Tax Incentives and Business Investment: New Evidence from Mexico

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Tax Incentives and Business Investment: New Evidence from Mexico *†

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Abstract

This paper provides new evidence on the response of business investment to tax incentives. I use the variation provided by recent reforms to the Mexican corporate tax system, including the elimination and reintroduction of accelerated depreciation allowances applicable to investment undertaken outside the three main Mexican metropolitan areas. I show that investment is very sensitive to changes in tax variables and interest rates, with an estimated elasticity of investment with respect to the user cost around -2.0. The results are robust to different specifications and instrumental variables approaches. The large elasticity is shown to be the result of the large cross sectional variation in the user cost of capital and also a product of the small open economy nature of the Mexican economy. In particular, large investment responses of plants owned by multinational firms and a elasticity of imported assets considerably larger than that of domestically purchased goods. Furthermore, the use of panel data at the establishment level allows me to identify the discrete nature of investment decisions and to show that the capital accumulation pattern is consistent with nonconvex adjustment costs and irreversibilities, similar to those found for the US. Thus, the large elasticity compared to US estimates cannot be attributed to differences in adjustment costs. Finally, I provide evidence that the large investment response is not an artifact of misreporting or tax evasion since the elasticity of investment in other assets such as transportation equipment and land, which is harder to misreport, is also high.

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1 Introduction

There is a large number of studies estimating the elasticity of business investment with respect to the user cost of capital. A recent wave of empirical work since the early 1990s has used panel data and clever estimation techniques to generate a new consensus estimate of this elasticity between -0.5 and -1.0, implying that taxes, interest rates, and depreciation rules affect investment decisions.[1]

The study of the responsiveness of investment to the user cost in other countries provides a natural robustness check for the results found using US data.[2] However, the available empirical evidence for developing economies is scarce due to data limitations and the complex way in which income from capital is taxed in many of these countries. This paper tries to partially fill this gap in the literature. Using a confidential panel database of Mexican manufacturing establishments, I estimate the elasticity of investment with respect to the user cost. Correcting my estimates for possible endogeneity and measurement error using instrumental variables (IV), my results show that the elasticity is significantly greater than unity, with a preferred estimate around -2.0.

This large elasticity is partially a result of using large cross sectional variation in the user cost of capital.[3] Previous to 1999, Mexican depreciation rules included the option to expense the present discounted value (PDV) of all future depreciation allowances using a favorable discount rate. Notably, only investments undertaken outside the three main metropolitan areas (Mexico City, Guadalajara and Monterrey) applied for this preferential tax treatment. In 1999 this system was eliminated to overcome a shortfall in government revenue caused by lower international oil prices. This policy change is arguably exogenous to firm investment decisions providing potentially valid instruments (this provision implied an increase in the user cost of 34% outside these metropolitan areas, compared to an increase of 19% within these areas). The

[1]See Chirinko (1993), Caballero (1999) and Hassett and Hubbard (2002) for reviews of the literature.

[2]See Cummins, Hassett, and Hubbard (1996) for a cross country analysis for 14 members of the OECD.

[3]This large cross sectional variation comes from: Industry variation driven by economic depreciation rates; pure time series variation driven by interest rates; time series and industry level variation driven by changes in the ratio of prices of capital goods and output; and time series, industry and regional variation driven by the changes to the system of depreciation allowances.

results of this paper are robust to different specifications and the use of IV strategies, including dynamic panel models.

The small open economy nature of the Mexican economy is shown to be another possible determinant of the large investment response. I show that the investment response of plants owned by multinational firms is large. My results suggest that investment by US, British, German and Swiss multinationals responded more to changes in the user cost than investment by other multinationals or domestic plants.

The small open economy nature is also recognized in the supply side of capital as a possible determinant of the high responsiveness of investment. Specifically, I show that the elasticity of imported assets is considerably larger than that of domestically purchased capital. This provides evidence of a response of domestic prices to tax incentives: managers adjusted more their investment in the international market (with fixed prices), while in the domestic market both prices and investment reacted.

The use of data at the establishment level also allows me to identify the discrete nature of investment, and show that investment is consistent with nonconvex adjustment costs and irreversibilities, similar to those reported in Caballero, Engel, and Haltiwanger (1995) for US manufacturing plants. Specifically, plants that according to a neoclassical model should disinvest rarely do so, while plants with capital shortfalls do invest, and this response is increasing in the size of the capital shortfall. This finding implies that the larger elasticity compared to US estimates is not caused by differences in the adjustment cost functions between Mexico and the US.

Arguably, if after investment incentives were removed managers were able to include capital expenditures as operating expenses, then the large elasticity could be just an artifact of misreporting. However, I show that the elasticity of investment in transportation equipment and land is also high. Since these assets are harder to misreport, this finding suggests that the large investment response is not due to misreporting or tax evasion.

The paper is divided as follows. Section 2 presents the review of the literature, with particular emphasis on the study of investment incentives in Mexico. Section 3 describes the reforms to the

Mexican corporate tax system. Section 4 briefly describes the database. Section 5 outlines the main empirical strategy and its results. Additional results aimed to explain the large estimated elasticities are presented in Section 6. Section 7 analyzes tax policy implications. Section 8 concludes. Finally, a detailed description of the database can be found in Appendix A.

2 Literature Review

2.1 Sensitivity of investment to the user cost

One decade ago, the empirical evidence suggested that taxes and interest rates have little effect on investment.[4] The estimated models implied implausibly large adjustment costs, in the range of one to five dollars per dollar of investment. However, several recent papers have been successful in explaining the reasons behind this result, and in some cases even correct the estimation techniques and show that investment is in fact sensitive to changes in the user cost of capital.

The small estimated elasticities can be explained, for example, by monopolistic competition in the capital goods market, which may cause prices and not quantities (investment) to react (Goolsbee (1998)). Moreover, there is a bias towards finding small effects of the user cost on investment if the common assumption of convex adjustment costs does not hold. Dixit and Pindyck (1994) argue that irreversibility might create ranges where investment does not react to changes in the user cost. Caballero et al. (1995) show that the pattern of investment is consistent with the presence of irreversibilities and nonconvexities, and estimate the long run elasticity of the capital stock with respect to its user cost to be close to -1.0, larger by an order of magnitude than those of the previous literature.[5]

Furthermore, one of the main explanations for the small empirical elasticities is measurement error in the user cost. Panel data at the asset, firm or plant level has been used to address this problem. For example, using a panel at the industry level, Goolsbee (2000) shows that the user cost variable has measurement error and that, after correcting the estimates using instrumental variables, the results show that taxes affect both prices and investment.

[4] See surveys by Chirinko (1993), Caballero (1999) and Hassett and Hubbard (2002).

[5] Doms and Dunne (1993) also show that plant level investment is composed of large and discrete episodes.

Using a panel of firm level data from COMPUSTAT, Cummins, Hassett, and Hubbard (1994) show that measurement error is present not only in the tax variables, but also in the measure of Tobin (1969) Q. Their IV estimate of the elasticity of investment with respect to the user cost lies between -0.5 and -1.0, close to the neoclassical prediction and equivalent to adjustment costs of only 10 cents per dollar of investment. More recently, Chirinko, Fazzari, and Meyer (1999) also use firm level variation in the cost of capital to estimate the elasticity of the capital stock with respect to its user cost. Their preferred IV estimate is close to -0.25.

An important fundamental concern with the empirical estimation is the difference between short and long run dynamics. House and Shapiro (2004) link this difference to firm expectations about future tax changes and show that for sufficiently forward looking investment in long lived assets, the elasticity to temporary changes in tax parameters is nearly infinite. These authors analyze the 2002 and 2003 changes to depreciation allowances and find that prices reacted very little while investment increased for the types of capital that qualified for bonus depreciation. In contrast, Desai and Goolsbee (2004) argue that depreciation rules were already close to full expensing, and thus these reforms produced only small percentage changes in the user cost, which explains the small effects on investment they find.

