor the financial commitments of the country, and more importantly, to induce creditors to roll-over maturing loans, the government negotiated a 52-billion dollar emergency support package with the international community, with the U.S. government and the IMF as the main suppliers of financial assistance.

III. The Hypothesis

The objective of this paper is to provide some empirical insight on the effect of monetary policy changes on capital accumulation by manufacturing firms in Mexico. To do so, it is important to first take into account the role of credit market imperfections in the monetary policy transmission mechanism in Mexico. Because with such imperfections persisting in domestic credit markets, a change in the monetary policy that raises the real interest rate reduces capital expenditures by firms, not only through its direct effect on financing costs but through several additional channels.

Bernanke and Gertler (1995) identify two mechanisms through which the "credit channel" of monetary policy transmission operates -- the bank lending channel and the financial accelerator mechanism. In the lending channel, a rise in interest rates leaves riskier projects in the pool of financially viable projects, increasing the monitoring costs for commercial banks. The rise in banks' intermediation costs eventually requires higher spreads, which reduces credit supply and discourages investment.[2] Through the financing accelerator mechanism, a rise in interest rates reduces the assets owned by economic agents. Since assets are used as collateral, there are higher agency costs in bank lending, and thus aggravate the conditions under which agents access credit markets.

An alternative version of the latter channel is the effect of interest rate changes on stock prices, which at the equilibrium should reflect the market value of a firm's future income stream. According to Tobin's q theory of investment, whenever the value of the firm lies below the cost of capital, a reduction in investment will follow. The presence of asymmetric information in credit markets reinforces this effect, since a firm's access to external finance hinges on the collateral it is able to offer, which depends on the value of the firm's assets as approximated by the market value of its stock. Therefore, increases in interest rates that are associated with a fall in stock prices make it harder for firms to access domestic credit markets.

These mechanisms apply to firms that, in general, have some access to credit, and especially to those large enough to be listed on the domestic stock exchange. However, when firms are prohibited from borrowing from banks to begin with, monetary policy will have little impact on investment through the lending channel. In this case, the transmission of monetary policy through the financial accelerator mechanism will be more pronounced. The muted effects

[2] Bernanke and Blinder (1988).

of the lending channel occur when loanable funds do not flow, either because interest rates are not fully market-determined, or because credit bureaus with the agenda to support certain sectors dictate financial intermediation. It could also happen when, after a banking crisis, commercial banks are so undercapitalized that no lending would occur at viable rates. Under these circumstances, a significant number of firms will be denied access to the domestic credit market. Moreover, firms that have access to alternative forms of credit, be them foreign supplier's credits or debt or equity issued in foreign markets, will opt out of the domestic credit market.

Comparing how investments by different type of firms respond to changes in macroeconomic conditions can reveal the relevant credit market imperfections. This approach exploits the idea that small firms are likely to face higher premiums when obtaining external funds. Larger firms not only tend to own more assets that can serve as collateral and are able to negotiate better terms with domestic banks, but they are also more likely to meet the conditions to be listed on the domestic stock exchange and thus have alternative sources of funds.

A question then arises: whether rising interest rates, due to monetary policy changes of the Central Bank, would have any effect on domestic private investment.

IV. Review of the Literature

IV.1. Credit Channel

Among the empirical studies that have looked at the macroeconomic relevance of credit market frictions, Gertler and Gilchrist (1994) concentrate on the different responses of small versus large firms to changes in various monetary policy indicators. They find that small firms are more sensitive to monetary policy shifts, which they explain through a model where credit market imperfections introduce risk aversion on the part of firms, making their behavior excessively sensitive to earnings flows and interest rate changes. Harris et al (1994) discuss whether financial reforms have had an impact on investment and on the allocation of credit, and whether these effects differ depending on the types of firms. They find that shifting from administrative toward market-based credit allocation has raised borrowing costs, particularly for smaller firms, while at the same time benefiting them by allowing a wider access to external finance. Kim (1999) studies how the credit channel in Korea was affected by the financial crisis of 1997-98. He looks at aggregate financial data and disaggregate bank balance sheets, and finds

that bank lending significantly amplified the real contraction that resulted from the restrictive monetary policy adopted after the crisis.

