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Financial Liberalization, Credit Constraints, and Collateral: Investment in the Mexican Manufacturing Sector

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Abstract

This paper examines the impact of financial liberalization on fixed investment in Mexico, using establishment-level data from the manufacturing sector. It analyzes changes in cash-flow sensitivities and uses an innovative approach to explore the role of real estate as collateral and deal with a potential censoring problem. The results suggest that financial constraints were eased for small firms but not for large ones. However, banks' reliance on collateral in their lending operations increased the importance of real estate. The results provide microeconomic evidence consistent with the role attributed to "financial accelerator" mechanisms during lending booms and during recessions that stem from financial crises.

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I. INTRODUCTION

Recent financial crises have spurred a renewed interest in the effects of financial deregulation in emerging markets. While some theoretical research and empirical analysis at the macro level has been undertaken in this area, empirical work using microeconomic data is still scarce.[2] This paper attempts to make a contribution to the latter literature by analyzing the Mexican case.

Prior to 1989, Mexico's financial system was highly regulated. In particular, between 1982 and 1988, the government financed its deficits through increased reserve requirements on the domestic banking sector, and bank credit to the private sector plummeted. This situation changed in late 1988, when a comprehensive liberalization of the financial sector was initiated. Government deficits, which had been reduced significantly, were now financed mainly through CETES (short-term debt comparable to U.S. Treasury Bills), and the volume of bank loans extended to the private sector increased dramatically. Credit expansion was further bolstered by renewed capital inflows after a successful debt restructuring under the Brady Plan and by a reduction in inflation.

This paper examines how these developments affected fixed investment using a unique, and largely novel[3] plant-level data set covering nearly 80 percent of value added in the manufacturing sector in the period 1984–94.[4]

We first follow the standard methodology adopted in empirical work on the importance of liquidity constraints for firm-level investment. We analyze the effect of the availability of internal funds on capital expenditures and its change over time across different types of firms that are likely to differ in their access to external finance. Then, going one step further, we address two commonly neglected issues. Given that zeroes represent a large fraction of the investment observations, we deal with the censoring problem that may arise in the presence of credit rationing. We also explicitly investigate the importance of collateral. Building on a simple model that stresses the role of minimum project sizes and collateral, we explore the function played by real estate as a collaterizable type of asset before and after 1989.

The results can be summarized as follows. First, the estimations show that cash flow is significantly correlated with investment before and after financial liberalization, particularly in the case of smaller firms. Second, financial constraints appear to have been

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[2]Among the exceptions are Atiyas (1992), Goeltom (1995), Harris, Schiantarelli and Siregar (1994), and Jaramillo, Schiantarelli and Weiss (1997).

[3]While other authors have used the year 1984–90 of this data set; to our knowledge, Gaston Gelos was the first person to have had access to the whole database.

[4]The only other micro-data-based study analyzing related issues in Mexico of which the authors are aware, Babatz and Conesa (1997), does not cover the years prior to 1988 (the period of the most marked financial repression) and only inspects the behavior of 71 stock-listed companies.

eased for small firms after financial liberalization, although these results are not robust across all estimation methods. Third, the value of a firm's real estate (a proxy for collateral) is shown to strongly influence investment throughout the period studied. Fourth, counting on real estate as collateral appears to have become more important after 1989.

This study adds to the still very limited body of research that links the recent empirical work on the importance of liquidity constraints at the firm level to an older strand of literature analyzing the effects of financial regulation in developing countries. To our knowledge, it is also the first study providing microeconomic evidence for the frequently mentioned role of real estate as collateral during lending booms.

The remainder of the paper is organized as follows: Section II briefly reviews the main issues to be addressed. Section III discusses some salient features of the data, describing the main differences across industries and types of establishments. The fourth section analyzes how the role of internal funds in the determination of investment change over time. Section V discusses a simple theoretical model that emphasizes the role of collateral and the possibility of minimum project sizes, and presents results from an alternative econometric approach motivated by that framework. In that section, we also present some bank-level evidence on the use of collateral. Section VI draws conclusions.

II. CREDIT CONSTRAINTS, FINANCIAL REFORM, AND INVESTMENT

After the outset of the debt crisis in 1982, private investment in Mexico dropped sharply, by approximately 37 percent, and stayed at low levels until the end of the decade. In 1989, investment began to recover slowly, and the expansion continued until GDP growth fell markedly in 1993. Undoubtedly, various factors were responsible for the low levels of capital expenditures and the overall unsatisfactory economic performance until the end of the eighties: the decline in the terms of trade, macroeconomic uncertainty, and debt-overhang effects have often been named among them.[5] However, little formal attention has so far been paid to the role of liquidity constraints.[6]

Until late 1988, Mexico's financial system was a textbook case of financial repression: high reserve requirements, coupled with regulated interest rates and officially directed bank funding to preferential sectors, resulted in low levels of financial intermediation. Beginning in late 1988, a rapid process of financial liberalization was initiated. The reforms proceeded quickly and included the liberalization of interest rates, the reduction in reserve requirements, and the abolition of forced lending. This deregulation, together with a renewed access to international capital markets, and the beneficial effects of the stabilization plan adopted in 1987, led to an enormous increase in loan volumes. This is also reflected in the evolution of credit to the manufacturing sector, which is shown in Figure 1.

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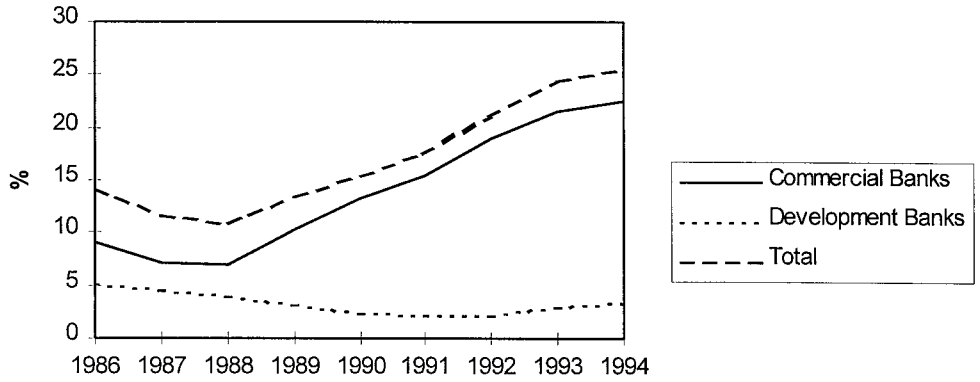
[5] See for example, Cardoso (1993), Goldsbrough et al. (1996) and Warner (1994)

[6] An exception is İşcan, (1998), who uses industry-level data.

Figure 1. Credit Extended to the Manufacturing Sector
(As percentage of sectoral GDP)



Source: Banco de México

The questions that this paper seeks to answer are: how was investment in the manufacturing sector affected by financial reform? To what extent were firms financially constrained before and after liberalization? Which firm types and sectors benefited most from the increased availability of credit after 1989? Is there evidence for the importance often attributed to the role of real estate as collateral during lending booms? For policy purposes, it seems to be crucial to provide answers to this set of questions. Not only is it important to understand the precise way in which financial liberalization in a developing economy affects bank lending behavior and firms' access to external finance[7], but also, learning more about the significance of these credit constraints is relevant for monetary and exchange-rate policy and for the understanding of the dynamics of boom- and bust cycles. For example, if firms are financially constrained, being able to obtain credit only against collateral, shocks to the net worth of firms may be propagated through "financial accelerator" mechanisms as described in Bernanke, Gertler and Gilchrist (1996). Under more stringent conditions, if firms are bank-dependent, the *volume* of loans in an economy may affect real activity[8] beyond its effect on interest rates. Such propagation mechanisms may be particularly relevant when understanding the euphoria and lending booms preceding and the severe macroeconomic repercussions of financial crises. Lastly, the existence of credit constraints also has implications for the design of tax policies. Average, rather than marginal tax rates may, particularly in the case of younger companies, have decisive effects on firms' ability to invest.

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[7] "External" financing as used here and in the following refers to funds external to the firm, not to access to foreign capital markets.

[8] See Bernanke and Blinder (1988).

Since the early seventies, a strand of the development economics literature has focused on the impact of financial deregulation in developing countries on the supply of loans, the screening of borrowers and the consequent reduction in financial constraints and improvements in investment efficiency.[9] The effects of financial liberalization are in general ambiguous: on the one hand, the availability of credit intermediated through the banking system increases with financial liberalization, but on the other hand, the cost of capital rises for those firms which previously had access to credit at regulated rates. Furthermore, due to the removal of credit constraints for private borrowers, savings may decline. The total supply of credit may also shrink after financial liberalization if curb loans constitute a large share of total loanable funds and are good substitutes with demand deposits.[10] This is due to the fact that banks are subject to reserve requirements, while the informal market is not. Ultimately, the effects can only be assessed empirically.[11]

Recently, another substantial body of research has been stressing the importance of financial constraints for firms' investment decisions in countries with highly developed financial systems.[12] The informational and enforcement problems emphasized in that work are likely to be much more relevant in a developing country like Mexico. There is no reason to believe that financial deregulation contributed to improve creditors' rights,[13] and it is unclear whether it affected the degree of informational asymmetries between borrowers and lenders. The rise in real interest rates after financial deregulation may have potentially exacerbated asymmetric information problems inherent to credit markets and weakened borrowers' balance sheets.

Finally, motivated in particular by the recent Asian crisis episodes, researchers have begun to pay increasing attention to bank lending behavior, and more generally, to incentive structures in the financial sector during the build-up of financial fragilities preceding crises. Building partly on the aforementioned "financial accelerator" mechanisms, various models stress the role of moral hazard and asset prices, particularly real estate, in the development of lending and investment booms.[14]

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[9]See McKinnon (1973) and Shaw (1973). Earlier studies emphasizing the importance of financial deepening for economic development include Gurley and Shaw (1955), Goldsmith (1969) and Wai (1972). See also the discussion in Caprio, Atiyas and Hanson (1996).