2.2 Investment incentives in Mexico

The economic analysis of tax investment incentives in developing countries requires consideration of some additional factors compared to developed economies. Auerbach (1995) provides a detailed discussion on this topic and concludes that the two main differences in the analysis are the consideration of the effects of investment incentives on Foreign Direct Investment (FDI), and the possible exogeneity of the required after-tax return on investment.[6]

Evidence on the effect of investment tax incentives in Mexico is scarce. Most of the analysis of investment that has been done at the aggregate or micro level has not considered the effects of taxes on investment.[7] For example, Gelos and Isgut (2001a,b) analyze the investment behavior

[6]See Hines and Gordon (2002) for a review of the theory and empirical results on international taxation and FDI.

[7]Notably, many papers that study the impact of cash flow, liquidity and financial liberalization on investment

of Mexican and Colombian manufacturing plants following the methodology of Caballero et al. (1995). They do not construct a measure of the user cost of capital, but only use one of its non-tax components (the relative prices of capital goods and output) in order to identify the adjustment function. Moreover, their relative price parameter does not vary across industries. Gelos and Isgut (2001b) find that investment patterns are consistent with the presence of irreversibilities but not nonconvexities. This contrasts with my results in Section 6.3, where I show that investment of Mexican manufacturing plants is consistent with both irreversibilities and nonconvexities.[8]

The general omission of tax considerations is striking given the fact that tax incentives for investment in Mexico have undergone large changes since 1950.[9] In fact, those changes motivated Feltenstein and Shah (1995) to develop a computable general equilibrium model to study the impact of taxes on investment in Mexico. Their calibrations show that taxes do affect investment and that for two reforms with the same revenue impact, reductions to the corporate income tax rate are more effective to incentive investment than investment tax credits.[10]

In a time series framework, Shah and Slemrod (1995) analyze the effects of taxation on the aggregate flow of FDI to Mexico during the 1960-1990 period. Their results suggest that the FDI flow is very sensitive to taxes. The estimated elasticities also imply that the tax effect on FDI in the form of new transfers from abroad is larger than the one on FDI in the form of retained earnings of multinationals. Also using a time series framework, Pérez-López (2004) develops a forecast model for Mexican investment where he proxies the tax component of the user cost by including the ratio of income taxes (both personal and corporate) to GDP as an explanatory variable in his aggregate error correction model of investment. The coefficient of this term goes in the wrong direction although is not significantly different from zero.[11]

also omit the consideration of taxes. See Gelos and Werner (1999), Babatz and Conesa (1997), for example.

[8]The differences can be caused by the different time period of study (Gelos and Isgut (2001b) study plants during 1984-1994, while I use 1994-2002). The difference can also be caused by the different methodology to calculate both the capital stock and the user cost, as explained in Section 4 and in the Appendix A.

[9]See Feltenstein and Shah (1995) for a summary of the changes between 1950-1985.

[10]Decreasing the corporate tax rate from 42% in 1987 to 35% in 1988 would have yielded an increase in manufacturing investment of 4.9%, while a 10% investment tax credit in 1988 would have only increased it by 2.2%.

[11]Pérez-López (2004) attributes his finding to large measurement error in his average effective tax rate (the corporate and personal income taxes are fully integrated, so it is not possible to get the corporate share of revenue).

At the micro level, Schwartzman (1985) finds no support for the view that taxes affect investment in Mexico. He models the behavior of investment in a small open economy and suggests that real exchange rate fluctuations contributed to the large volatility of Mexican investment during 1975-1985 (through its effect on Q). Schwartzman (1985) estimates structural Q-model equations for investment in a panel of 20 Mexican firms. His results support the view that Q-model regressions explain the behavior of investment in Mexico, but also that taxes play a very secondary role in affecting investment. His tax-unadjusted regressions econometrically outperform the tax-adjusted regressions. The contrasting results reviewed in this section, pose the question of whether taxes affect investment in Mexico; answering this question is the goal of this paper.

3 The Mexican corporate tax system and its recent reforms

3.1 General overview of the corporate tax system

According to Gordon and Ley (1994), the Mexican and the US tax systems are relatively similar. "Both federal governments tax corporate income in virtually the same rate (34 percent in Mexico and 35 percent in the US), and both have a progressive personal tax with a maximum rate of 35 percent in Mexico and 39 percent in the US" (Gordon and Ley 1994, p. 436).

The differences come from the definition of taxable income.[12] The Mexican tax system is completely neutral with respect to inflation, while the US system is not. Also, there is full integration of the personal and corporate tax system in Mexico.[13] Finally, the Mexican Constitution mandates firms to distribute 10% of pre-tax income to workers and employees each fiscal year. This profit sharing scheme increases the burden of corporate taxation.

It should be noted that investment tax credits are small and very specific in Mexico (targeted to agriculture mostly). Therefore, since the following analysis focuses on manufacturing

[12] Also, the US government relies more on the payroll tax while the Mexican government collects a substantial amount of funds through the Value Added Tax.

[13] Dividends from Mexican firms are tax-exempt as well as all capital gains realized in the Mexican Stock Exchange (Bolsa Mexicana de Valores). Therefore, I omit the discussion of the different predictions of the views of dividend taxation (see Poterba and Summers (1985)).

establishments, I omit its consideration.

The corporate tax rate is a flat 34% (1994). Depreciation allowances are based on a straight line method of deductions for fixed assets. The specific percentage deduction for each asset is specified in the Income Tax Law (Ley del ISR). For machinery and equipment, this percentage also depends on the industry in which it is used. Table A-1 shows annual depreciation rates applicable to selected assets, and to machinery and equipment in selected industries.

By 1994, depreciation rules also included the option to immediately expense the PDV of future depreciation allowances using a fixed (and favorable) real discount rate of 5%.[14] For example, in the case of the purchase of a building, with annual depreciation deductions of 5% (20 years of straight line depreciation), the law allowed the option to immediately expense 62% of the acquisition cost, which is considerably higher than the 35% PDV of depreciation allowances when using the market real riskless rate.

Importantly for the following analysis, this Optional Accelerated Depreciation (OAD, or so called "Depreciación Inmediata"), was only applicable to investment expenditures undertaken outside the three main metropolitan areas of the country, i.e., Mexico City, Guadalajara and Monterrey. For many years, this system was used by the government to promote decentralization.[15]

3.2 Recent reforms to the corporate tax system

In the aftermath of the Tequila Crisis (1994-1995), the Mexican government approved some measures designed to increase economic activity, growth and investment. These measures included a decrease in the discount rate to calculate the OAD rate from 5% to 3%. This change considerably increased the value of depreciation allowances. In the previous example, it represented the immediate expense of 74% of the original investment instead of 62%.

By the end of 1998, the federal government presented to the Congress a series of reforms designed to increase government revenue collections. The dependence of Federal Government

[14]This favorable rate was 7.5% before 1991.

[15]These three metropolitan areas represent 38.1% of national manufacturing production and 22.8% of Mexican population.

revenue on oil, combined with low international oil prices made necessary to take some politically costly actions. Since the elimination of special regimes for the Value Added Tax did not get support in Congress, other measures were proposed, including some aimed at increasing the effective tax rate on corporations.

The approved law included an increase of the corporate tax rate to 35% and the elimination of the OAD system. The OAD was replaced with a system of differential taxation of retained earnings over distributed earnings. Specifically, retained earnings were taxed at 30% and distributed profits were subject to the full 35% tax rate while the 5%×(Taxable Income) tax liability was deferred until distribution.