For the case of Mexico, Copelman and Werner (1995) analyze whether devaluation expectations, the cash/deposit ratio, and a measure of financial deregulation resulted in a quantitative change of real credit in the economy. They find that, for the period 1984-94, different indicators of credit shocks had very significant impact on investment and output. Gelos and Werner (1999) examine the effects of financial liberalization on fixed capital investment in Mexico. They use establishment level data from the Annual Industrial Survey of the manufacturing sector in Mexico.[3] They analyze changes in cash flow sensitivities across different firm sizes, and obtain estimates showing that cash flow is significantly correlated with investment before and after financial liberalization. They also study the relevance of collateral in credit operations, and find that banks' reliance on collateral increased after financial liberalization eased the constraints for small firms.

Finally, Martínez et al (2000) analyze how the behavior of the spread between active and passive rates offered by banks is affected by changes in interest rates, and find a statistically and economically significant effect. Moreover, the authors also analyze the behavior of non-financial firms that are listed on the Mexican stock exchange. They study how credit between companies is affected by real interest rate changes, finding again a statistically significant effect.

IV.2 Capital Market Imperfections and Investment

If all firms had equal access to capital markets, their responses to changes in the cost of capital would differ only because of different investment demand. Indeed, in a Modigliani-Miller world measures of firm's liquidity should not enter significantly in a correctly specified investment regression, given that internal and external funds are perfect substitutes for the firm. In contrast, in an environment where information asymmetries prevail as a result of bankruptcy costs and contract enforcement problems, external funds will be more costly for the firm than internal funds. The wedge between them arises from the need to compensate lenders for adverse selection and moral hazard problems on the borrower's side. Generally, the theory predicts that the premium on external funds will decrease with the firm's net worth. Moreover, since internal

[3] The dataset utilized in the present study also comes from the Mexican Annual Industrial Survey.

funds in the form of cash flow both improve the firm's current financial position and increase the funds available for investment, investment should respond positively to increases in cash flow.

A substantial body of literature has emerged in recent years analyzing the effects of financial constraints on investment. The usual methodology is to examine whether adding cash-flow measures to standard investment equations helps to explain the behavior of capital expenditures. Empirically, the major problem with this approach arises from the possibility that cash flow may be correlated with investment for other reasons. Even without financial constraints, since current cash flow is often a good predictor of future profitability, firms' acquisition of new assets will respond to increases in cash flow.

This identification problem can be resolved by including a proxy for expected profitability, such as Brainard/Tobin's marginal q, in the regression. However, in practice it appears that average q has low explanatory power in investment equations.[4] Moreover, including a traditional proxy for q in a regression together with a liquidity variable has a weak theoretical justification. In principle, the problem can be avoided by estimating the Euler equations directly, since this way the impact of future profitability on current decisions can be controlled for. The difficulty with this method is that the small sample properties are poor and it is very susceptible to misspecification problems.

An alternative is to focus on the differences across firms that are likely to indicate their relative access to external financing and the size of the premium on external funds they face, as suggested by Fazzari et al (1988). For example, small firms are more likely to be liquidity constrained. The argument is that there are economies of scale in the collecting and processing information that mitigates the problems associated with asymmetric information between borrowers and lenders. Smaller firms are also more likely to have lower collateral and be exposed to higher idiosyncratic risks. The rest of this paper follows this line of argument.

V. A Simple Empirical Model

Tobin's q model of investment and the accelerator model are the most common econometric specifications used to explain the behavior of investment flows. Since the dataset does not contain information on firms' financial flows, it is hard in this context to arrive at a

[4] See Chirinko (1997) and Gilchrist and Himmelberg (1998).

reasonably accurate estimate of Tobin's q. Therefore the accelerator model seems a suitable alternative.

Accelerator models come in many forms.[5] Assume that under the absence of adjustment costs, the desired capital stock can be written as a log linear function of output and the user cost of capital. Thus, under a CES production function subject to constant returns to scale the desired capital stock will be given by

$$k_{it} = a - bC_{it} + y_{it}$$

where k_{it} denotes the (natural) log of the desired capital stock for firm i in period t, C_{it} denotes the log of the real user cost of capital and y_{it} denotes the log of the firm's output. Taking first differences on both sides of the previous equation and using the approximation $I_{it} \approx (-\delta + \Delta K_{it}) K_{it-1}$, where δ is the rate of depreciation, we obtain

$$\frac{I_{it}}{k_{it-1}} = \delta - br_{it} + \Delta y_{it} \qquad (1)$$

where r_{it} is the real interest rate faced by firm i during period t. Equation (1) summarizes the fundamental relationship over which the empirical analysis in this section is based upon. It is important to note, however, that in the following econometric analysis we make several assumptions in order to arrive at reasonable estimates of the parameters involved.