[10]See Buffie (1984) and a discussion in Warman and Thirwall (1994).

[11]In addition to the aforementioned micro-level studies, see for example Borensztein and Lee (1998) and King and Levine (1993).

[12]For surveys, see Hubbard (1998) and Schiantarelli (1995).

[13]See Babatz and Conesa (1997).

[14]See Chan-Lau and Chen (1998), Edison et al. (1998), Krugman (1998), McKinnon and Pill (1997) and Schneider and Tornell (1998).

Here, we make an attempt to contribute to these three strands of research. The methodology used in this paper borrows from recent work on the wedge between the cost of internal and external funds in order to examine the impact of both factors (administrative controls and informational asymmetries/enforcement problems), and changes in their magnitude over time.[15] In addition, methodological improvements to deal with some aspects neglected in the literature will also be proposed.

Note that it will be difficult to distinguish the impact of domestic financial liberalization from changes in the severity of financial constraints brought about by effects of the debt crisis and changes in the access to foreign capital. This is due to the fact that financial liberalization coincided with Mexico's return to voluntary international capital market financing. An attempt will be made to deal with this issue, but while the primary interest of this paper lies in exploring the effects of financial reform, the broader set of questions developed above concern more generally the role that financial constraints have played in determining investment behavior in the eighties and early nineties, independently of whether the ultimate cause for these constraints were domestic or external.

III. DATA ISSUES AND SUMMARY STATISTICS

The data used are from the Annual Industrial Survey conducted by Mexico's National Institute of Statistics, Geography, and Information (INEGI).[16] The survey covers 3199 manufacturing establishments from 1984–94. The completion of the questionnaire is compulsory, and the purpose of the survey is merely statistical and not linked to tax collection. The database is a balanced panel: exiting plants were discarded from the sample by the collecting agency. However, according to INEGI, the number of exiting plants was very small. This can partly be explained by the fact that the survey attempts to cover roughly 80 percent of value added in manufacturing, having therefore a bias towards larger and more successful firms. Nevertheless, a substantial number of small establishments is included in the sample.

The unusually rich database comprises a large number of variables, covering mainly production, input use, labor force, sales, inventories, investment expenditures and capital stocks. Data on capital expenditures is grouped into five categories: machinery, transport equipment, land, buildings, and other. This differentiation is particularly useful when investigating the nature of adjustment costs. Investment is defined as purchases minus sales of assets plus improvements. After the elimination of extreme outliers and plants with incomplete and inconsistent data, the balanced panel contains 1046 establishments. Details of the construction of capital stocks and investment rates as well as the criteria used for the elimination of outliers are given in Appendix I.

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[15]For a similar approach, see Atiyas (1992), Harris, Schiantarelli and Siregar (1994) and Jaramillo, Schiantarelli and Weiss (1997).

[16]Instituto Nacional de Estadística, Geografía e Informática

A disadvantage for our purposes is the fact that most of the information is given at the establishment level only. To some extent, this limitation can be overcome. First, the data do contain information about profits at the firm level, which can be used to construct a measure of the firm's cash flow. Secondly, it is possible to identify plants within the sample that pertain to a common firm;[17] in that respect, the database has advantages over data used for similar studies[18] in other countries. There is no indication of interconnections of establishments within the sample. Obviously, this does not preclude the possibility that there be other plants or firms outside the sample linked to establishments in the data set. Since the coverage of the sample is quite comprehensive, however, the working hypothesis maintained in the following is that all plants are single-establishment firms.[19] As will be discussed later, if this hypothesis is violated in reality, it will be *more difficult* to find links between financial factors and investment.

After eliminating establishments with less than three employees, incomplete or inconsistent data and extreme outliers, the sample used for all further purposes contains 1046 plants. A detailed description of the methods used in constructing the variables and eliminating outliers is given in Appendix I.

The establishments were divided into three size categories, according to the total number of employees. Plants with less than 100 employees were classified as "small," establishments with between 100 and 500 employees were categorized as "medium" and those with more than 500 employees were considered "large." Firms were classified as exporting if export sales represented at least ten percent of their total sales. The main characteristics of the establishments are presented in Table 1. The table shows that, despite the bias towards larger firms, the database contains a significant number of smaller plants. Most establishments in the sample fall into the medium-size category.

The most notable difference concerns the capital stocks and the number of employees of large firms: exporting establishments generally seem to be larger than non-exporting plants and their capital intensity is higher.[20] In the "small" category, plants were classified as "exporting" in only 7.4 percent of the cases, while they constitute about 41 percent of the large establishments. The greater capital intensity also explains why cash flows relative to capital stocks are lower for the export-oriented firms.

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[17]This is feasible since the data contain the registered capital of the firm.
[18]See, for example, Harris, Schiantarelli and Siregar (1994) for a study of financial constraints of Indonesian manufacturing establishments.
[19]Therefore, the words "firm" and "plant" will be used interchangeably in what follows.
[20]Although the mean capital-labor ratios are not given here, they are always lower for nonexporting firms.

Table 1. Summary Statistics for Exporting and Non-Exporting Firms

Firm Class	Number of Plant-Year Observation	Total Personnel 1990	Capital Stock K_t 1990	Investment I_t/K_{t-1}	Cash Flow CF_t/K_{t-1}
Small					
Exporting	190	59	12780	0.07	0.12
		(25)	(23421)	(0.17)	(0.14)
Non-exporting	2377	52	7031	0.06	0.19
		(24)	(12583)	(0.10)	(0.27)
Medium					
Exporting	1436	274	49779	0.05	0.17
		(114)	(84165)	(0.06)	(0.21)
Non-exporting	4460	243	29755	0.09	0.18
		(109)	(52927)	(0.12)	(0.26)
Large					
Exporting	1234	1525	270104	0.07	0.19
		(1936)	(355163)	(0.09)	(0.28)
Non-exporting	1809	1041	146864	0.06	0.20
		(757)	(207784)	(0.08)	(0.27)

The figures represent means and standard deviations (the latter in parentheses). The capital stock figures are given in thousands of pesos of 1994. Cash flow was constructed based on distributed profits and reported depreciation. (See Appendix I.) A firm was classified as exporting if exports represented at least ten percent of total sales in any year. Investment refers to gross investment (See the appendix for details.) Source: Author's calculations based on data from INEGI.

Other important differences across plant categories are also worth emphasizing, particularly in the context of the discussion of liquidity constraints to follow. Across sectors, there exists substantial heterogeneity concerning the exposure to demand shocks and in the resulting variability of sales. Similar arguments can also be made concerning the exposure to varying costs of raw materials or intermediate inputs. The distinction between exporting and the nonexporting sectors is likely to be an important one in the Mexican case. To a large extent, volatility in profitability has been related to real exchange rate movements, and the risk to which firms have been exposed has been an asymmetric one. Slow real exchange rate appreciation was often followed by discrete devaluation. As a consequence of sharp devaluations, the higher domestic currency cost of imported capital goods and the drop in demand due to a fall in real wages hurt nonexporting firms severely, while exporting firms were able to compensate for these negative shocks by higher export revenues. More generally, with a volatile domestic market, export-oriented firms are less vulnerable to demand shocks at home, generating a more predictable income stream. This reasoning is supported by the results from simple regressions that show that, while there is a clear negative relation between upward movements in the real exchange rate (depreciations) and sales, this negative relation is lower, the higher is the export share in total sales.

IV. THE ROLE OF INTERNAL FUNDS

A. Main Issues

In recent years, a substantial body of literature has emerged analyzing the effects of financial constraints on investment.[21] The usual methodology is to examine whether adding cash flow measures to standard investment equations helps explaining capital expenditure. The reasoning is the following: in a Modigliani-Miller world, measures of firm's liquidity should not enter significantly in a correctly specified investment regression, given that for the firm, internal and external funds are perfect substitutes. In contrast, in an environment with informational asymmetries, bankruptcy costs and law enforcement problems, external funds will be more costly for the firm than internal funds. This wedge arises from the need to compensate lenders for adverse selection and moral hazard problems on the borrower's side.[22] Generally, the theory predicts that the premium on external funds will decrease with the firm's net worth.[23] Higher cash flows today improve the financial position and the net worth of the firm and increase the internal funds available for investment. Therefore, investment should respond positively to increases in cash flow.[24]

Empirically, the main problem with this approach stems from the possibility that cash flow may be correlated with investment for other reasons.[25] Even without financial constraints, firms will respond to increases in cash flow if current cash flow is a good predictor of future profitability, which is likely to be the case. One possibility of overcoming this identification problem is to include a proxy for Brainard/Tobin's marginal q in the regression, which summarizes expected profitability. But the theoretical justification for including a traditional proxy for q and a liquidity variable in a linear regression is weak. As Chirinko (1997) points out, the q variable not only captures profitable investment

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[21]See, for example, Fazzari, Hubbard and Peterson (1988), Schaller (1993) or Bond, Elston, Mairesse and Mulkay (1997). For developing countries, an early example using industry level data from Columbia is Tybout (1983). See also Nabi (1989), Harris et al. (1994) and Jaramillo et al. (1997).

[22]The costs stemming from these problems are also labeled "agency costs," since they arise from principal-agent relationships. There is a large theoretical literature deriving these general results in a variety of set-ups. See, for example, Townsend (1979), Stiglitz and Weiss (1981), Gale and Hellwig (1985) or Bernanke and Gertler (1989).

[23]See, for example, the model in Bernanke and Gertler (1989) and the discussion in Bernanke, Gertler and Gilchrist (1996).

[24]Jensen (1986) offers an alternative explanation for a link between cash flow and investment based on manager's incentives to undertake investments regardless of their profitability.