During 2001, the federal government promoted the discussion of a fundamental tax reform. The discussion included the academia, tax advisors, corporations, and the government. At the end, failures in the political negotiations at the Congress resulted in a new tax law that was far from a fundamental reform. Nevertheless, the corporate tax rate was gradually decreased from 35% in 2002 to 32% in 2005 (1% each year). Moreover, the OAD system was reinstalled with a discount rate of 6% while the preferential treatment of retained earnings was abandoned. The OAD immediate expense in the approved system, however, was not allowed to be made in the year of acquisition, but until the next one.

The government noticed that the system of OAD was considerably less effective than the one in effect in 1998 (both because of the high discount rate and because of the deferral rule). The Income Tax Law was further modified in 2003 decreasing the discount rate to calculate the OAD to 3% and allowing the immediate expense to be done partially (one third) in the year of acquisition, and the rest (two thirds) in the following year. Moreover, for the fiscal year 2004 the deferral rule was two thirds in the first year and one third in the second; for fiscal year 2005 and beyond, it was possible to expense the full PDV in the same year of acquisition. Finally, in 2005 the corporate tax rate was again reduced 1% each year from 30% to 28% in 2007.

3.3 Time series behavior of tax parameters during 1994-2002

The top panel of Table 1 summarizes the tax rules applicable in each year. It is useful to consider its effects on the PDV of depreciation allowances, the cost of capital and the effective marginal tax rate. Section 4 and Appendix A describe in detail the construction of these variables.

The present value of depreciation allowances was calculated using the standard formula:

$$z = \sum_{t=0}^{T} \frac{NDR \times V}{(1+\rho)^t}, \tag{1}$$

where, z: present value of depreciation allowances, ρ: real discount rate (for a plant in the OAD region, is the rate allowed by the government to calculate the accelerated depreciation; for a plant in the 3MMA region, is the riskless long term interest rate), NDR: is the Normal Depreciation Rate, i.e., the percentage of the purchase value of an asset that the government allows to deduct each year, V is the purchase value of an asset, and T is the number of years until full depreciation is achieved, according to NDR.

The cost of capital was estimated using the well known derivation in Jorgenson (1963):

$$COC = \frac{p^K}{p^Y} \times \frac{(r+\delta) \times (1-\Gamma)}{(1-\tau)}, \tag{2}$$

$$\Gamma = ITC + \tau z, \tag{3}$$

where, COC: user cost of capital, p^K: price of capital, p^Y: price of output, r: required rate on return (the riskless rate, ρ, plus a time varying risk premium), δ: economic depreciation rate, ITC: investment tax credits, and τ: corporate tax rate.

The effective tax rate (i.e., the hypothetical tax rate on pure economic income that yields the same cost of capital as the actual regime of depreciation allowances and corporate tax rate) was calculated as:

$$ETR = \frac{(r+\delta) \times (1-\Gamma) - (r+\delta) \times (1-\tau)}{(r+\delta) \times (1-\Gamma) - \delta \times (1-\tau)}, \tag{4}$$

where, ETR: Effective Tax Rate.[16]

The bottom panel of Table 1 presents, as an example, the time series behavior of these tax parameters for investment in machinery and equipment in the automobile parts industry. The table distinguishes between the values for plants located inside the main metropolitan areas (3MMA) and those that qualified for the OAD. As is evident from the table, the 1999 reform implied a differential increase in the user cost for the two regions.

4 Data

4.1 Encuesta Industrial Anual (EIA), 1994-2002

The Annual Industrial Survey (Encuesta Industrial Annual, or EIA) is conducted by the Mexican Statistical Agency, INEGI (Instituto Nacional de Estadística, Geografía e Informática), and is housed at its headquarters in Aguascalientes, Mexico. In this study I use the most recent panel: 1994-2002. INEGI follows a non-random sampling procedure to determine the group of manufacturing plants that would be surveyed. This procedure is described in INEGI (2005) and summarized in Appendix A.

The EIA panel consists of 7,171 manufacturing establishments in 205 6-digit industries, which excludes maquiladoras, basic petrochemical plants, refineries and also micro-industry plants (i.e., plants with less than 15 employees). A small random sample of new plants is added every year. The variables used in the empirical analysis include:

- Location: state and municipality.
- Industry: 9 (2-digit) "subsectores", 50 (4-digit) "ramas" and 205 (6-digit) "clases".
- Employment: total payroll.
- Profit Sharing: total payments to employees and workers due to the profit sharing scheme (10% of pre-tax income).

[16] The ETR is implicitly defined by:

$$r = (1 - ETR) \times (COC - \delta). \quad (5)$$

Solving for ETR derives in Equation 4.

- Output: value of production.
- Assets: Asset values, purchases, sales, depreciation and write-offs. This information is broken down into five categories of asset types: Machinery and equipment, constructions and facilities, land, transportation equipment and other assets. Asset values and depreciation are reported at historic costs or gross book value.

4.2 Other plant level data sources

I also use aggregate information (at the 6-digit industry level) for asset values and depreciation (both at historic cost) from the previous panel of the EIA (1984-1994). This information was averaged over the years to estimate industry economic depreciation rates. These rates were used in the calculation of the user cost of capital. I imputed these rates at the 4-digit industry level in the 1994-2002 panel of plant level information.

INEGI officials allowed me to merge EIA data with information for assets values at market prices (or replacement costs) from the 1994 Industrial Census, for a subsample of 4,997 plants. The information was also broken down into five asset categories: machinery and equipment, constructions and facilities, land, transportation equipment, and other assets.

In 1994, the EIA was jointly surveyed with a Technology Database (Encuesta Nacional de Empleo, Salarios, Tecnología y Capacitación, ENESTYC). INEGI officials provided matched information regarding country of equity ownership for a subsample of 6,845 plants. The questionnaire asked the ownership percentage for the following countries: Mexico, USA, Germany, Canada, France, Netherlands, Japan, UK, and Switzerland.

4.3 Construction of variables

Different variables were constructed for the analysis. Given the available data on the EIA, it was not possible to estimate models at the firm level, but only at the plant level. The details are presented in Appendix A at the end of the paper. Here, I just briefly summarize the process:

- Region: Plants were classified according to its location inside or outside the three main metropolitan areas (3MMA), since only those outside qualified for the accelerated depreciation.

- Capital stock (K): I use the perpetual inventory method, taking as the initial capital stock the market value of assets from the 1994 Industrial Census. Depreciation rates were estimated using gross book value depreciation and asset values as explained in the Data Appendix.[17]
- Gross Expenditures (GE): is the sum of all assets purchased either in the domestic market or imported from abroad.
- Net Expenditures (NE): equals gross expenditures minus economic depreciation.
- Retirements (R): is the value of sales of assets, reported at market value.
- Investment (I): is the sum of gross expenditures minus retirements.
- Cash Flow (CF): is estimated by multiplying the profit sharing amount by 10.[18]
- Cost of Capital (COC): it is estimated at the 4-digit industry level for the two different regions (3MMA or OAD) using Equation 2 and the following inputs:
  - The capital-output price ratio (p^K/p^Y): is the output deflator for each 2-digit industry divided by the price index for fixed capital accumulation.[19] It was set equal to 1 in 2002.
  - Corporate Tax Rate (τ): comes from Income Laws, and was adjusted to include the burden of the profit sharing rate.
  - Real required rate of return (r): was assumed equal to the real riskless interest rate, plus a time varying risk premium equal to the difference between the short term nominal interest rate on private and government bonds.[20]

[17] Previous studies that have used the EIA use the initial reported gross book value of assets as the initial capital stock in the perpetual inventory method. This procedure can yield misleading measures in short panels for two reasons. First, this method approximates the market value of assets by the book value of assets in the initial year, relying on the length of the panel to erode this bias. Second, the reported book value in the EIA is not net of depreciation, and thus might include assets already fully depreciated. The use of market value figures from the 1994 Census allows me to overcome these problems.