Given that in the context of an economy where credit markets have not functioned effectively for a long time (namely, during the period before financial liberalization, 1984-88; and after the financial crisis, 1995-2000), we want to account for the effect of financial factors when estimating a behavioral relationship for capital expenditures by the firm. Therefore, in order to study the effect of liquidity constraints on investment we include firms' cash flow (CF_{it}) as an additional explanatory variable. So, in the specification given by equation (2), ϕ captures the sensitivity of investment to changes in cash flow

[5] See Eisner and Nadiri (1968).

$$\frac{I_{it}}{K_{it-1}} = \beta \frac{\Delta S_{it}}{K_{it-1}} + \phi \frac{CF_{it}}{K_{it-1}} + \lambda_t + \nu_i + \varepsilon_{it} \qquad (2)$$

where K_{it-1} and ΔS_{it} denote firm i's capital stock at t-1 and the change in sales in period t, respectively, β measures the sensitivity of the flow of investment to changes in sales,[6] and where ε_{it} is a stochastic error. Other variables that are incorporated in the estimation will be discussed below. In this specification ν_i denotes firm specific effects and λ_t captures factors that are common to all firms. Note that since we do not have access to data on the user cost of capital specific to each firm, we must assume that this variable enters equation (2) as a factor that is common to all firms in the sample. In the equations that we estimate below we allow ϕ, the cash flow coefficient, to vary with the size of the firm, and in order to capture the difference in these coefficients we introduce interactive dummies for the different firm sizes considered.

VI. Dataset and Variables

This study uses annual panel data of Mexican manufacturing industries covering the period 1984-1999.[7] The dataset comes from the Annual Industrial Survey conducted by Mexico's National Institute of Statistics, Geography and Information (INEGI[8]). The methodology of this survey changed in 1994. For the period 1984-94 the survey covered 3,199 manufacturing establishments grouped into 129 3-digit industries. For the period 1994-99, the survey covered 6,226 establishments grouped into 205 3-digit industries. Since the Annual Industrial Survey is used as an input for the Industrial Census and annual GDP calculations, its sample size accounts for roughly 80 percent of value added in manufacturing. The completion of the questionnaire is compulsory, and the purpose of the survey is merely statistical and not linked to tax collection.

The unit of observation of the survey is the manufacturing establishment. However, since the collecting agency does not provide information at the plant level, I can only work at the 3-digit industry level, where plants are grouped into industrial classes. The new methodology effective after 1994 increased the number of establishments considered in the sample and

[6] If, instead of using the change in total production, the change in sales were utilized, the empirical results would not vary significantly.
[7] In-bond industries (maquiladoras) are not included.
[8] Instituto Nacional de Estadística, Geografía e Informática.

partitioned some 3-digit level industries into two or more industrial classes. In order to account for this change in methodology in 1994, all industrial industries that had split into two or more classes under the new methodology are dropped. Therefore, the following analysis includes only those industrial classes that remained unchanged in terms of their definition. This means that for the 3-digit level industries in this study, only the number of plants changed with the new methodology. Since we have information on the number of plants in each industry, we were therefore able to characterize the behavior of the average plant in each 3-digit industry for both sub-periods, 1984-94 and 1994-99.[9] This is how the dataset covers the whole period 1984-99. After eliminating extreme outliers and classes with incomplete and inconsistent data, I have a panel of 87 industrial classes. Details on the criteria used for the elimination of outliers are given in Appendix I.

The survey contains variables on production, input use, labor, sales, inventory, investment expenditures and capital stock. Data on investment expenditures are grouped into five categories: machinery, transport equipment, land, buildings, and others. As can be noted, although information on financial flows is absence, the survey is very specific about the types of investment expenditures.

Based on the survey, I compiled data on investment, capital stock, number of employees, change in sales and cash flow. The variables that are utilized in this study were constructed according to the following methodology:

Investment (I_{it}): it is calculated as the sum of acquisitions of machinery, transport equipment and buildings plus improvements minus sales of these types of assets.

Capital Stock (K_{it}): The survey includes this variable for five asset classes (machinery, land, buildings, transport equipment and other) valued at replacement cost for each year. However, I constructed an alternative evaluation for the capital stock based on a perpetual inventory method. With the replacement value of capital reported for 1984 (the beginning of the survey) I utilized reported investment values to build the capital stock for the subsequent years. I assumed depreciation rates for land, buildings and other assets.