[25]The correlation between cash flow and investment is known at least since Meyer and Kuh (1957).

opportunities, but also capitalizes the impact of financing constraints.[26] Apart from these problems, Caballero and Leahy (1996) highlight that in the presence of fixed costs, cash flow might be correlated with investment since in that case there is no sufficient statistic for investment. Under these circumstances, even the inclusion of marginal or average q would not solve the problem. In fact, in practice it generally appears that average Q has low explanatory power in investment equations,[27] and that the estimated size of adjustment costs is implausibly high.

Gilchrist and Himmelberg (1998), building on Gilchrist and Himmelberg (1995) and Abel and Blanchard (1986) have addressed the first of the aforementioned issues and attempt to disentangle "financial q" from changes in the net present value of the marginal product of capital. They use VAR estimates to construct the expected value of future marginal products of capital and the expected present value of future financial state variables of the firm, conditional on observed fundamentals, including current financial variables. Here, an attempt was made to follow Gilchrist and Himmelberg (1998), without much success. One problem is that it does not seem likely that a linear projection can appropriately capture the prevalent expectations in a period characterized by substantial regime shifts and discrete events.

Brown (1998) has recently proposed an alternative test of financing constraints which is based on the assumption that a component of the stochastic process governing the disturbances to the firm's profit is nonstationary. The idea is that for financially unconstrained firms, both cash flow and the capital stock are endogenous and adjust in order to maintain the long-run equilibrium relationship between the two variables, while for constrained firms that are investing all of their profits, only the capital stock adjusts. Under certain strong assumptions, this can be used to devise a Granger causality test to test for the presence of financial constraints. Given that we only have ten years of observations, this makes it very difficult to correctly specify VARs for the pre- and post-liberalization periods, and we therefore did not pursue this approach.

Estimating Euler equations directly[28] in principle circumvents the problem, since the impact of future profitability on current decisions is controlled for. However, the difficulty with this method is that it is very susceptible to misspecification problems, and that its small sample properties are poor. As Mairesse (1994) points out, the Euler equation estimates also seem to be sensitive to the normalization rule. In addition, as discussed in Gilchrist and Himmelberg (1995) and Schiantarelli (1995), Euler equations may fail to detect capital market imperfections for firms whose overall level of investment is restricted by financial constraints, but for whom the tightness of these constraints does not change over time

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An alternative way of tackling the identification problem is to focus on differences across firms that are likely to be indicative of their access to external financing and the size of the premium on external funds they face, following Fazzari, Hubbard and Petersen (1988).

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[26]The only additional variable entering (nonlinearly) in Chirinko's investment equation is interest payments.

[27]See, for example, Fazzari, Hubbard and Petersen (1988).

[28]See İşcan (1998) for an example using Mexican industry-level data.

For example, small firms are more likely to be liquidity constrained.[29] The argument is that there are economies of scale in the collecting and processing of information about their situation that help to overcome the problems associated with asymmetric information between borrowers and lenders.[30] Smaller firms are also more likely to have lower collateral and to be exposed to higher idiosyncratic risks.[31] Meaningful distinctions across firm types can also be made according to ownership structure and sectors, as pointed out above. This line of reasoning will be followed here; a detailed discussion is given below.

In addition, since our interest lies primarily in assessing the effect of financial liberalization, attention will be focused on *changes* in the cash flow sensitivities of investment. A priori, there is no reason to believe that the correlation of current cash flow with future profit opportunities decreased after financial liberalization in 1989. If one does observe a decline in the coefficients on cash flow with financial deregulation, this will be indicative of a loosening of financial constraints.

The issue remains of which empirical investment model to adopt as the baseline specification. Apart from models of the Brainard/Tobin's q variety, simple accelerator specifications are the most widely used in the literature. Models stressing the importance of the user cost of capital do not lend themselves to panel data estimation, given that it is difficult to obtain information about cross-sectional variations in this variable. In this section, a simple accelerator specification will be adopted, with the change in output as the accelerator variable. Although not an entirely satisfactory proxy, the change in output in the accelerator model should capture short-term changes in expected profitability fairly well.[32]

We will therefore proceed in the following way. First, we check for nonlinearities in the relationship between cash flow and investment using a nonparametric technique. Second, we estimate standard accelerator equations including cash flow. For purposes of comparison, we also estimate an Euler equation despite the aforementioned difficulties. In the next section, the specification is modified to take into account the role of irreversibilities and/or fixed costs of investment.

In order to ascertain whether the assumed linear relationship between internal funds and investment is supported by the data, we carry out a nonparametric estimation of the relation between investment and cash flow, normalized by the lagged capital stock.

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[29]Although generally accepted, this argument is not fully grounded in theory. As Kaplan and Zingales (1997) note, there does not necessarily need to exist a monotonic relationship between the severity of financial constraints and the coefficient on cash flow.

[30]See Bernanke, Gertler and Gilchrist (1996). Note that simple economies of scale in the administrative costs of the banks may also lead to higher costs of funds for small credits.

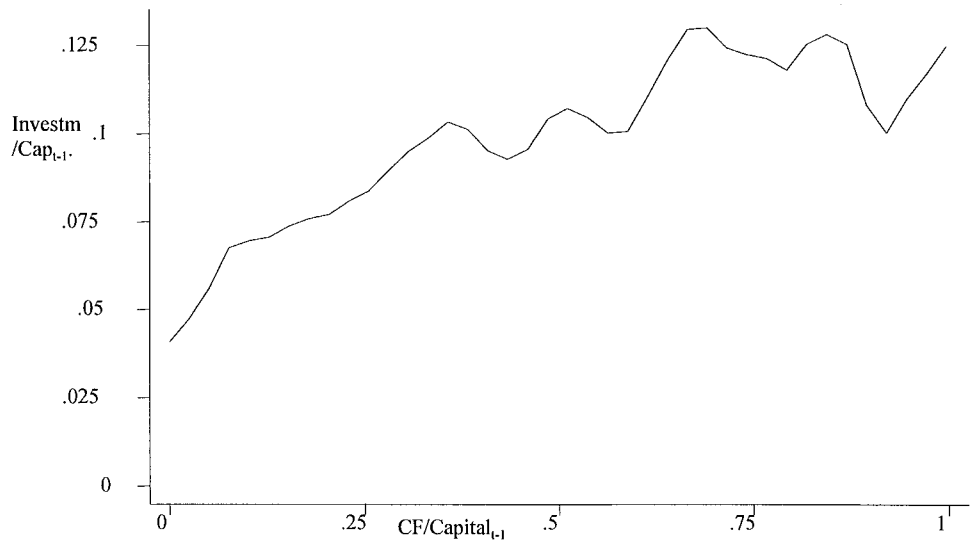
[31]For the case of Mexico, Glaessner and Oks (1998) report that in late 1993, the nominal interest rates for large prime borrowers was 17–22 percent, while small and medium scale enterprise borrowers faced rates of around 27–36 percent. However, such differences in rates may also partly reflect economies of scale on the banks' side.

[32]Alternatively, one could include the change in sales as the activity variable. The results presented in the following are not essentially affected by this choice.

Specifically, we use a Nadarya-Watson kernel estimator with an Epachenikov kernel. This regression imposes almost no restrictions on the shape of the function. For any value of cash flow, the estimator computes a weighted average of the observed investment rates in its neighborhood, with weights given by the kernel.[33]

Figure 2 displays a clear positive association between the two variables; moreover, the relationship can be well approximated by a linear function, at least for values of cash-flow-to-capital ratios of up to around 0.75.[34] It therefore seems reasonable to proceed with a standard linear specification.

Figure 2. Kernel Regression of Investment on Cash Flow



To control for unobserved heterogeneity across firms, changes in the cost of capital, and other aggregate effects not explicitly modeled here, the model is estimated with fixed and time effects. All variables are scaled by the lagged capital stock. In order to test for the effect of internal liquidity, cash flow is included in the regression equation, giving:

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[33] We use a bandwidth of 0.06; however, the shape of the graph is not very sensitive to the choice of bandwidth.

[34] The estimation was only carried out using cash-flow-to-capital ratios of less than one, which represent about 98 percent of all observations. This was done since the estimation method is quite sensitive to outliers.

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

Here, I_{it}, K_{it}, Δy_{it}, CF_{it} denote investment, the capital stock, the change in output and the cash flow of firm i at time t, respectively, and λ_t, ν_i and ε_{it} stand for time effects, time-invariant firm effects and idiosyncratic error terms.

If the firm-specific effects are not correlated with the explanatory variables, this equation can be estimated using random effects. On the other hand, if the effects are correlated with the right-hand side variables, an estimation with fixed effects (Least Squares Dummy Variables = LSDV) is appropriate. Hausman tests reject the hypothesis of no correlation at all usual significance levels; therefore, only the results of regressions with fixed effects are presented here.

An additional problem arises due to the possible endogeneity of the explanatory variables. The right-hand side variables may be correlated with the idiosyncratic error. For example, cash flows tend to be (initially) lower when investment is higher because of expenses associated with investment expenditures, such as increased labor costs. Due to time aggregation problems, increases in output may be the result of increases in investment. A less extreme view would consider the right hand-side variables as predetermined, rather than strictly exogenous, i.e. $E(x_{it}\epsilon_{is}) \neq 0$ for $s < t$. In order to address these issues, the estimation was also performed with LSDV, but also with a Generalized Method of Moments (GMM) instrumental variables estimator developed by Arellano and Bond (1991). There, the model is estimated in first differences, with lagged levels of the regressors as instruments. If the right-hand side variables are endogenous, twice-lagged levels are valid for a serially uncorrelated error in the levels equation; if the variables are predetermined, levels lagged one period or more are permissible. However, the drawback of this method is that measurement error problems may be exacerbated; in addition, lagged levels of the regressors are not always good instruments. In particular, cash flow and changes in output lagged two periods or more proved to be only weakly correlated with current differences. This is explainable by the large changes in economic conditions experienced during the observed period. Despite these problems, the GMM estimates using instruments lagged one period and more will be discussed in addition to the LSDV results.