[18] As previously noted, Mexican Constitution mandates firms to distribute 10% of pre-tax profits. This is the same approach that Gelos and Werner (1999) followed to get a measure of cash flow.

[19] The first comes from the Mexican National Income and Product Accounts and the second from Banco de México.

[20] The real riskless rate is the rate on UDIBONOS (inflation indexed long term government bonds). The risk premium is the difference between the rate on private commercial paper and CETES (short term government bonds).

- Present discounted value of depreciation allowances (z): calculated based on Equation 1 using normal depreciation rates or the optional accelerated depreciation rates according to each plant location (OAD or 3MMA), from Income Tax Laws.
- Economic depreciation (δ): estimated at the 6-digit industry level using data from the 1984-1994 EIA panel, and assigned at the 4-digit industry level for each plant in the 1994-2002 EIA panel.

4.4 Other minor sources

Other series needed for the analysis were derived from different sources. Price indices and different real and nominal interest rates were obtained from the Mexican Central Bank (Banco de México).

4.5 Summary statistics

Summary statistics for the most relevant variables are presented in Table 2. The top panel shows the mean, standard deviation, quartiles and number of observations for the cost of capital, the different investment and capital expenditure variables, and cash flow and output to capital ratios. The middle panel shows the means by subgroups of regions (3MMA region or OAD region). For all variables the difference in the means is statistically different from zero. Finally, the bottom panel shows means for plants with majority ownership by Mexicans or foreigners.

5 Main empirical specification and results

In this section I analyze investment in machinery and equipment. Investment in other types of assets (i.e., constructions, land and transportation equipment) is considered in Section 6.4. As noted in Section 4, the unit of analysis is the manufacturing establishment (plants). Due to confidentiality reasons, and mainly due to the EIA questionnaire itself, it was not possible to merge information at the firm level. This has the drawback of not been able to estimate models with financial variables, i.e., Q-type models like Summers (1981). Before turning to the specific firm model used to derive the regressions, it is useful to consider a pure differences-in-differences approach.

5.1 Differences-in-differences regressions

Given the potential exogenous nature of the 1999 and 2002 reforms, I regress investment rates on a dummy equal to one in the years in which the Optional Accelerated Depreciation system was in effect (1994-1998 and 2002), a dummy equal to one if the plant is located outside the three main metropolitan areas (i.e. where the OAD system applies), and the interaction between the two:

$$\begin{aligned}\frac{I_{it}}{K_{it-1}} &= \alpha_i + \beta_1 OAD_{it}^{period} + \beta_2 OAD_{it}^{region} + \beta_3 (OAD_{it}^{period} \times OAD_{it}^{region}) \\ &\quad + \eta_t + \epsilon_{it}, \end{aligned} \qquad (6)$$

where, I: investment, K: capital, OAD^{period}: equals one in 1994-1998 and 2002, OAD^{region}: equals one for plants outside the main metropolitan areas, α: plant fixed effects, η: year fixed effects (included when OAD^{period} is excluded), and ϵ: the disturbance term.

Table 3 presents the results of these regressions. The positive and significant coefficient on the interaction term suggests that plants in OAD regions reduced more their investments in the years in which the accelerated depreciation was eliminated compared to plants that did not qualify for this special tax treatment. The last four columns specifically exclude the Tequila Crisis (1994-1995). Note that the coefficient on the interaction term is robust to the inclusion of year fixed effects instead of the OAD^{period} dummy. Therefore, the results show that even without considering the large cross sectional variation in the user cost induced by the reforms, the effect of the reform on investment is large. The task of the next subsections is to use this variation and introduce a more elaborated model of firm behavior to estimate the elasticity of investment with respect to the user cost of capital.

5.2 Elasticity of investment with respect to its user cost

According to neoclassical theory, a firm maximizes its value by choosing the optimal capital stock (after optimally choosing variable inputs) that maximizes the stream of after tax profits, subject to the capital accumulation process equation:

$$\begin{aligned} \max V_s &= \sum_{s=t}^{\infty} \frac{(1-\tau_t)p_t^Y F_t(K_{t-1}) - p_t^K C(I_t, K_{t-1}) I_t (1-\Gamma_t)}{(1+r_t)^{-(s-t)}}, \\ s.t. \quad & K_t = (1-\delta_t)K_{t-1} + I_t, \end{aligned} \tag{7}$$

where, $F(\cdot)$: production function, $C(\cdot)$: capital adjustment cost function, and the rest of the variables are defined as above.

Auerbach and Hassett (1992) and Auerbach (1989) derive an analytical solution for investment of a profit maximizing firm under a constant growth trend, multiplicative shocks to the production function and adjustment costs that are linear in K and I. The solution characterizes investment as a partial adjustment process toward the desired capital stock, which depends on current and future expected values of the user cost. The main differences between the derivation in the aforementioned papers and previous implementations of the partial adjustment model (like Hall and Jorgenson (1967)) are: first, that the friction is derived endogenously from a formal model with adjustment costs instead of ad-hoc delivery lags; and second, that investment depends on current and future values of the user cost, instead of past values of this variable.

Equation 8 shows my econometric specification. As in Cummins et al. (1994), I depart from Auerbach and Hassett (1992) and assume that firms see tax changes as permanent, thus using only the current value of the cost of capital instead of current and future values. Moreover, since in many applications I specifically use instrumental variables to control for endogeneity, the COC variable in my specifications has the current value of both tax and non-tax variables (and not a combination of current tax values and lagged values of non-tax variables like the model in Cummins et al. (1994)).

Following the literature on investment equations, I present results both with and without the inclusion of the cash flow to capital ratio. Even if a positive and significant coefficient on this term should not be interpreted as a sign of financial constraints (Kaplan and Zingales (1999)), it has proven to have explanatory power for investment.

$$\frac{I_{it}}{K_{it-1}} = \alpha_i + \beta COC_{it} + \gamma \frac{CF_{it}}{K_{it-1}} + \eta_t + \epsilon_{it}, \quad (8)$$

where, CF: cash flow and the rest of the variables are defined as above.

The top panel of Table 4 shows the results of estimating Equation 8 by OLS including plant and year fixed effects. The first two columns use the full sample period 1994-2002, while the next columns exclude the Tequila Crisis period. The standard errors are clustered at the "4-digit industry × region (3MMA or OAD)" level, since this is the level at which the COC variable is constructed.

Across all specifications, Hausman (1978) tests reject the hypothesis that fixed and random effects (not reported) coefficients are not systematically different, implying that random effect models are inconsistent. The results excluding the Tequila Crisis show a negative and significant relationship between the investment rate and the user cost. The results are robust to the inclusion or exclusion of the cash flow variable.

The elasticity of investment with respect to the user cost is derived from multiplying the coefficient β by the ratio of the means of the COC and I/K variables. The last row of the top panel displays these elasticities. Excluding the Tequila Crisis the elasticity lies around -1.5 for 1996-2002 and -1.6 for 1997-2002, considerably larger than those found for the US (with a similar methodology Cummins et al. (1994) found an elasticity of -0.6 for US firms).

To see the extent to which classical errors-in-variables or measurement error might be present, the bottom panel of Table 4 estimates the same Equation 8 by first differences (with the same clustering), instead of fixed effects. The two estimators have the same probability limit under the assumption that there are no errors-in-variables, and should only differ due to sampling error.[21] Classical errors-in-variables should bias the first differences estimator toward zero. The two estimators systematically differ when using the full 1994-2002 sample, but do not differ when I exclude the Tequila Crisis. The logic of this result is clear given two facts: First, the dramatic increase and volatility of interest rates during the crisis (Table 1) might introduce measurement error in the user cost. Second, from 1995 to 1996, changes in investment and changes in the user cost might present legislative endogeneity, i.e., the fact that policy makers tend to introduce investment incentives when investment is perceived to be "low" (as mentioned in Section 3.2, in 1996 the government increased the value of depreciation allowances trying to promote investment in the aftermath of the crisis).