[9] The dataset is balanced in the sense that exiting plants are discarded from the sample by the collecting agency, according to whom few exiting plants were discarded.

Cash Flow (CF_{it}): Since Mexican law requires every firm to pay out ten percent of profits to its employees, to obtain cash flow we simply multiplied the profit-sharing figures by ten and added reported depreciation (which in most cases reflects accounting, not economic values).[10]

Change in Sales (ΔS_{it}): This variable is defined simply as the annual change in reported sales.

Price Indices: The producer price index was used as a deflator for Investment and the Capital Stock. For Cash Flow and the Change in Sales I used the wholesale price index. All indices are the average for the corresponding year.

According to the total number of employees, the establishments were classified into three size categories. Plants with less than 100 employees were classified as small, establishments with 100 - 200 employees were categorized as medium, and those with more than 200 employees were considered large. The main characteristics of the different group of plants are presented in Table 1.

Table 1. Summary of Firm Characteristics

	Employees by Firm	Investment / Kt-1	Cash Flow / Kt-1
Small	72	0.10	0.21
	(20)	(0.2)	(0.2)
Medium	138	0.10	0.23
	(15)	(0.1)	(0.3)
Large	337	0.13	0.28
	(233)	(0.2)	(0.3)

VII. Empirical Results

VII.1 Investment and Cash Flow

The initial results are presented in Table 2.

[10] See Gelos and Werner (1999) for more details on the reasoning behind this methodology as a measure of Cash Flow in the context of the Annual Industrial Survey.

Table 2. Regression Results

	1	2	3	4
Constant	0.041	0.038	0.000	0.000
	(9.15)	(8.38)	(-0.014)	(-0.018)
Cash Flow/ Kt-1	0.29	0.30	0.48	0.48
	(24.12)	(24.03)	(17.71)	(17.52)
ChSales/Kt-1	0.002	0.002	0.001	0.001
	(1.85)	(1.67)	(1.46)	(1.32)
CF(dummy Lg)			-0.27	-0.27
			(-8.43)	(-8.12)
CF (dummy Med)			-0.19	-0.18
			(-5.46)	(-5.36)
Sample	85-99	85-99	85-99	85-99
		Excluding 95		Excluding 95
# of Observations	1305	1218	1305	1218
Adjusted R2	0.31	0.32	0.35	0.36
F	295.8	293.1	115.9	113.9

In regression number 1 a simple investment equation is estimated where the share of current investment on the capital stock is explained by the change in sales and cash flow, both as a proportion of the lagged capital stock. Both coefficients are statistically significant and of the expected sign. This first regression is estimated for the whole sample period. In the second regression, 1995, a year of an extraordinary fall in aggregate investment expenditures, is excluded from the sample with the results remaining practically unchanged.

It is important to note that in these regressions coefficients of both Cash Flow and the Change in Sales are of the expected sign and statistically significant. To the extent that the Change in Sales captures the existence of investment opportunities for the firm, the statistical significance of the variable Cash Flow implies that it reflects credit market imperfections.

Regressions 3 and 4 attempt to capture variations in the cash flow coefficient that depend on the size of the firm. This is done by incorporating dummy variables (that interact with the variable Cash Flow) according to whether the data on investment, sales and cash flow correspond to a large or medium firm.

As in Regressions 1 and 2, the coefficients for the variables Cash Flow and Change in Sales are of the expected sign. However, for the latter variable the coefficient is not statistically significant. The parameters for the interactive dummies are statistically significant, therefore suggesting that the estimates of Cash Flow coefficients vary with firm size. Moreover, the

negative sign of the interactive dummy coefficients indicates that capital expenditures by large and medium firms are less sensitive to changes in Cash Flow than investment by small firms.

From the results, the Cash Flow coefficient for small firms is 0.48, which means that a rise of 1% in the firm's cash flow leads to an increase of 0.48% in investment. On the other hand, a 1% increase in Cash Flow leads to a 0.29% (= 0.48-0.19) increase in investment by medium firms, and a 0.21% (= 0.48-0.27) increase in investment by large firms. The evidence seems to suggest that capital expenditures by small firms are twice as sensitive to changes in cash flow than investment by large firms. From this result we can conclude that other sources of finance, i.e. external funds, are not as accessible for small firms as they are for medium or large firms. We can interpret the relationship between access to external funds and firm size as a result of agency problems in credit markets.