In the estimation, we allow the coefficient on cash flow to vary across firm size categories by interacting cash flow with dummies for each size class. Apart from the arguments given above, this distinction may be meaningful in an environment where political connections—at least before financial deregulation—were important for the obtention of credit. In this regard, larger firms most likely had an advantage. Similarly, firms will also be distinguished according to their ownership structure (private vs. public, and with vs. without

foreign ownership[35]) and according to whether they were exporters or not. A priori, one would expect publicly owned firms to be less financially constrained than private companies, particularly in the earlier years of the sample. For example, public firms probably benefited more from selective credit policies or faced soft budget constraints. Similarly, firms with foreign participation are more likely to have access to foreign capital and to suffer less from liquidity constraints. As discussed above, exporting firms generate a more predictable income stream than non-exporting firms, and should therefore be preferred by lenders.

As in any sample separation, the question of a possible endogeneity of the selection criteria arises. Some criteria may be correlated with the idiosyncratic component of the error term. For example, changes in firm size might be correlated with movements in investment. In principle, this problem leads to the same econometric approach as discussed above.[36]

By including an interaction term of cash flow with time dummies after 1989, it can be tested whether the effect of liquidity changed after financial liberalization. However, care has to be taken not to attribute all changes after that year to internal financial liberalization. Firstly, around 1988/89, economic conditions transformed in various ways, which may also influence our estimates. As noted earlier, the severity of the debt problem diminished; after a successful debt renegotiation within the Brady plan, capital began to return to Mexico. These capital inflows were partly intermediated by banks, but also contributed to an impressive rise in the Mexican stock market. The reduction in financial constraints stemming from these inflows certainly cannot only be attributed to a liberalized internal financial system. Secondly, the stabilization program adopted in 1988 may by itself have led to a credit expansion through a remonetization of the economy and a decrease in risk associated with lower inflation levels.[37] Thirdly, significant trade liberalization measures were undertaken, reducing import barriers and resulting in an increased outward orientation. An increased ability by Mexican manufacturing firms to compete on international markets might have contributed to an easing of credit constraints, as argued in the earlier discussion of exporting vs. nonexporting firms.

Although, as mentioned above, there are reasons to suspect that the obtained cash flow estimates will reflect more than the pure liquidity/net worth effects, there are also reasons to believe that the coefficients on cash flow will be biased towards zero. If the working assumption of single-establishment firms is violated, the relation between the cash flow variable (constructed using data on profits at the firm level) and plant-level investment will be blurred. In addition, despite the fact that this survey is not used for tax purposes, firms

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[35]Data on ownership structure was only available until 1990. Although after that date, privatization of many enterprises continued, the classification of 1990 had to be retained for the following years, possibly affecting the results.

[36]See Schiantarelli (1995).

[37]See Khamins (1996) for a discussion of these issues.

will in general be inclined to underdeclare their profits. Lastly, there are some problems related to the construction of the cash flow variable that are discussed in Appendix I.

B. Results

The results of OLS (LSDV) and GMM estimations are presented in Table 2. Looking at the results for all firms, observes that, according to both estimation methods, cash flow enters significantly for small and medium firms, and, in the LSDV case, also for large establishments. However, the cash flow coefficient for large firms is not significant in the GMM estimation. Overall, the coefficients are overall lower than the ones in most other studies, but comparable to those reported by Harris et al. for a similar dataset from Indonesia.[38]

As expected, the size of the coefficients on cash flow decreases with firm size. Concerning shifts in the importance of cash flow after 1989, the results in the first two columns indicate that small firms benefited strongly from the increased credit availability after 1989.[39] According to the LSDV estimates, the relationship between cash flow and investment becomes stronger after 1989 for medium and large firms. This is not confirmed by the GMM estimation.[40]

The coefficient on the change in output is positive and significant in the LSDV case, but not significant according to the GMM estimates. In addition, the size of the coefficient is small compared to most, but not all, of the estimates found in the literature for other countries. These results remain essentially unaltered when using either the change in sales or the growth rates of sales or output as the activity variable or when including lagged values of the same.

Since most of the firms in the sample are privately owned, the results do not change noticeably when examining only those firms without public ownership. However, the figures for the public enterprises are different: except for the case of small establishments, neither the LSDV nor the GMM estimates indicate the presence of a significant relationship between cash

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[38]When the data include many smaller firms, issues related to the life cycle of a firm may bias the coefficient on cash flow towards zero. As the data show, those firms that invest more initially tend to have higher variable costs at the beginning and therefore lower cash flows than the mean. Later on, the same firms have lower investment and higher cash flows.

[39]It is interesting to note that in a survey carried out in 1991 among manufacturing firms in the electrical sector, of the firms classified as "microenterprises," 10.7 percent indicated that access to financing was their major growth impediment, whereas 16.6 of the "small" firms named this factor as the most important one. Only 2.9 percent of the "medium" and none of the "large" firms felt that financing constraints were the single most important limiting factor. Unfortunately, the survey does not provide the definition of the size categories used therein. See CANAME (1991).

[40]Note the results of the GMM estimation for all firms need to be interpreted with caution, since the Sargan test of overidentifying restrictions does not support the instruments used.

flow and investment. These firms appear to operate in a very different environment: note that the activity variable does not enter significantly in the LSDV case, either. These results are in line with our ex-ante expectations. There is no evidence for a change in the effect of internal funds for public firms after 1989.

Comparing firms with foreign participation with those that are purely Mexican-owned, the expected difference shows up for small firms, but not for medium-sized and large establishments. Small Mexican firms appear to have relied to a much lesser degree on internal funds for investment financing after 1989; the evidence is less strong in this regard for establishments with foreign participation.

Regarding the contrast between exporting and nonexporting plants, again the a-priori presumption is confirmed for small, but not for medium-sized establishments: the cash flow coefficient for small nonexporting firms is significant at the 5 percent level in the LSDV estimation, while this is not the case for exporting firms. The GMM estimation delivers a higher coefficient for nonexporters, and, surprisingly, a negative one for exporting plants. Both methods, however, show a significant decline in the effect of liquidity for small nonexporting firms after the beginning of financial deregulation.[41] Interestingly, the coefficient on current cash flow and its standard error were unaltered when including the actual values of cash flow at $t + 1$ in the regressions.[42]

A natural question arises as to whether there are meaningful differences in cash flow sensitivites across sectors. Rajan and Zingales (1998) use differences in the reliance on external finance across manufacturing sectors in the U.S. to test whether those sectors that appear to be more in need for external financing develop faster in countries with more developed financial markets. Using the same classification as these authors, in the sample used here, no correlation between their measure of external financing and the size of our cash-flow coefficients could be found.

Overall, there is a strong link between cash flows and investment for most types of firms. The differences in the size and significance of the cash flow coefficients across firm classes are to some extent consistent with a-priori presumptions. More importantly, for small and exporting firms the effects of cash flow on investment decreases strongly after 1989, suggesting that financial liberalization resulted in an easing of financing constraints for these

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[41]Babatz and Conesa (1997), using data from 71 stock-listed firms, do not find a significant difference in the cash flow sensitivities between exporting and nonexporting firms when estimating a similar specification prior to 1992. With the beginning of 1992 (the year of bank privatization), the coefficient on cash flow declines for exporting, but not for nonexporting firms.

[42]Cash flows at t+1 did not enter significantly. See Harris et al. (1994) for a similar finding.

Table 2. Accelerator Model (LSDV and GMM)

Variable	All Firms		Only Private		Only with Public Participation		Only with Foreign Participation		Only Purely Mexican		Only Non-Exporting		Only Exporting	
	LSDV	GMM	LSDV	GMM	LSDV	GMM	LSDV	GMM	LSDV	GMM	LSDV	GMM	LSDV	GMM
Cash flow small firms $\frac{CF_{it}}{K_{it-1}} D_s$	0.10	0.17	0.11	0.16	-0.07	0.49	0.05	0.08	0.11	0.19	0.10	0.14	0.12	-0.02
	(7.20)	(6.60)	(7.23)	(4.81)	(-0.19)	(2.50)	(1.56)	(8.00)	(6.79)	(4.52)	(6.56)	(4.52)	(1.92)	(-4.43)
Cash flow, medium-sized f. $\frac{CF_{it}}{K_{it-1}} D_m$	0.05	0.05	0.04	0.05	-0.03	-0.05	0.05	0.03	0.04	0.05	0.03	0.03	0.10	0.12
	(4.68)	(2.67)	(4.68)	(2.44)	(-0.40)	(-0.43)	(3.21)	(1.72)	(3.56)	(2.34)	(2.58)	(1.47)	(5.59)	(6.50)
Cash flow large firms $\frac{CF_{it}}{K_{it-1}} D_l$	0.04	-0.02	0.04	-0.05	0.09	0.10	0.04	0.01	0.03	-0.03	0.02	-0.06	0.07	0.05
	(2.23)	(-0.63)	(1.97)	(-2.05)	(1.01)	(0.42)	(2.00)	(0.70)	(1.14)	(1.04)	(0.97)	(-2.67)	(2.89)	(1.98)
Cash flow small firms after liberal. $\frac{CF_{it}}{K_{it-1}} D_s D_{after}$	-0.04	-0.10	-0.04	-0.10	0.29	-0.30	0.03	-0.05	-0.05	-0.12	-0.03	-0.07	-0.08	0.01
	(-2.52)	(-3.27)	(-2.70)	(-2.72)	(0.78)	(-1.53)	(0.84)	(-3.32)	(-2.80)	(-2.80)	(-2.00)	(-2.14)	(-1.23)	(0.68)
Cash flow, medium-sized f. After liberalization $\frac{CF_{it}}{K_{it-1}} D_m D_{after}$	0.02	-0.03	0.02	-0.03	0.04	-0.20	-0.01	0.01	0.04	-0.05	0.03	-0.02	-0.03	-0.04
	(2.06)	(1.39)	(2.22)	(-1.19)	(0.49)	(-1.02)	(-0.97)	(0.52)	(3.19)	(-1.76)	(3.02)	(-0.96)	(-1.49)	(-1.63)
Cash flow, large firms after liberal. $\frac{CF_{it}}{K_{it-1}} D_l D_{after}$	0.03	0.01	0.04	0.04	-0.07	-0.11	-0.01	0.00	0.07	0.02	0.05	0.05	-0.01	0.04
	(2.10)	(0.24)	(2.19)	(1.50)	(-0.80)	(-0.43)	(-0.26)	(0.11)	(2.91)	(0.69)	(2.53)	(1.95)	(0.30)	(-1.19)
$\frac{\Delta y_{it}}{K_{it-1}}$	0.01	0.00	0.01	0.00	0.01	-0.01	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.01
	(4.64)	(0.25)	(4.66)	(0.24)	(0.86)	(-0.89)	(2.57)	(1.09)	(4.07)	(-1.23)	(3.91)	(-0.69)	(2.77)	(2.40)
Wald test	163.31	70.52	162.1	55.53	8.96	14.85	46.0	110.33	133.8	53.91	126.4	53.12	51.45	78.9
	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(2)	(7)	(7)	(7)	(7)
m1	-	-33.85	-	-13.92	-	-5.50	-	-7.24	-	-12.22	-	-10.09	-	-6.87
m2	-	-2.42	-	-1.49	-	0.98	-	-1.22	-	-1.11	-	-1.44	-	-0.91
Sargan test	-	159.6	-	53.32	-	59.22	-	92.6	-	93.9	-	101.65	-	78.88
		(74)		(74)		(74)		(74)		(74)		(74)		(74)
# of obs.	10460	9414	9841	8807	619	241*	3070	2673	7390	6435	7860	7074	2600	2340