5.2.1 Logarithmic and industry aggregate regressions

The fact that the elasticity is the product of the estimated coefficient and the ratio of the means of the user cost and the investment rate variables implies that a greater than unity elasticity might be an artifact of the ratio of the means (because of fat tails) and not really an effect of the coefficient. A valid solution to this problem would be to estimate the model in logarithms, since the coefficient then would be interpreted directly as the elasticity.

In this case, however, this basic approach can be misleading because the many zeros in the investment rate variable are replaced by missing values when taking logs. Moreover, Tobit panel models are inconsistent since they can only be estimated through random effects.[22] I address this issue by aggregating information to the "6-digit industry $\times$ region" level (in order to get rid of many of the zeros) and then run the model in logs. For these regressions, I cluster the standard errors at the 4-digit industry level.

The top panel of Table 5 displays both the results of the regressions in levels and logs at the plant level. Note that when taking logarithms 30% of observations are lost. The elasticity from the model in logs is less than that found in levels. This result was expected since, as shown in

[21] I also estimate cross sectional IV regressions as in Hausman and Griliches (1986). These regressions support the results of the analysis presented in Table 7, which uses a subset (only first differences) of these equations.

[22] As mentioned before, Hausman (1978) Tests reject the null that fixed and random effects models are not systematically different. Since under the null both models are consistent but under the alternative only the fixed effects model is, this is evidence that the random effects model is inconsistent.

Section 6.3 investment is lumpy (many periods of inactivity are followed by large adjustments), thus the lost observations can provide a lot of power to explain the large elasticities because they represent the extensive margin of the elasticity. The elasticity is still higher than unity and double the size of the US benchmark (which is calculated in levels).

At the aggregate 6-digit industry level only 6% of observations are lost when taking logs. The most important result from these regressions is that the elasticity is unaffected by the use of levels or logarithms. Regardless of the model, this elasticity is close to -1.3. Although smaller than the elasticity at the plant level, this number is still greater than unity, and more than double the size of the US benchmark. This table provides evidence that the large elasticity found in Table 4 is not an artifact of the ratio of the means.

5.3 Instrumental variables estimation

To make the estimation robust to endogenous determination of the user cost and investment rates (a common shock might affect interest rates and investment rates), I estimate three different models with instrumental variables. For the first set of IV regressions, I instrument the user cost with its lagged value together with current values of tax variables.[23] Specifically, the instruments in this regression are the first lag of the cost of capital and the current value of depreciation allowances (z).[24] The results of this estimation are shown in the top panel of Table 6.

The estimated elasticities for 1996-2002 and 1997-2002 differ in their magnitude. While estimations for 1994-2002 and 1996-2002 show elasticities around -1.8, this figure is around -2.5 for 1997-2002. Note also that when I exclude the Tequila Crisis, Hausman (1978) tests (performed on exactly the same sample) do not reject the hypothesis that the difference between the OLS and the IV coefficients is not systematically different. The two estimators have the same probability limit under the null hypothesis that the right hand side variables are exogenous.

Using z might still introduce some endogeneity since the discount rate to get the PDV of depreciation allowances in the 3MMA region depends on the current interest rate (only its

[23]This is a common approach in the literature; see Hassett and Hubbard (2002).

[24]In other specifications where the cash flow to capital ratio is included (not reported), I also included this variable as endogenous and used its lag as an additional instrument. The results look similar to Table 6, however, the results for 1997-2002 are only marginally significant.

riskless component). That is not true for OAD regions, where z is independent of the current interest rate. For this reason, the bottom panel shows the second IV strategy where instead of using z as an instrument, I use a dummy for plants that qualify for the optional accelerated depreciation in the years in which the system was in effect (i.e., the interaction between a dummy for the OAD region times a dummy for years 1994-1998 and 2002). Using the "reform×region" dummy potentially eliminates the source of simultaneity of interest rates. The table shows that the results from this exercise are similar to those using z as the instrument. Note also that overidentification tests strongly reject the null, and the significance levels of these tests are greater by an order of magnitude compared to the top panel (as would be expected given the possible small endogeneity of z). In summary, Table 6 provides evidence of a strong response of investment to the user cost, and in particular to tax incentives, with a preferred IV estimate of −2.0 (columns (3) and (4) in the bottom panel).

Even if the exclusion restriction for the use of z or the "region×reform" dummy as instruments does not hold, the panel nature of the database still allows me to estimate IV models using lagged levels of the right hand variable in models estimated in differences. Hausman and Griliches (1986) show that there can be many equations to estimate (first differences, second differences, etc.) with all non-coincident levels as instruments (or levels one or more periods apart depending on the assumptions about the serial correlation of measurement error).

Table 7 shows the estimation in first differences (in order to get rid of the unobservable plant effects), using non coincident lagged levels of the user cost as instruments. I estimate the model with the Generalized Method of Moments Dynamic Panel estimator developed by Arellano and Bond (1991), including one lag of the left hand side variable as another explanatory variable. The estimates of this model also show a negative and significant relationship between the user cost and investment, though the elasticities are less precisely estimated (between −1.0 and −2.0).

Overall, Tables 6 and 7 show that the results of Section 5.2 are robust to IV strategies and that the elasticity of investment with respect to the user cost is large compared to US standards, with a preferred IV estimate around −2.0.

5.4 Long run elasticity of the capital stock with respect to its user cost

The previous section describes the instantaneous reaction of investment to changes in the user cost. In this section, I also provide estimates of the long run elasticity of the stock of capital to changes in the user cost. For this purpose, I rely on delivery lags as in Chirinko et al. (1999). The specification consists of regressing the investment rate on present and lagged percentage changes of the user cost ($\Delta COC/COC$), present and lagged percentage changes of output ($\Delta Y/Y$), and present and lagged levels of the cash flow to capital ratio (CF/K):

$$
\begin{aligned}
\frac{I_{it}}{K_{it-1}} &= \alpha_i + \sum_{k=0}^{4} \beta_k \left(\frac{\Delta COC_{it-k}}{COC_{it-k-1}}\right) + \sum_{k=0}^{4} \gamma_k \left(\frac{\Delta Y_{it-k}}{Y_{it-k-1}}\right) \\
&\quad + \sum_{k=0}^{4} \psi_k \left(\frac{CF_{it-k}}{K_{it-k-1}}\right) + \eta_t + \epsilon_{it}. \qquad (9)
\end{aligned}
$$

where, Y: output, and the rest of the variables are defined as above.

Chirinko et al. (1999) show that, under certain assumptions, the sum of the coefficients on the lagged changes in the user cost (β_k) can be interpreted as the elasticity of the capital stock with respect to the user cost. Table 8 shows the sums of these coefficients along with their clustered standard errors using plant and year fixed effects. The last two columns use the Dynamic Model estimator (Arellano and Bond (1991)), which includes one lag of the dependent variable, and use levels of the left and right hand side variables as instruments in the regression in first differences. The average of the elasticities in this table is -1.1.

These results are not inconsistent with the findings of Sections 5.2 and 5.3. In those sections, my estimates of the elasticity of investment to the user cost were two to four times larger than the benchmarks for the US reported by Hassett and Hubbard (2002). With a different methodology, Chirinko et al. (1999) find a long run elasticity of the capital stock around -0.25; I obtain elasticities that are around four times this benchmark.