VII.2 The Effect of Real Interest Rate Changes on Capital Expenditures by Firms

Given the evidence on credit market imperfections, the response of economic agents to macroeconomic disturbances will be different from the one that would prevail in markets with complete information. Therefore, firms' capital expenditures could be affected by macroeconomic disturbances in ways other than where agency problems are not present. In particular, monetary policy changes that raise the real interest rate could affect capital expenditures by firms not only through the usual cost channel but also through the credit channel as explained earlier. Moreover, a rise in the real interest rate could affect small and large firms in different degrees, since firms access the market for credit under different conditions depending on their size.

In order to capture how real interest rate fluctuations affect capital expenditures by manufacturing firms, an additional variable is now introduced into the analysis, namely, the real interest rate. A proxy for this variable is constructed by adjusting the nominal rate on short-term government bonds (Cetes) by the observed inflation rate for the previous twelve months.[11] Therefore, ex post real interest rates are used, given that prior to 1997 no other indicator of inflation expectations is available for the Mexican economy.

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[11] That is, $r_t = \frac{1+i_t}{1+\pi_t} - 1,$ where i_t is the nominal return on 28 day CETES, and π is the inflation rate observed during the past twelve months.

Therefore, in this section we estimate the following econometric model

$$\frac{I_{it}}{K_{it-1}} = \beta \frac{\Delta S_{it}}{K_{it-1}} + \phi \frac{CF_{it}}{K_{it-1}} + r_t + \lambda_t + \nu_t + \varepsilon_{it} \qquad (3)$$

where r_t is the real interest rate. The results are presented in Table 3.

Table 3. Regression Results

	1	2	3	4
Constant	0.018	0.019	0.012	0.012
	(2.01)	(2.13)	(1.19)	(1.16)
Real Interest Rate	-0.002	-0.002	-0.001	-0.001
	(-4.88)	(-5.47)	(-1.94)	(-1.97)
Cash Flow/ Kt-1	0.47	0.47	0.47	0.47
	(17.33)	(17.16)	(17.31)	(17.20)
Sales Change/Kt-1	0.0014	0.0013	0.0014	0.0013
	(1.54)	(1.43)	(1.54)	(1.42)
Cash Flow(dum Lg)	-0.27	-0.26	-0.27	-0.27
	(-8.34)	(-8.05)	(-8.42)	(-8.21)
Cash Flow (dum Med)	-0.18	-0.18	-0.18	-0.18
	(-5.31)	(-5.18)	(-5.37)	(-5.29)
RIR (dum Lg)			-0.0009	-0.0013
			(-1.16)	(-1.60)
RIR (dum Med)			-0.0005	-0.0008
			(-0.68)	(-0.90)
Sample	85-99	85-99 Excluding 95	85-99	85-99 Excluding 95
# of Observations	1305	1218	1305	1218
Adjusted R2	0.36	0.37	0.36	0.37
F	104.5	104.2	81.4	81.4

In regressions 1 and 2, the estimates for the Cash Flow coefficients are of the right sign and significant. As before, the dummies that interact with Cash Flow are also statistically significant, indicating that investment by small firms is more sensitive to changes in cash flow. Moreover, the estimates for the coefficient of Changes in Sales are of the expected sign albeit not statistically significant. Finally, the coefficient on real interest rate is statistically significant and

of the expected negative sign. Therefore, a rise of 100 basis points in the real interest rate causes a fall in investment by Mexican manufacturing firms of between 0.16 and 0.19%.[12]

These results conclude that real interest rate changes affect capital expenditures by firms not only through their effects on financing costs, but also through other mechanisms. There is evidence for the existence of credit market imperfections. However, one should also note that this is not a direct test for the alternative channel through which real interest rate changes affect investment.[13]

In regressions 3 and 4 of Table 3, we can ascertain whether the effects of changes in real interest rates on capital expenditures depend on firm size. In regression 3, the coefficient for the dummy variable corresponding to large firms that interacts with the real interest rate is statistically insignificant. However, when the year 1995 is withdrawn from the sample, as is done in regression 4, this coefficient has the right sign and is statistically significant. Moreover, the estimate for the interest rate semi-elasticity of investment is more than twice of the corresponding coefficient for small firms. That is, a one percent rise in the real interest rate causes a fall of 0.25% in investment expenditures by large firms, and a fall of 0.12% in investment by small firms.