Dependent variable: $(I/K)_{it}$. T statistics in parentheses. Time dummies were included in all regressions. (coefficients omitted). In the GMM estimation, the model was estimated in first differences, with levels of the regressors lagged one or more periods as instruments. The reported Wald test is a significance test for all the included variables (except dummies); the test statistic is distributed as $\chi(p)$, where p is the difference between the number of instruments and the number of regressors. m1 y m2 are tests of first- and second order autocorrelation with a N(0,1) distribution. The Sargan test is a test of the overidentifying restrictions (see Sargan (1988)). To correct for heteroskedasticity, a two-step estimation procedure was used. D's denote dummy variables for size and for the period after 1989. The DPD program developed by Arellano and Bond (1989) was used in the estimation.

companies.[43] Why did cash flow sensitivities not decrease as much for medium and large firms? Some of these companies may have benefited from preferential credit distributed through public development banks prior to financial liberalization. As mentioned before, large firms were more likely to have had political connections facilitating access to credit before the process of liberalization was initiated; to some extent they were also able to finance themselves through the stock market or stock brokerages.[44] In addition, the aforementioned rise in real interest rates may have resulted in an increased cost of finance for large firms that had access to credit prior to 1989, but not for those smaller firms that were essentially cut off from capital markets. This means that for big companies, financial liberalization had two-sided effects on the cost and availability of external funds, which is reflected in less pronounced changes in the cash-flow coefficients.

As an additional check for the validity of our interpretation of the results presented above, we also estimated an Euler equation despite the aforementioned problems associated with this approach. Jaramillo, Schiantarelli and Weiss (1997) develop a framework in which agency costs increase with the stock of debt and where there is a debt on ceiling. Since, as noted earlier, we unfortunately do not have information on debt levels, we had to adopt a simpler approach. Following Bond and Meghir (1994) and Bond, Elston, Mairesse, and Mulkay (1997), consider the problem of a firm maximizing the present discounted value of its stream of cash flows.[45] Let L_{it} denote variable factor inputs, ω_{it} the price of variable factors, and p^I_{it} the price of investment goods, β the discount factor and δ the depreciation rate. If $F(K_{it}, L_{it})$ is the production function gross of adjustment costs and $G(I_{it}, K_{it})$ the adjustment cost function, and E_t the expectations operator conditional on information available in period t, the firm's problem can be written as:

$$\max E_t\left[\sum_{j=0}^{\infty}\beta(p_{it}F(K_{it},L_{it})-p_{it}G(I_{it},K_{it})-\omega_{it}L_{it}-p^I_{it}I_{it})\right]$$

$$\text{s.t. } K_{it}=K_{it-1}-\delta K_{it-1}+I_{it} \qquad (2)$$

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[43]Harris et al. obtain a similar result for Indonesia. Jaramillo et al. do not find an significant impact of financial liberalization in Ecuador.

[44]See Maxfield (1997).

[45]The exposition here closely follows Bond, Elston, Mairesse, Mulkay (1997).

The optimal investment path can be expressed in terms of an Euler equation. Under the assumption of competitive markets and constant returns to scale in $F(K_{it}, L_{it})$, and assuming that $G(I_{it}, L_{it}) = \frac{b}{2}\left[\left(\frac{I}{K}\right)_{it} - c\right]^2 K_{it}$, this equation becomes:

$$\left(\frac{I}{K}\right)_{it} - \alpha_1\left(\frac{I}{K}\right)_{it}^2 = \alpha_2 E_t\left(\frac{I}{K}\right)_{i,t+1} + \alpha_3\left[\left(\frac{\pi}{K}\right)_{it} - J_{it}\right] + \alpha_0,$$

$$\pi_{it} = p_{it}F(K_{it}, L_{it}) - p_{it}G(I_{it}, K_{it}) - \omega_{it}L_{it} \qquad (3)$$

Here, π_{it} denotes the gross operating profit and J_{it} the real user cost of capital. In order to proceed with an econometric implementation, replace $E_t\left(\frac{I}{K}\right)_{i,t+1}$ by the realized $\left(\frac{I}{K}\right)_{i,t+1}$ plus a forecast error. Replacing the costs of capital by time- and firm-specific effects, the equation becomes:

$$\left(\frac{I}{K}\right)_{i,t+1} = \gamma_1\left(\frac{I}{K}\right)_{it} - \gamma_2\left(\frac{I}{K}\right)_{it}^2 - \gamma_3\left(\frac{\pi}{K}\right)_{it} + \lambda_{t+1} + \nu_i + \varepsilon_{it} + 1 \qquad (4)$$

By estimating this equation, we are in principle controlling for the relation between current profits and expected future profitability. It can be shown that under the null hypothesis of the absence of financial constraints, $\gamma_1 \geq 1, \gamma_2 \geq 1,$ and $\gamma_3 > 0$ [46]. Under the alternative hypothesis, the equation is misspecified. Since in that case, investment and cash flow are positively linked, one would expect a positive sign on the coefficient on profit in the equation, given the high correlation between profits and cash flows. Similarly as above, we used interaction dummies for the three firm size classes and for the pre- and post-liberalization period to ascertain differences in the effect of profits. Given that estimation of this model with LSDV would yield biased estimates due to the presence of a lagged dependent variable, we again employ the estimator proposed by Arellano and Bond (1991), see Table 3.

The results are broadly consistent with the ones reported previously. While the coefficient on profits is significantly positive for the case of small firms, as expected in the presence of financial constraints, it is insignificant for medium-sized establishments and

[46] See Bond, Elston, Mairesse and Mulkay (1997).

Table 3. Euler Equation Estimation (GMM)

Variable	Estimate
$\left(\frac{I}{K}\right)_{t-1}$ **Lagged investment rate**	0.20 (5.02)
$\left(\frac{I}{K}\right)^2_{t-1}$ **Lagged squared investment rate**	-0.27 (-2.06)
$\left(\frac{\pi}{K}\right)_{t-1} D_s$ **Profits, small firms**	0.03 (5.00)
$\left(\frac{\pi}{K}\right)_{t-1} D_m$ **Profits, medium-sized firms**	0.00 (0.86)
$\left(\frac{\pi}{K}\right)_{t-1} D_l$ **Profits, large firms**	-0.03 (-2.69)
$\left(\frac{\pi}{K}\right)_{t-1} D_s D_{after}$ **Profits, small firms after liberalization**	-0.03 (-1.64)
$\left(\frac{\pi}{K}\right)_{t-1} D_m D_{after}$ **Profits, medium-sized firms after liberal.**	0.00 (0.30)
$\left(\frac{\pi}{K}\right)_{t-1} D_l D_{after}$ **Profits, large firms after liberalization**	0.00 (0.01)
Wald test	72.8 (8)
Sargan test	74.9 (69)
m1	-19.03
m2	0.97
Number of observations	9414

Dependent variable: $(I/K)_t$. Time dummies were included in all regressions. (coefficients omitted). In the GMM estimation, the model was estimated in first differences, with levels of the regressors lagged one or more periods as instruments.

significantly negative for large firms. After 1989, the coefficient on small firms becomes zero, although this change is only significant at the ten percent confidence level. No significant change is apparent for medium and large firms. While supporting our earlier conclusions, these results should not be given a high weight due to the strong assumptions necessary for a proper interpretation of the estimates. Moreover, the estimation appeared to be somewhat sensitive to the number of instruments used.

V. Fixed Minimum Project Size and the Role of Collateral

The estimations above overlook two problems that have rarely been treated explicitly in the empirical literature: the likely presence of indivisibilities in investment and the possibility that a firm is completely cut off from credit markets. If, for example, an investment project requires a minimum size to be carried out, credit rationing may prevent a firm from undertaking the investment. In particular, in developing countries, the phenomenon of credit rationing may be more important than the more subtle issue of changes in the external finance premium (see Dailami and Giugale, 1991 and Rama, 1993). In addition, the empirical analysis above concentrated on the role of internal funds, and neglected the importance of collateral, which plays a salient role in the theoretical on borrower-lender relationships literature and in the descriptions of recent lending booms preceding crises.