5.5 Long run elasticity of the targeted investment with respect to its user cost

Finally, I also estimate the long run elasticity of the targeted capital stock or targeted investment with respect to its user cost. According to the analysis in Caballero et al. (1995), this elasticity can be estimated under the assumption that deviations between the actual capital stock and the frictionless capital stock (the one that the firm would choose if there were no adjustment costs) are not persistent. Since the difference between the frictionless and the actual capital is a function of the capital output ratio and the user cost in the neoclassical model, the former assumption suggests estimating a cointegrated regression of the capital output ratio on the user cost, where the cointegration vector is in fact the long run elasticity of the capital stock with respect to the user cost:[25]

$$\ln\Big(\frac{K_{it-1}}{Y_{it}}\Big) = \alpha + \beta COC_{it} + \epsilon_{it}. \tag{10}$$

Table 9 shows the results of estimating this model (clustering standard errors at the plant level). To compare these results to those for the US (reported in Caballero et al. (1995)), I also allow for different elasticities (the coefficient β) for each 2-digit industry. In columns (2), (4) and (6), I also include lagged differences of the cost of capital to control for small sample biases, as suggested by Caballero (1994). Caballero et al. (1995) report coefficients for the different industries between 0.0 and -2.0, averaging -1.0. My preferred estimates (1996-2002 controlling for small sample bias, column (4)) show elasticities ranging from -1.7 to -4.7, with a pooled COC coefficient of -3.4, three and a half times higher than that for the US, again consistent with the results of Section 5.2.

6 Explaining the large elasticities: additional results

In this section, I explore additional results that might help to explain the large estimated elasticities found in Section 5. First, in Section 6.1 I consider the role of FDI on investment. The

[25]See Section 6.3.

presence of multinational firms, with presumable more outside options for investment, might explain why investment is so responsive. Section 6.2 also presents indirect evidence on the reaction of prices to changes in tax incentives. Goolsbee (1998) shows that large price reactions reduce the response of investment in the US. If prices do not react in Mexico, this might also help to explain the large elasticities. Then, section 6.3 analyzes whether adjustment costs are convex. Convex adjustment costs might explain the difference between these large elasticities and those of the US (where adjustment costs have been found to be nonconvex). Finally, in Section 6.4 I explore another possible explanation for the large elasticities: misreporting of capital expenditures. I look at the elasticities for different types of capital, in particular, investment in transportation equipment and land, which are potentially more difficult to misreport.

6.1 FDI and Investment Incentives

Table 2 shows that plants owned by multinational firms invest more, have higher cash flow to output ratios and smaller output to capital ratios. In this section I explore whether the response to changes in the user cost is also different from that of domestically owned plants.

To perform this exercise, I interact the user cost variable with dummies for the country with majority ownership for each plant. The results displayed in Table 10 show that US, British, German and Swiss multinationals reacted more than other multinationals, and also more than domestic firms. Notably, these countries have the largest ownership concentration among the sample, as can be seen in Column (4).

The differential response of multinational firms might be due to international taxation rules. According to the traditional theory of international taxation, there are two main systems to tax foreign income. The first system is called Territorial Taxation. In this system, profits that a multinational receives from operations in other countries are exempt from taxation in the country where the multinational is incorporated. In this system, for example, the profits generated by a plant owned by a German multinational and located in Mexico are taxed in Mexico but are exempt from taxation in Germany. Thus in this system, multinational firms face the same burden of taxation as domestic firms.

The other main system is called Worldwide Taxation. In this system, profits that a multinational receives from operations in other countries are included in a "worldwide" measure of income, which is the basis for taxes in the country of incorporation. In some cases, the government of the country of incorporation allows claiming tax credits on the taxes paid to foreign governments (with some possible limit). In this system, for example, the profits generated by a plant owned by a US multinational and located in Mexico are taxed in Mexico and they are also included as taxable income in the US. However, the multinational firm can claim tax credits to the Internal Revenue Service in the US for taxes paid to the Mexican government. In this set up, multinational firms might avoid facing the full burden of taxation in the host country.

Column (2) of Table 10 displays the general method of taxing foreign income in these nine countries (OECD (1991)). According to this classification, in Column (3) I present results of regressing the investment rate on interactions of the user cost variable and dummies for the different taxation systems. The counterintuitive result indicates that the response by multinationals incorporated in countries with territorial systems of taxation is slightly lower than those incorporated in countries with worldwide systems of taxation. However, a linear test of the hypothesis that the coefficients are equal is unable to reject the null. Once transformed to elasticities, the difference is even smaller. This finding implies that the reason behind the higher response of multinational firms does not rely on international taxation issues, but probably on more available options for investment.

The analysis of this subsection shows that the response of multinational firms is larger than that of domestically owned plants, which, together with the plausible assumption that multinational firms have more outside options for investment, partially explains the large elasticities found in Section 5.

6.2 Price response to changes in tax incentives

As noted in the literature review, there is evidence that prices react to changes in tax incentives, reducing its effect on investment. Thus, the large elasticities found in this paper might be due to price insensitiveness. To see if that is the case, I run separate regressions for capital expenditures in the domestic market and imports of capital goods.[26] Under perfect markets for international and domestic capital goods and no other imperfections in the financial markets, the elasticities of both imports and domestic purchases should be about the same. Moreover, the reforms to the Mexican tax system are unlikely to change the international prices of capital goods but, if the domestic capital goods market is not perfect, domestic prices might change. In that case the estimated elasticity of imports would be higher than that of domestically purchased assets.

Table 11 shows the results of these regressions.[27] The elasticity of imported investment triples that of domestically purchased capital goods (-0.9 versus -3.1). This table thus presents evidence of a possible domestic price response to changes in tax incentives. This finding suggests that the openness of the Mexican economy and its proximity to the US market of capital goods might explain the large elasticities, since prices in the international capital goods are fixed.

6.3 Nonparametric analysis of the adjustment cost function

The use of plant level data allows me to perform a detailed analysis of the investment process, in order to determine the nature of adjustment costs. The presence of convex adjustment costs could explain the large elasticities found in this paper, compared to nonconvex adjustment costs as those found for the US. For this purpose, I construct a measure of the desired capital stock, following Caballero et al. (1995), by first imputing the frictionless capital stock to each firm, using Equation 11 (the former is the capital stock that the firm would choose if adjustment costs were temporarily removed, while the latter is the capital stock that the firm chooses when there are no adjustment costs at all).

$$\ln(K^*_{it}) - \ln(K_{it-1}) = \eta_{it}\Big(\ln(Y_{it}) - \ln(K_{it-1}) - \theta_i COC_{it}\Big), \tag{11}$$

where, K^*: frictionless capital (before adjustments take place).

To obtain K^*, some parameters need to be estimated. As in Caballero et al. (1995), θ_i is taken to be equal to the coefficient of the cointegrated regression in Table 9 (Column (4)); this is

[26] The results are the same if the model is estimated as a Seemingly Unrelated Equations Model (SUR).

[27] The user cost for imports of assets is adjusted for changes in the foreign exchange rate.

because deviations between actual and frictionless capital stock are assumed not to be persistent, which implies that there is a long run relationship between the variables in the right hand side of the equation that can be estimated by cointegration. The value for η_{it} is approximated as the cost share of machinery and equipment for each 2-digit industry, with data for input costs from the EIA.[28]

Once the frictionless stock of capital (K^*) has been determined, the desired capital stock (K^d) is assumed to be proportional to the frictionless capital, up to a plant specific constant. This constant is estimated as the average difference between the actual capital and the frictionless capital for the five observations in which the investment rate is closest to the median investment rate:

$$\ln(K_{it}^d) = \ln(K_{it-1}^*) - d_i, \tag{12}$$

where, d_i: plant specific constant.