This result indicates that the effect of changes in the real interest rate on capital expenditures is stronger for large firms than for small firms, which could be justified by the fact that large firms relies more heavily than smaller firms on the formal credit market. In other words, given that the cost of external funds to the firm are associated with the real interest rate, large firms, which have a greater exposure to formal credit, are more affected by changes in real interest rates.

The results obtained here reinforce the evidence found earlier in favor of the existence of credit market imperfections. Moreover, based on these results we can conclude that:

a) changes in real interest rates seem relevant to the behavior of investment expenditures by manufacturing firms in Mexico, and
b) the effect of changes of real interest rate is stronger for larger firms.

[12] These results are consistent with the effect of a rise in the exante real interest rate on the output gap obtained by Martinez et al (2001).
[13] In order to do this we would need to perform an additional test where we analyze for example the effect of real interest rate changes on the capital stock of different types of firms.

The Sensitivity of Investment by Firms in the Exportable Sector to Real Interest Rate Changes

Given that large firms are more likely to be export-oriented, I test whether export-oriented firms are also more sensitive to real interest rate changes than firms that concentrate their operations in the domestic market.

In order to perform this test we first need to classify firms according to whether part of their output is sold abroad. I classified firms that sell at least 15% of their output to foreign entities as being export-oriented. Surprisingly, not all export-oriented firms are large.[14]

In a similar exercise (see Table 4), I analyze whether export-oriented firms are less sensitive to cash flow changes. According to regressions 1 and 2, although the coefficient of the export-orientation dummy that interacts with the cash flow variable is negative, its size is very small and not statistically significant. Therefore, there is some evidence supporting the hypotheses that export-oriented firms are less sensitive to cash flow changes.

Table 4. Regression Results

	1	2	3	4
Constant	0.01	0.01	0.03	0.03
	(1.55)	(1.35)	(2.27)	(2.32)
Cash Flow / Kt-1	0.37	0.37	0.36	0.36
	(11.91)	(11.64)	(11.50)	(11.20)
Real Interest Rate			-0.001	-0.001
			(-1.67)	(-2.07)
Sales Change / Kt-1	0.023	0.023	0.023	0.024
	(4.84)	(4.68)	(4.95)	(4.91)
Cash Flow (dummy X)	-0.032	-0.025	-0.034	-0.026
	(-0.79)	(-0.61)	(-0.83)	(-0.63)
RIR (dummy X)			-0.0009	-0.0010
			(-1.00)	(-0.98)
Sample	85-99	85-99	85-99	85-99
		Excluding 95		Excluding 95
# of Observations	585	546	585	546
Adjusted R2	0.40	0.41	0.41	0.42
F	98.3	94.4	68.1	66.5

In order to test whether export-oriented firms are more sensitive to real interest rate changes, just as before, I included a dummy that interacts with the real interest rate only for the export-oriented firms. As observed in regression 3 and 4 of Table 4, although the sign of the

[14] Since we have data on the share of sales that is exported only for the survey that runs from 1994 to 1999, we calculate the average for the whole period using this measure.

coefficient of this dummy variable is negative, as expected, it again comes out not statistically significant. We, therefore, are not able to conclude that firms in the exportable sector are more sensitive to real interest rate changes, even when the majority of these firms are large and medium firms.

Although most of the export-oriented firms are large and medium firms, this group also includes a significant number of small firms. This observation, together with the evidence for size-dependent sensitivities with respect to both cash flow and real interest rate changes, may explain why the results on export-oriented firms are not salient.

VII.3 The Effect on Investment of Changes in the Foreign Interest Rate

In an economy open to international capital inflows, interest rate fluctuations do not always reflect changes in the Central Bank's monetary policies, but are sometimes explained by movements in foreign interest rates or in the country's risk premium. Moreover, in an emerging market like Mexico, fluctuations in the risk premium by far dominate the movements in risk free foreign interest rates during the period considered in this paper. Therefore, to isolate monetary policy changes from overall movements in real interest rates, we have to account for fluctuations in the risk premium. In what follows we analyze how changes in foreign interest rates, measured by the return of government bonds placed in international capital markets, affect the results so far on the behavior of capital expenditures of manufacturing firms in Mexico.

To approximate the movements in foreign interest rates, I use the implicit return of the EMBI (Emerging Market Bond Index) for Mexico. Table 5 accounts for the fact that real interest rate changes can sometimes reflect movements in risk perceptions by international investors. From the results in regressions 1 and 2, the sign and statistical significance of the coefficients for Cash Flow and Change in Sales remain unchanged. Moreover, in regression 1 both coefficients for the real interest rate and the EMBI are statistically significant and of the expected sign. However, when the year 1995 is excluded from the sample in regression 2, the coefficient for the real interest rates loses its significance.