Empirically, the large number of observations with zero investment (approximately 13 percent) needs to be taken into account. Although there are other possible, for example technological, reasons for this phenomenon, an explanation based on liquidity constraints is given here. The model is a simple two-period moral hazard model with a risk neutral firm and a risk neutral lender as presented in Hoshi, Kashyap and Scharfstein (1992) and Holmström (1993).[47]

A. The Case of Fixed Project Size

At time zero, $t = 0$, firm i has an opportunity to invest in a project that requires an investment of size I. At $t = 1$, the gross payoff from the investment is either R (in case of success) or 0 (in case of failure). The firm can influence the probability of success through its choice between two technologies. If it uses the efficient technology H, the probability of success will be p_h. Alternatively, it can use an inefficient technology L with a probability of success $p_l < p_h$, which would leave B dollars for the firm to use for unproductive activities/perquisites in both cases. The lender cannot observe the choice of the firm. This creates the moral hazard problem. Assume that the expected return is negative if the inefficient technology L is chosen, and positive in case the efficient technology H is used:

$$p_h \cdot R - I > 0 > p_l \cdot R - I + B \qquad (5)$$

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[47]An extended version of the model is used by Holmström and Tirole (1997).

The amount of cash that could be obtained by selling the firm's assets in the second period is A; this represents the maximum that the firm can be forced to pay under liquidation. In the simplest case, in which the firm has no cash, it will borrow the whole amount needed for the investment project.

A contract $C = (y_s, y_f)$ between the lender and the firm, where y_i is the amount that the investor is paid back in case of success (s) or failure (f), is viable if a number of restrictions are satisfied. The first is that the payments are feasible:

$$y_s \leq R + A \qquad y_f \leq A \tag{6}$$

In addition, the following incentive compatibility constraint must hold to induce the firm to choose the efficient technology:

$$p_h \cdot (R + A - y_s) + (1 - p_h) \cdot (A - y_f) \geq p_l \cdot (R + A - y_s) + (1 - p_l) \cdot (A - y_f) + B \tag{7}$$

For the lender to break even in expectations (where for convenience the opportunity cost is assumed to be zero), the following condition must hold:

$$p_h \cdot y_s + (1 - p_h) \cdot y_f \geq I \tag{8}$$

It can be shown that in equilibrium $y_f = A$, so that in case of failure of the project, the lender receives all assets of the firm. Using this insight, one can solve for the level of assets (collateral) that is necessary to undertake an investment of a given size:

$$A \geq I - p_h \cdot R + p_h \frac{B}{(p_h - p_l)} \tag{9}$$

Note also that *if the total assets of a firm are lower than* $I - p_h R + p_h B/(p_h - p_l)$*, the investment project cannot be carried out.* Although this model is extremely simple, it captures some important aspects of reality not considered in other models. In particular, the possibility of credit rationing motivates frequent episodes of zero investment in a natural way.

In order to proceed with an empirical implementation, a few problems have to be overcome. First, the INEGI data do not include many financial variables, so that an accurate measure of a firm's collaterizable net worth cannot be constructed.[48] However, the data do provide a disaggregation of the capital stock in land and buildings and equipment. Therefore,

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[48]For example, the data do not cover debt figures, although they contain information about interest payments. Obviously, it would be against the logic of this paper to assume a common interest rate for all firms in order to deduce the debt stock.

in what follows, the value of real estate (land and buildings) of the firms is used as a proxy for collaterizable assets. This choice is sensible given that real estate is the most widely used form of collateral for longer-term credits in Mexico. This is mainly due to problems with registries for movable capital; it is not feasible for lenders to ensure a unique claim on such types of collateral.[49] Glaessner and Oks (1998) note that collateral "usually takes the form of real estate equal to as much as three times the value of the loan." According to the predictions of the model, we would expect that, ceteris paribus, the probability of investment increases with value of the firm's real estate.

Following Chamberlain (1980), a logit estimation with fixed effects was carried out, where in addition to the value of real estate, cash flow, time dummies, and the change in output were included in the regression. The change in output is intended to capture changes in profitability. The coefficient on cash flow was not constrained to be equal to the real estate coefficient, since it is not clear that all of the internal funds available at the time of investment can be seized in case of bankruptcy. To avoid spurious correlation, capital expenditures on real estate were subtracted from investment, and net revenues from sales of land or buildings were deducted from cash flow. Formally, the model can be written as:

$$\frac{I_{it}}{K_{it-1}}^{*} = \beta \frac{\Delta y_{it}}{K_{it-1}} + \phi \frac{CF_{it}}{K_{it-1}} + \theta \frac{RE_{it}}{K_{it-1}} + \lambda_t + \nu_i + \varepsilon_{it} \quad , \qquad (10)$$

$$I_{it} = 1 \ if \ \frac{I_{it}}{K_{it-1}}^{*} > 0 \ ,$$

$$I_{it} = 0 \text{ otherwise,}$$

where RE_{it} denotes the value of the real estate owned by the firm. In other words, for the moment we ignore the actual size of the investment project and concentrate on the probability of observing positive capital expenditures.[50] Table 4 presents the estimates. The results support the predictions of the model and indicate that a higher value of real estate significantly increases the probability that a firm invests. In fact, the value of real estate is the most

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[49]See Glaessner and Oks (1998).

[50]In a logit model, the probability that I_{it} equals one is given by the expression

$$\frac{e^{\beta \frac{\Delta y_{it}}{K_{it-1}} + \phi \frac{CF_{it}}{K_{it-1}} + \theta \frac{RE_{it}}{K_{it-1}} + \lambda_t + \nu_i}}{1 + e^{\beta \frac{\Delta y_{it}}{K_{it-1}} + \phi \frac{CF_{it}}{K_{it-1}} + \theta \frac{RE_{it}}{K_{it-1}} + \lambda_t + \nu_i}} .$$

important variable determining the probability of investment.[51] These qualitative results remain unaltered when modifying the model so as to restrict attention only to investments above the maintenance/depreciation threshold of seven percent, i.e. replacing $I_{it} = 1 \; if \; \frac{I_{it}}{K_{it-1}}^{*} > \delta$ above.

Table 4. Logit Estimation with Fixed Effects

	Cash flow $\frac{CF_{it}}{K_{it-1}}$	Cash flow after 1989 $\frac{CF_i}{K_{it-1}} D_{after}$	Real Estate $\frac{RE_{it}}{K_{it-1}}$	Real Estate After 1989 $\frac{RE_{it}}{K_{it-1}} D_{after}$	Change in Output $\frac{\Delta y_{it}}{K_{it-1}}$	Wald Test of Joint Significance $\chi^2_{(14)}$	No. of obs.
Threshold: 0	1.43 (3.53)	0.58 (1.32)	6.46 (5.54)	0.38 (1.15)	0.10 (2.63)	258.5	5240
Threshold: δ	1.19 (5.84)	0.08 (0.37)	7.29 (10.41)	2.09 (7.56)	0.07 (2.38)	523.1	8020

Note: t-statistics in parenthesis. Time dummies included in the regression (not shown). The number of observations is higher in the second estimation since the conditional logit estimation requires within-plant variation in outcomes, i.e. ignores plants that invested in each year or in none. There are fewer plants without variation when adopting the depreciation rate as the relevant threshold.

However, the latter results suggest that while the role of cash-flow is unchanged after financial liberalization, the importance of real estate increased after 1989.

B. Variable Project Size

A generalization of the model allows for a variable project size. Suppose again that at time zero, t = 0, firm i has an opportunity to invest in a project that now requires a minimum investment of size I_{min}. However, above I_{min}, the investment project can be carried out at any size. At t = 1, the gross payoff from the investment is either R·I (in case of success) or 0 (in case of failure). Similarly, let the amount that the firm can divert be no given by B·I. The results derived previously can easily be modified to obtain:

[51]Black, de Meza and Jeffreys (1996) provide evidence on the importance of real estate for entrepreneurial decisions.

$$A \geq I + I\cdot[\,-p_h\cdot R + p_h \frac{B}{(p_h - p_l)}\,] \qquad (11)$$

If the value of the total assets of a firm is less than I_{min}- $I_{min}[p_hR - p_hB/(p_h-p_l)]$, the investment project cannot be undertaken. Put differently, the amount of collateral determines the size of investment. Following similar arguments as before, this suggests estimating a specification of the following form:

$$\frac{I_{it}}{K_{it-1}}^{*} = \beta \frac{\Delta y_{it}}{K_{it-1}} + \phi \frac{CF_{it}}{K_{it-1}} + \theta \frac{RE_{it}}{K_{it-1}} + \lambda_t + \nu_i + \varepsilon_{it} \;, \qquad (12)$$

$$\frac{I_{it}}{K_{it-1}} = \frac{I_{it}}{K_{it-1}}^{*} \; if \; \frac{I_{it}}{K_{it-1}}^{*} > I_{\min i}$$

$$= 0 \; if \quad \frac{I_{it}}{K_{it-1}}^{*} \leq I_{\min i}$$

Similarly as in the estimations above, the change in output is included to control for changes in profitability.

This is a Tobit model with fixed effects. Fixed effects are essential in order to control for unobserved heterogeneity, in particular concerning the minimum size of the firm's investment project $I_{min\,i}$. (Note that the fixed effects ν_i and $I_{min\,i}$ cannot be identified separately.) However, estimation of a Tobit model with fixed effects is not trivial; this is due to the difficulty in deriving the maximum of the likelihood function.[52] Honoré (1992) has developed an estimator that relies on the symmetry of the distribution of the latent variable;[53] this method was used in the estimation. Similarly to the approach followed in the previous section, a test was carried out on whether the post-liberalization coefficients on cash flow and real estate differ from the ones for the period 1984–88. The results are presented in Table 5. The results are strong: the value of real estate (RE) has an important effect on the investment decisions of all but publicly-owned firms; the coefficient on RE is higher than the one on cash

[52]See Baltagi (1995), p. 179.