With a measure of the desired capital stock at hand, it is then easy to explore the nature of adjustment costs. For example, I can analyze mandated investment (i.e., the investment that is necessary to close the gap between the actual capital stock and the desired capital stock). Furthermore, I can also explore the pattern of the average adjustment function (i.e., the ratio of actual investment to mandated investment).

Figure 1 shows histograms for the actual investment rate, the estimated shock and the mandated investment rate. Following Caballero et al. (1995) I standardize these measures by removing plant means and dividing by plant standard deviations. Note how actual investment is more skewed (thicker right tail) and has higher kurtosis (spike) than mandated investment. Mandated investment even displays negative excess kurtosis. This pattern is consistent with the presence of irreversibilities and nonconvexities in the capital accumulation process.

Using nonparametric estimation, I also show the relationship between investment and mandated investment in the top panel of Figure 2. Irreversibilities are evidenced by the small response of actual investment to negative mandated investment, i.e., resilience to disinvest. At

[28] Appendix B of Caballero et al. (1995) shows the details in the derivation of this approximation.

large negative levels of mandated investment, actual investment is in fact flat. Moreover, consistent with nonconvex adjustment costs, the slope of the line in the positive side of mandated investment is increasing. Under convex adjustment costs, large investment episodes should be avoided and replaced by small and gradual adjustments. Nonconvex adjustment costs provide a rationale for higher proportional investment responses to higher mandated investment.

Further evidence can be derived from nonparametric estimation of the average adjustment function, which is shown in the bottom panel of Figure 2. Once again, note that the left hand side of the figure is almost flat, confirming that investment is irreversible: negative mandated investments are in general not followed by negative adjustments to the capital stock. The smoother line shows an S-pattern, as found by Caballero et al. (1995) for US plants. As noted in Section 2.2, my results contrast with those of Gelos and Isgut (2001b). These authors find irreversible but convex adjustment costs. The differences could be due to the different time period of study or the use of different capital stock and user cost variables, as noted in Section 4 and the Appendix A.[29]

The evidence presented in this section rejects that adjustment costs are convex. In fact, the adjustment cost function resembles that for US manufacturing plants. Therefore, the explanation for elasticities larger than those of the US does not lie on convex adjustment costs.

6.4 Investment in other types of capital

The previous analysis considers only investment in machinery and equipment. One possible explanation for the large estimated elasticities can be that firms misreport capital expenditures. For example, in response to the 1999 reform, which increased the user cost for many plants, managers could have tried to report some capital expenditures as operating expenses (tax evasion). The likelihood that this might contaminate information on the EIA is small for two reasons. First, firms are not liable for tax purposes regarding the information reported on the survey. Second, in the validation process INEGI officials match investment information (flow of

[29] Gelos and Isgut (2001b) study 1984-1994. Also, they do not construct a measure of the cost of capital, but only use the relative prices of capital and output. Moreover, they use gross book value to measure the initial capital stock in their perpetual inventory method, while I was able to use the initial market value of assets from the 1994 Industrial Census.

purchases of capital goods) to asset values (balance sheet), reducing the misreporting.

Even though the possibility of misreporting is low, I analyze the behavior of other types of capital to provide further evidence on a generalized response of investment to changes in the user cost. These other asset categories are: constructions and facilities, land and transportation equipment. It is important to note, however, that the tax depreciation rules for these other types of capital do not vary by industry, which in turn reduces the variation in the COC variable and might decrease the precision with which the coefficients of the regressions are estimated.

Table 12 shows the results of these regressions. In these regressions the unit of observation is each asset category in each plant, thus each regression includes "plant $\times$ asset" fixed effects. I cluster the standard errors in these regressions at the "4-digit industry $\times$ region $\times$ asset" level.

The first two columns show the results of pooling all types of capital together. The number of observations is not just the product of the number of plants times the number of periods times four since many plants present missing values for investment in these other types of capital. The results show an elasticity even higher than that of Table 4. This might be due to larger elasticities for some asset classes than for machinery and equipment. Columns (3) and (4) show the coefficients separated by asset categories.

Note that all coefficients are negative and significant. The largest coefficient corresponds to transportation equipment. Land also presents a coefficient larger than that of machinery and equipment. Constructions and facilities has a coefficient smaller than machinery and equipment, but also negative and highly significant.

Since land, constructions and transportation equipment are harder to misreport for tax evasion, I conclude that the large elasticity found in Section 5 is not an artifact of tax evasion practices.

7 Policy implications

Worldwide tax policy discussions rarely omit the debate of the efficiency advantages of consumption taxes versus income taxes. Since most countries have in fact hybrid systems, tax reform discussions are overwhelmingly related to the optimal choice of instruments to gradually move to consumption taxes. The implications for tax policy of a large response of investment to changes in the user of cost, as the one found in this paper, are presumably important in this setting.

The results of this paper imply that fiscal policies designed to change the corporate tax rate, investment tax credits and depreciation allowances are effective in promoting investment. Moreover, the user cost not only varies due to changes in taxes, but also with changes in interest rates. The results of Sections 5 and 6 also imply that monetary policies aimed to change interest rates can have important consequences on manufacturing investment.

The validity of using these elasticities for tax policy analysis lies on the "structural" nature of the model from which they are derived. The specifications are robust to the inclusion of year fixed effects and, in many cases, linear tests (not reported) were unable to reject the null that the coefficients of the year effects are equal. Overall, this mitigates the possible critique that the estimated coefficients should not be used for policy implications.[30]

In this section, I discuss the magnitude of these responses. First, I predict the effect that the tax provisions for 2003, 2004 and 2005 can have on manufacturing investment in Mexico,[31] based on the estimated elasticities. Then, I compare these results with the hypothetical introduction of a 10% Investment Tax Credit (ITC) in 2003 (together with the elimination of the OAD system). Finally, I estimate the impact of allowing full expensing of investment for all plants in 2003.

Table 13 presents the calibrations of these scenarios. Each row represents the period of analysis: either for the actual reforms approved by the Congress or for the ITC and full expensing scenarios. The first two columns show the weighted average level and percentage change in the user cost (weighted by the capital stock), respectively. The last two columns show the predicted level of the investment rate: Column (3) under the assumption of a conservative elasticity of -1.5 (OLS) and Column (4) under the assumption of my preferred IV estimated elasticity of -2.0.

In the top panel, the initial level of the investment rate is taken to be equal to the actual

[30] See Lucas (1976).

[31] The reforms include the reduction in the discount rate to calculate OAD to 3%, and the reduction of the corporate tax rate. See Section 3.2.

weighted (by capital stock) level of the investment rate in 2002 (around 9.0%). This very small investment rate might bias the policy results downwards. To get the level of investment in each year, I make calculations at the 4-digit industry level.[32] The predicted investment rates for 2005, under the approved reforms, are between 11.2% and 12.0%. The introduction of a 10% investment tax credit (repealing the OAD system) is predicted to increase investment rates to 12.4%-13.5% and full expensing to 12.7%-13.9%. Notably, the approved changes are nontrivial when compared to the ITC and full expensing scenarios, and are predicted to have an important effect on investment.

Assuming a level of the investment rate equal to the average for the period 1994-2002 (16.3%), the predicted changes are considerably larger in absolute value. The cumulative effect of the approved reforms gives a weighted average investment rate in 2005 of 20.3%-21.6%. A 10% ITC (repealing the OAD system) would have increased the weighted average investment rate to 22.3%-24.3%, compared to 22.9-25.2% in the full expensing scenario.

8 Conclusions

This paper provides additional evidence on the responsiveness of investment to changes in the user cost of capital. I use a panel database of Mexican manufacturing plants and take advantage of the large variation in the user cost provided by recent reforms to the Mexican corporate tax system in order to identify the elasticity of investment with respect to its user cost.