This result is consistent with the evolution of Mexico's foreign exchange rate regime during the past two decades. Up to 1994, Mexico had a practically fixed exchange rate regime, implying little monetary independence. When Mexico adopted a flexible exchange rate regime, one should expect that monetary policy to become effective. However, after the devaluation in

1994, the domestic banking system became practically dysfunctional, and most of the funds for capital formation by Mexican firms came from other sources, and particularly, from abroad. Therefore, it is conceivable, as the empirical evidence shows, that foreign interest rates are affecting investment in Mexican firms more than domestic interest rates.

Table 5. Regression Results

	1	2	3	4	5	6
Constant	0.04	0.04	0.04	0.03	0.04	0.03
	(3.63)	(2.71)	(3.07)	(2.18)	(3.00)	(2.00)
Real Interest Rate	-0.001	0.001	-0.001	0.002	-0.001	0.002
	(-1.77)	(0.45)	(-0.73)	(0.84)	(-0.79)	(0.74)
Cash Flow/ Kt-1	0.45	0.45	0.45	0.45	0.45	0.45
	(13.10)	(12.38)	(13.07)	(12.34)	(13.04)	(12.33)
Sales Change/ Kt-1	0.002	0.002	0.002	0.002	0.002	0.002
	(1.85)	(1.75)	(1.85)	(1.78)	(1.85)	(1.78)
Embi	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
	(-4.67)	(-3.53)	(-4.66)	(-3.53)	(-2.96)	(-2.10)
Cash Flow(dumLg)	-0.32	-0.32	-0.32	-0.32	-0.32	-0.32
	(-8.01)	(-7.54)	(-8.00)	(-7.51)	(-7.99)	(-7.51)
Cash Flow(dumMed)	-0.21	-0.21	-0.21	-0.21	-0.21	-0.21
	(-5.01)	(-4.75)	(-5.03)	(-4.68)	(-4.98)	(-4.68)
RIR(dummyLg)			-0.0003	-0.0003	-0.0004	-0.0005
			(-0.23)	(-0.12)	(-0.24)	(-0.15)
RIR(dummyMed)			-0.001	-0.003	0.000	-0.003
			(-0.54)	(-1.13)	(-0.27)	(-0.86)
EMBI(dummyLg)					-0.000004	-0.000004
					(-0.09)	(-0.10)
EMBI(dummyMed)					0.00002	0.00001
					(0.60)	(0.19)
Sample	91-99	91-99 Excluye 95	91-99	91-99 Excluye 95	91-99	91-99 Excluye 95
# or Observations	1089	968	1089	968	1089	968
Adjusted R2	0.26	0.25	0.26	0.25	0.26	0.25
F	48.2	42.3	38.5	34.0	32.1	28.3

Given that in the previous subsection has found the existence of differentiated effects of real interest rate changes for large, medium or small firms, in regression 3 to 6 I test whether there is a parallel effect in the case of movements in the foreign interest rate. From Table 5, the effects of changes in the risk premium do not seem to vary by firm size. However, the estimate for the coefficient of the foreign interest rate remains statistically significant throughout these regressions, while this is not true for the estimate of the real domestic interest rate coefficient. Although we do not find a differentiated impact of changes in foreign interest rates by firm size, movements in foreign interest rates do seem to influence firms' capital expenditures.

VII.4 The Effect of the Evolution of the Credit Market on Investment by Firms

As mentioned before, Mexico's credit markets changed considerably during the period 1984-1999. The first big structural change was the financial liberalization during the early 1990s. The other significant development was the financial crisis that followed the devaluation of late 1994. As a final exercise, I attempt to analyze whether the estimated coefficients vary significantly as firms faced different credit market conditions during the sample period. In other words, I test whether the evolution of credit markets in Mexico affects the size and significance of the parameters estimated so far. In Tables 6 and 7 I duplicate the same regressions with the sample periods being different.

Table 6, the estimates for Cash Flow coefficients retain their statistical significance independent of changes in the time periods. However, the size of the coefficients estimated for the each sample does differ. More specifically, medium and large firms seem much less sensitive to changes in cash flow during the 1990s, and more so during the second part of the decade, whereas the opposite is true for small firms.