[53]A brief description of the main idea behind the estimator is given in Appendix III. Heckman and MaCurdy (1980) develop another method in the context of a labor supply model.

Table 5. Tobit Estimation with Fixed Effects

Variables	All	Only Private	Only w/ part. Publ.	Purely Mexic.	Only w/ Foreign Part.	Only Non-Export	Only Export.
$\frac{RE_{it}}{K_{it-1}}$	0.39 (6.30)	0.37 (5.86)	0.91 (4.16)	0.38 (4.27)	0.41 (5.92)	0.40 (5.76)	0.36 (3.13)
$\frac{RE_{it}}{K_{it-1}} D_{after}$ **after liberalization**	0.04 (3.61)	0.04 (3.53)	0.30 (0.98)	0.05 (3.25)	0.04 (2.11)	0.06 (3.71)	0.02 (0.81)
Cash flow small firms $\frac{CF_{it}}{K_{it-1}} D_s$	0.15 (4.28)	0.15 (4.01)	33.01 (0.00)	0.17 (4.40)	0.06 (1.33)	0.14 (3.93)	0.10 (1.71)
Cash flow, medium-sized firms $\frac{CF_{it}}{K_{it-1}} D_m$	0.04 (3.07)	0.04 (3.05)	-0.2 (-0.48)	0.03 (2.05)	0.04 (2.67)	0.02 (1.92)	0.07 (3.38)
Cash flow large firms $\frac{CF_{it}}{K_{it-1}} D_l$	0.05 (2.83)	0.04 (2.27)	0.04 (0.41)	0.04 (1.66)	0.05 (2.61)	0.05 (2.41)	0.06 (1.88)
Cash flow small firms after liberalization $\frac{CF_{it}}{K_{it-1}} D_s D_{after}$	-0.04 (-1.16)	-0.04 (-1.1)	-32.6 (0.00)	-0.06 (-1.32)	0.03 (0.00)	-0.03 (-0.89)	-0.10 (-1.45)
Cash flow, medium-sized firms after liberalization $\frac{CF_{it}}{K_{it-1}} D_m D_{after}$	0.03 (1.95)	0.03 (1.98)	0.22 (0.55)	0.06 (3.04)	-0.01 (-0.94)	0.04 (2.54)	-0.01 (-0.57)
Cash flow, large firms after liberalization $\frac{CF_{it}}{K_{it-1}} D_l D_{after}$	0.04 (2.24)	0.05 (2.22)	0.35 (0.36)	0.09 (2.89)	0.00 (0.00)	0.05 (1.09)	0.02 (0.72)
$\frac{\Delta y_{it}}{K_{it-1}}$	0.01 (3.67)	0.01 (3.56)	0.00 (-0.02)	0.01 (3.26)	0.01 (1.95)	0.01 (2.94)	0.01 (2.55)
χ^2 **test**	251.0	234.8	124.8	199.6	106.2	202.5	87.3
No. of observations	10460	9841	619	7390	3070	7860	2600

The dependent variable is $(I/K)_{it}$ (excl. purchases of real estate). T-statistics are given in parentheses. Year dummies included in all regressions (coefficients omitted). The Newton optimization algorithm, as implemented in the OPTMUM routine of GAUSS, was used with a polynomial loss function. The program PANTOB described by Campbell and Honoré (1992), kindly made available by Bo Honoré, was employed in the estimation.

flow.[54] The pattern of cash-flow coefficients across firms, in turn, is similar to the one found earlier, and, in some cases, more in line with the a-priori predictions. Cash flow matters for most types of firms: exceptions are public enterprises, small foreign-owned firms, large Mexican establishments, and small and large exporting firms.[55] However, the drop in the cash flow coefficient for small firms after 1989 is not significant in these estimates. Interestingly, consistently with the earlier results, for purely Mexican-owned large firm, the correlation between cash flow and investment appears to increase after 1989. The results concerning the importance of real estate, in line with those reported in Table 2, also indicate that liquidity constraints are important for all but public firms, and that they become less significant after liberalization.[56]

Concerning the interpretation of the high t-statistics on the real estate variable, one might suspect that, despite excluding purchases of land and buildings from investment, a spurious correlation could be present, since non-real estate investment spending could be correlated with investment in other assets. If one does not control sufficiently for the common factor driving both types of expenditures (expected profitability), the observed correlation may then possibly not be interpreted in our sense.[57] However, three facts may be noted here: first, investment in real estate is only weakly correlated with other capital expenditures. Secondly, regressions including only those cases in which investment in real estate was zero, gave qualitatively very similar results. Thirdly, the main results were unaltered when including the investment expenditures on real estate as an additional explanatory variable or when using lagged values of the real estate variable.

Note that it is more difficult than in the case of cash flow to argue that the reason why real estate matters for investment is that its value is correlated with profit opportunities of the firm. Changes in profit opportunities could be idiosyncratic or aggregate. Idiosyncratic changes in the value of real estate can only come from purchases or sales, which were discussed above and were found not to be driving the results. In contrast, upward movements in land prices are likely to be correlated with general improvements in business conditions. However, these types of aggregate effects are controlled for by the inclusion of time dummies. Lastly, cross-sectional variations in the firms' *stocks* of real estate are unlikely to be systematically associated with differences in future profit opportunities.

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[54]As mentioned earlier, cash could be regarded as collateral, so that one would expect the coefficient on real estate and on cash flow to be of similar size. However, as noted above, it may be more difficult to repossess cash.

[55]The coefficients on purely Mexican medium-sized firms and on large public firms are only significant at the ten percent level.

[56]One would expect the effect of cash flow to diminish with increased collateral value. An interaction term of cash flow and real estate in fact had the anticipated negative coefficient, which however was not always significant.

[57]This would only be the case insofar as current investment on real estate contributes significantly to current real estate stocks.

For some classes of firms, the importance of collateral appears to increase after 1989. Apart from nonexporting firms and firms with foreign participation, this is also true for large companies (not shown). This is not as surprising as it may seem. Although an increased availability of credit should have contributed to a reduction of liquidity constraints, there is no reason to believe that the informational and enforcement problems that motivate the use of collateral diminished after the liberalization of the financial sector. However, many firms that previously were completely cut off from any credit, were now in principle eligible for bank loans. For them, possessing collateral became more important.[58] These firms were new borrowers, whose risks were difficult to assess for lenders.[59] On the banks' side, credit expansion was not accompanied by a comparable increase in their technical capabilities.[60] The type of lending conducted throughout most of the eighties, namely the intermediation of resources to the public sector, did not foster the development of credit-analysis techniques.[61] Moreover, access of foreign banks to the Mexican market, which possibly could have promoted the implementation of more advanced credit risk monitoring practices, was tightly restricted. Due to lack of experience, technology and human resources, credit was extended mainly against collateral. Although there is little detailed information available on this issue, Table 6 shows the percentage of collaterized loans over 20 million pesos taken over by the agency formed to recapitalize the banks after the crisis (FOBAPROA).

One would expect a lower-than average reliance on collateral for the case of these larger loans, since they were presumably extended to larger commercial borrowers with a longer track record. Nevertheless, the majority of banks extended these credits against collateral. Of the 1022 loans for which this information is available, 60 percent (representing 51 percent of the total value) were backed by collaterizable assets. As mentioned earlier, in most cases, the collateral consisted of real estate. Real estate prices had collapsed in the early eighties, but experienced an enormous upswing since 1987.

One (partial) description of the lending boom preceding the 1994/95 crisis would be the following: rising real estate prices made it easier for firms to access credit, which allowed the completion of projects and improved the firms' financial situation. This in turn lowered the cost of finance and led to further investment activity and higher demand for land. It is easy too see how such a "financial accelerator" process can be self-reinforcing until it is interrupted by an

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[58]In a survey conducted by the World Bank (1994), insufficient collateral was mentioned by firms, together with high interest rates, as the main deterrent from investment.

[59] Related to these issues, McKinnon and Pill (1997) explain how credible economic reforms may, in the presence of unavoidable deposit insurance, lead banks to lend overly aggressively, which in turn sends false signals to the borrowers regarding the likely outcome of the reform process. See also Sundararajan and Baliño (1991), p.13.

[60]See Gruben and McComb (1997).

[61] See Díaz de León and Schwartz (1997) and Mancera (1997). According to Mishkin (1996), p. 28, "Mexican banks did not have formal credit bureaus for household and small business lending which would monitor loans to make sure that borrowers were not taking on excessive risk."

Table 6. Proportion of Collateralized Loans Over 20 Million Pesos

Name of Bank	Percentage
Atlantico	100
Banamex	80
Bancen	62
Bancomer	76
Banorte	71
Banpais	n.a.
BBV	73
Bital	100
Capital	27
Cremi	n.a.
Interestatal	90
Obrero	n.a.
Oriente	n.a.
Promex	64
Pronorte	75
Santander Mex.	96
Serfin	30
Union	0

Source: FOBAPROA

economy-wide shock.[62] Schneider and Tornell (1998) formalize a similar argument, combining agency problems in the borrower-lender relationship with the presence of implicit bailout guarantees by the government. In their model, a gradual development of a lending boom occurs because there is an inelastically supplied asset (land) that can serve as collateral. Higher lending to negative expected value projects increases the demand for real estate, increasing the value of collateral. There are, however, limits to the validity of too simple stories. For example, at least within our sample, the lending boom years are not associated with a marked rise in the demand for land by firms. One factor not discussed here is the rise in the non-corporate demand for real estate; the years 1989–94 were also associated with a housing boom facilitated by easy credit.