Table 6. Regression Results

	1	2	3
Constant	-0.01	-0.03	0.04
	(-3.08)	(-2.55)	(2.03)
Cash Flow/Kt-1	0.43	0.44	0.49
	(18.89)	(13.16)	(7.18)
ChSales/Kt-1	0.0145	-0.0002	0.0014
	(2.24)	(-0.28)	(1.23)
Cash Flow (dum Lg)	-0.14	-0.26	-0.38
	(-4.19)	(-6.50)	(-5.16)
Cash Flow (dum Med)	-0.15	-0.17	-0.25
	(-5.45)	(-3.88)	(-3.19)
Sample	85-90	90-94	94-99
# of Observations	522	435	522
Adjusted R2	0.66	0.43	0.16
F	172.0	55.9	18.1

These results imply that medium and large firms tend to be less sensitive to cash flow changes towards the end of the nineties, unlike small firms. Somehow large and medium firms were able to overcome the absence of commercial banks in the domestic credit market by seeking such foreign credit sources as suppliers' credits.

Finally, the estimated coefficient for Change in Sales seems to have lost some statistical significance during the two latter sample periods. Therefore, the overall fit of the regression is best in the case of the initial sample. Moreover, the regressions of Table 6 have low degrees of freedom and their results should be interpreted with caution.

In Table 7 we observe once more that the estimates of the coefficients for the cash flow for medium and large firms diminish as the sample approaches the latter part of the nineties. As was also the case before, for small firms the corresponding coefficient rises, implying higher sensitivity of these manufacturing establishments to cash flow changes in more recent periods. With respect to the estimated coefficient for the change in sales, again it loses economic and statistical significance during the more recent periods, perhaps due to smaller samples.

Table 7

	1	2	3
Constant	-0.003	-0.044	0.084
	(-0.50)	(-2.74)	(3.14)
Real Interest Rate	-0.001	0.002	-0.004
	(-2.57)	(1.24)	(-2.50)
Cash Flow/Kt-1	0.44	0.44	0.45
	(19.16)	(13.20)	(6.60)
ChSales/Kt-1	0.016	0.000	0.001
	(2.53)	(-0.23)	(1.22)
Cash Flow (dum Lg)	-0.14	-0.27	-0.35
	(-4.38)	(-6.58)	(-4.70)
Cash Flow (dum Med)	-0.15	-0.18	-0.24
	(-5.63)	(-3.96)	(-2.94)
RIR (dum Lg)	0.0003	-0.0036	0.0015
	(0.74)	(-1.39)	(0.69)
RIR (dum Med)	0.00035	-0.00273	0.00041
	(0.82)	(-1.05)	(0.18)
Sample	85-90	90-94	94-99
# of Observations	522	435	522
Adjusted R2	0.6682	0.4301	0.1814
F	117.59	37.39	13.83

Finally, the estimated coefficient for the real interest rate becomes statistically significant only in the case of regressions 1 and 3, corresponding to the sample periods 1985-90 and 1994-99. Moreover, the coefficients become larger during the latter period. As a final remark, there is no evidence for a differentiated real interest rate effect for larger firms over time.

VIII. Conclusions

This study attempts to shed some light on the effect of real interest rate changes on investment in Mexico. I estimated standard investment equations where the costs of internal versus external funds are differentiated. I find that internal funds in the form of cash flow have played a significant role in explaining capital expenditures by manufacturing firms. Moreover, small firms seem more sensitive to changes in cash flow than large firms. Investment flows also respond to changes in real interest rates, where there also seems to be a differentiated response between large and small firms. Namely, large firms are more sensitive to real interest rate fluctuations. It could therefore be concluded that real interest rate changes affect investment by manufacturing firms in Mexico not only through the usual financial cost channel, but also through the credit channel.

Given the fact that, in an economy open to foreign capital flows, domestic interest rate fluctuations are partly explained by changes in foreign interest rates, I further test whether foreign interest rates explain investment behavior. The foreign interest rates have more statistically significance effect than domestic interest rates. This result seems to suggest that domestic monetary policy is not completely independent of the world economy, an observation that is perhaps due to sample limitations. While it is only during the past two years that monetary policy in Mexico had been more independent and proactive in combating inflation, the sample data only go up to 1999.[15]

Finally, I find evidence for increasing sensitivity of small firms with respect to cash flow over time. However, I find little evidence that the interest rate elasticity of investment has varied during key phases during the evolution of Mexican credit markets.

[15] See Martínez et al (2001).

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