[62] See, for example, Bernanke, Gertler and Gilchrist (1996), Kiyotaki and Moore (1997) and Edison, Luangaram and Miller (1998). Schneider and Tornell (1998) construct a model that combines bailout guarantees with a financial accelerator mechanism in order to explain the dynamics of asset prices during lending booms.

However, similar mechanisms may also help to explain the severity of the recent Mexican crisis. Even before the actual crisis, the share of nonperforming loans was rising, a situation that was worsened by the 1993 drop in real estate prices and a fall in stock market prices in 1994. This made lenders more reluctant to lend and increased incentives to engage in risky activities.[63] (With reduced collateral values, there is less to lose.) When finally the exchange-rate crisis hit the balance sheets of many firms severely, this effect in turn contributed to a decline in lending, giving again rise to similar financial accelerator effects as described earlier.[64] A decline in borrower's net worth in general increases the premium in the cost of external over internal funds, reducing investment even for firms with high-return projects, and potentially leading to an economy-wide decline in asset prices. These lower investment levels, in turn, decrease the availability of funds in the next period, which again depresses capital expenditures, and so forth. This reasoning is in line with the view expressed, among others, by Mishkin (1996), who, in discussing the Mexican 1994/95 crisis, attributes an important role to balance-sheet effects and informational asymmetries. The presented interpretation underscores the riskiness of overcoming agency problems in borrower-lender relationships through the use of collateral whose value itself is prone to move with aggregate shocks.

VI. Conclusion

Throughout the examined period, financial constraints significantly influenced investment behavior in the Mexican manufacturing sector. Financial repression contributed to the low levels of investment observed between 1982 and 1988,[65] with small firms being the most strongly affected by financial constraints. The analysis indicates that financial liberalization seems to have eased financing constraints for some, in particular small firms, although this result is not robust across estimation methods. For larger, purely Mexican-owned and nonexporting firms, the reliance on internal funds even appears to have increased after 1989. Possibly, however, some of these firms were over-leveraged during the period of financial repression.

In addition, it is shown that collateral, in the form of real estate, played an important role in determining investment, even more so after 1989. One interpretation is the following:

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[63]The ensuing vulnerability of the financial system in turn made the Central Bank reluctant to pursue tight monetary policies when investors started to lose confidence.

[64]Apart from the drop in domestic demand, firms were hit by unhedged foreign currency liabilities. An analysis of a database of the 580 largest Mexican firms (Expansión, 1996) reveals that, in 1994, the average ratio of foreign currency liabilities to total liabilities was 33 percent. Moreover, this ratio appears to be unrelated to the exposure of firms as measured by the ratio of exports minus imports divided by total sales (the correlation coefficient is -0.05). However, the database does not contain any information on the degree of hedging.

[65]This conclusion is in line with that of İşcan (1998), who argues that financial constraints were particularly severe during 1982–84, and attributing them to a large extent to debt-crisis effects.

financial liberalization did not translate so much into a reduction in the premium of the cost of external funds over internal funds, but rather into an increase in the number of firms that were potentially eligible for credit. However, the poor state of the banks' evaluating and monitoring capacities, together with prevailing legal and enforcement problems, led banks to rely heavily on collateral in their lending decisions: having real estate became more important for firms. Since this collateral-based lending probably increased the vulnerability of the financial sector,[66] these facts highlight the need for a better understanding of the incentives guiding lending behavior in order to adopt effective banking regulation and supervision.

One implication from the results is that, although financial liberalization in an initially financially repressed economy helps to increase the availability of credit for previously disadvantaged firms, one should not expect an elimination of financial constraints. Enforcement difficulties and problems of asymmetric information in lender-borrower relationships, which constitute a main reason for financing constraints, are likely to remain important. Broader reforms would be required to tackle these problems, for example in the area of bankruptcy laws and creditor protection. Similarly, it takes time to build screening and evaluation capacities on the banks' side.

Moreover, these issues may be relevant for an understanding of the severity of the Mexican crisis 1994/95. In addition to increasing the financial system's vulnerability to aggregate shocks prior to the crisis, the effects of the devaluation were exacerbated. Banks were suddenly stuck with large quantities of real estate, since many firms were hit hard by the increase in the peso value of their debts. Given the prevailing agency problems, the unwillingness of banks to continue lending possibly resulted in a "financial accelerator" mechanism, which led the economy further into recession. The findings regarding the importance of real estate are consistent with the role often attributed to asset, in particular real estate prices in recent financial crisis episodes.

Finally, the results provide microeconomic evidence consistent with the existence of a credit channel of monetary transmission, even after financial liberalization. If firms are credit-constrained and bank-dependent, under certain additional circumstances the quantity of loans in the economy can influence real activity,[67] beyond its effects through interest rates. This implies a need for tracking the distribution of the firms' financial situation: the higher the share of credit-constrained firms with weak balance sheets, the stronger such propagation mechanisms will be. Although further investigation of this issue is warranted, the possibility of such a transmission mechanism needs to be explicitly taken into account in the design of monetary policy.

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[66]For a study of banking system fragility in Mexico focusing on other aspects, see González-Hermosillo, Pazarbaşioglu and Billings (1997).

[67]In addition to firms being bank-dependent, the other conditions that need to be fulfilled for a "credit channel" to exist, are that the monetary authority can influence the supply of loans in the economy by affecting banks' reserves and that the price level does not adjust immediately to offset any nominal increase in the quantity of money. See Bernanke and Blinder (1988). For Mexican evidence using aggregate data, see Copelman and Werner (1997).

APPENDIX I

CONSTRUCTION OF THE VARIABLES

Capital Stock: The survey includes replacement cost values for five categories of fixed assets: machinery equipment, buildings, land, transport equipment and other. However, due to the strong variability of these series, we opted for not using these values. Instead, a perpetual inventory method based on reported investment figures was used, with the replacement cost numbers for 1984 as the initial stocks. The assumed deprecitation rates are zero for land, four percent for buildings and seven percent for all other assets. (The following price indices were used as deflators: producer price indices for machinery and construction, a land price index for Mexico City, and the wholesale price index for Mexico City.)

Investment: Investment is defined as purchases minus sales of used and new assets plus improvements on existing assets plus capital assets produced for own use. Machinery and transport equipment investment was deflated by the mid-year machinery price index, other investment by the mid-year wholesale price index, purchases of land by the mid-year Mexico City Land Price Index, construction expenditures by a construction mid-year price index.

Cash flow: Initially we tried to calculate the cash flow at the establishment level by adding all income from sales and subtracting all expenses. However, this series was problematic due to a variety of reasons. For example, the survey does not include income from financial activities, and the reported cost figures contained many errors. Maybe more importantly, for our purposes the relevant cash flow is the one at the firm, not at the plant level; in case that the hypothesis of single-firm establishments is violated, the relevant information would be the one at the firm level. Therefore, an alternative method was used. Mexican law requires every firm to pay out ten percent of profits to its employees. We multiplied the profit-sharing figures by ten and added reported depreciation (which in most cases reflects accounting, not economic values) to obtain cash flow. Obviously, these figures are problematic, since profit-sharing is never negative. However, only 3.4 percent of the observations are equal to zero. In rare cases, firms were allowed to depart from the rule prescribing ten percent profit-sharing; in general, such deviations were more likely if a firm faced a difficult situation and commited itself to reinvest its profits. Obviously, these cases tend to bias the coefficient on cash flow towards zero. The mid-year wholesale price index was used to deflate cash flows.

Output: In the calculation of output values, a correction for maquila services (subcontracting work) had to be undertaken.[68] In general, output of the firm rendering subcontracting services is counted as output from the company paying for the services. Therefore, following Grether (1994), income for maquila services was added, and maquila costs were subtracted from the reported value of manufactured products. This correction may not be accurate in all cases. Mid-year producer price indices at the four-digit disaggregation level were used for deflation.

Price indices: All price indices were obtained from Banco de Mexico.

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[68] "Maquila services" in the survey do not denote factories (maquiladoras) operating at the Mexican-U.S. border under special tax preferences.

In order to eliminate outliers, establishments with zero or missing capital were eliminated entirely from the sample. In addition, plants that reported values for the chnage in output, investment and real estate, scaled by the lagged capital stock, in the top and bottom three percentiles, were discarded, as well as establishments with less than three employees.

APPENDIX II

HONORE'S ESTIMATOR FOR TOBIT MODELS WITH FIXED EFFECTS

The method is based on a generalization of Powell's (1986) trimmed least squares estimators for tobit models without fixed effects. The estimators are semiparametric; no parametric form for the disturbances has to be assumed. Heteroskedasticity across individuals is permitted.

Consider the case of two time periods. The data is assumed to be generated as transformations of unobserved latent variables Y_1^* and Y_2^* given by

$$Y_t^* = \alpha + X_t\beta + \varepsilon_t \qquad \text{for } t=1,2.$$

where X_1 and X_2 are K-dimensional vectors of explanatory variables, β is the parameter vector of interest, α is the fixed effect, and ϵ_1 and ϵ_2 are error terms. The econometrician observes $\{(Y_{it}, X_{it})$: t=1,2, i=1,...,n$\}$ where $Y_{it}=\max\{0,Y_{it}^*\}$, and Y_{it}^* and X_{it} are distributed as given above. Honoré shows that if ϵ_1 and ϵ_2 are i.i.d. conditional on (X_1, X_2,α), then the distribution of (Y_1^*, Y_2^*) conditional on (X_1, X_2) is symmetric around the 45°-line through $((X_1 - X_2)\beta,0)$. This symmetry is used to propose orthogonality conditions that must hold at the true parameter values. The proposed estimators for β are then defined by the minimization of objective functions that have as first order conditions the sample analogs of these orthogonality conditions. The estimators are proved to be consistent and asymptotically normal. Monte Carlo results show that the asymptotic results give a good approximation of the small sample distribution if $N \geq 200$. Note that the i.i.d. assumption concerning the ϵ's is not as restrictive as it may appear, since the fixed effect can capture some dependence between the error terms.

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