The results of this paper show that the elasticity of investment with respect to the user cost is larger than unity, with a preferred estimate of -2.0, implying that taxes affect investment decisions. These results are robust to different specifications, including estimating models of long run and short run investment dynamics. The results are also robust to different IV strategies, including instrumenting the user cost with current tax parameters or dummies for the reforms and the use of dynamic panel IV models.

Additional results show that the small open economy nature of the Mexican economy might

[32] Specifically, I multiply the investment rate in 2002 for each industry by one plus the product of the assumed elasticity and the change in the user cost for that industry. I obtain an aggregate measure by weighting industry investment rates using the capital stock in 2002.

explain the large elasticities. In particular, I show that plants owned by multinational firms respond more to changes in the user cost. Moreover, I show that even if domestic prices of capital goods reacted to changes in tax incentives, the openness of the Mexican economy and its proximity to the US market allow plants to adjust their imports of capital goods and respond to changes in the user cost. I also show that the pattern of investment is consistent with the presence of nonconvex adjustment costs, including irreversibilites, similar to those of US manufacturing plants. This implies that large investment responses are not explained by smoother adjustment processes compared to US firms. Finally, I present some evidence that the large elasticities are not the result of misreporting or tax evasion, since the elasticities of investment in transportation equipment and land (harder to misreport) are also high.

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A Data Appendix

A.1 Plant Level Data: EIA, 1994-2002

The Annual Industrial Survey (Encuesta Industrial Annual, or EIA) is conducted by the Mexican Statistical Agency, INEGI (Instituto Nacional de Estadística, Geografía e Informática), and is housed at its headquarters in Aguascalientes, Mexico. It began in 1963 and has been significantly improved over the years, increasing the sample size, industry representativity and improving the questionnaire. In this study I use the most recent panel: 1994-2002. I also combine this panel with aggregate information from the previous panel (1984-1994), as explained below in Section A.2. INEGI follows a non-random sampling procedure to determine the group of manufacturing plants that would be surveyed. This procedure, described in INEGI (2005), is based on the directory of plants of the XIV Industrial Census of 1994 and consists on the following steps:

1. Select the industries, among the 309 6-digit industries in the Mexican Classification System (CMAP), that contribute the most to total output.[33]
2. Select the plants with the largest output in each 6-digit industry, until each industry has at least 80% of total output.
3. Include all plants with more than 100 employees that were not selected by the previous criteria.
4. Include all plants in industries where production is highly concentrated.
5. Conversely, in industries where production is highly disaggregated, set the maximum number of selected plants to 100.

The result from this procedure is a sample of 7,171 manufacturing plants in 205 6-digit industries, which excludes maquiladoras, basic petrochemical plants, refineries and also micro-industry plants (plants with less than 15 employees). INEGI includes a small random sample of new plants each year; other plants are reclassified as necessary.

The variables used in the empirical analysis include:[34]

- Location: state and municipality.
- Industry: 9 (2-digit) "subsectores", 50 (4-digit) "ramas" and 205 (6-digit) "clases".
- Employment: total payroll.
- Profit Sharing: total payments to employees and workers due to the profit sharing scheme. The Mexican Constitution mandates firms to distribute 10% of pre-tax earnings to employees and workers each fiscal year. The figures in the EIA include actual payments during the year, regardless of its fiscal year.
- Output: value of production.
- Assets: The next set of variables, broken down for each of these five asset categories: Ma-

[33]The CMAP (Clasificación Mexicana de Actividades y Productos) is compatible with the International Standard Industrial Classification (ISIC) at the 4-digit level. The classification consist of the following categories: 1-digit sectores (e.g. Manufacturing, 3); 2-digit subsectores (e.g. Food products, beverages and tobacco, 31); 4-digit ramas (e.g. Dairy products, 3112); and 6-digit clases (e.g. Processing, bottling and packing of milk, 311201).

[34]The following variable definitions are based on INEGI (2005).

chinery and equipment;[35] constructions and facilities;[36] land; transportation equipment;[37] and, other assets.[38]

- Value of assets: the valuation is made at acquisition (historic) cost, defined as the purchasing price plus transportation and installation costs and import duties; excludes interest.
- Acquisition of new assets: includes the value of each fixed asset purchased and/or acquired through financial lease or received from other plants of the same firm during the year of study. Also includes expenses that improved currently used assets by increasing its useful life by more than one year, changing its nature or increasing its productivity. Information is broken down by whether the asset was bought in the domestic (new or used) market, or if it was directly imported from abroad.
- Production of assets for plant own use: includes the value of all fixed assets produced by the plant for its own use, using plant materials and personnel. The valuation is done at market prices.
- Sale of assets: is the amount effectively received for the sale of fixed assets owned by the plant during the year (excluding interest), regardless of whether they were originally bought from third parties or produced by the plant for own use.
- Depreciation of assets: means the consumption of fixed capital or reduction in the value of fixed assets used in production during the year, due to physical damage or obsolescence.
- Write-off of assets: includes the value of all assets retired, scrapped or destroyed due to its inoperative status. This value is reported at historic costs and thus cannot be used in the calculation of retirements.[39]

A.2 Industry aggregate EIA Data, 1984-1994

Industry aggregate information on asset values and depreciation (both at historic prices) was also used (at the 6-digit level). This information was averaged over the years to estimate industry economic depreciation rates. This rates were used in the calculation of the cost of capital at the 4-digit level in the 1994-2002 panel of plant level information.

A.3 XIV Industrial Census of 1994

INEGI officials allowed to merge EIA data with information for total assets at market prices (also called replacement costs) from the 1994 Industrial Census for a subsample of 4,997 plants.[40]

[35] Includes mechanic, electric and any other type of machinery and equipment, dies, molds, tools and laboratory equipment.

[36] Includes plants, warehouses, offices, stores, parking slots and facilities for water, electricity and steam conduction.

[37] Includes all automotive vehicles, ships, planes, carts, carriages, tractors and freight elevators.

[38] Includes office equipment and furniture, computers, original software and calculators; excludes intangible assets like patents.

[39] Given its inoperative status, the market value of these assets must be near zero, otherwise they could be sold to generate positive cash flow. In fact, the value is equal to zero at the following percentiles: machinery and equipment (76), constructions and facilities (95), land (97), transportation equipment (63), and other assets (78).

[40] The survey guidelines explain what the respondent should understand by replacement cost or market value. It is the sum of the acquisition cost, plus the value of all improvements and renovations, as well as the revaluation

The information was also separated by machinery and equipment, constructions and facilities, land, transportation equipment, and other assets.

A.4 1994 ENESTYC

In 1994, the EIA was jointly surveyed with a Technology Database (Encuesta Nacional de Empleo, Salarios, Tecnología y Capacitación). INEGI officials provided matched information regarding country of equity ownership for each plant for a subsample of 6,845 plants. The questionnaire asked the ownership percentage for the following countries: Mexico, USA, Germany, Canada, France, Netherlands, Japan, UK, and Switzerland.

A.5 Construction of the OAD dummy: Region variable

Due to confidentiality reasons, officials at INEGI directly constructed the variable for whether a plant qualified for OAD. The Income Tax Law expressly states that, to qualify for this preferential tax treatment of investment, the investment must be made outside the three main metropolitan areas or 3MMA (Mexico City, Monterrey and Guadalajara).[41]

According to the tax authority, these jurisdictions are delimited at the municipal level.[42] I provided INEGI with the list of municipalities and they matched a dummy variable for whether the plant was in the 3MMA region, or if it was located elsewhere, and thus qualified for OAD.

A.6 Construction of capital stock variable

The EIA asks plants to report asset values and depreciation at historic cost. It also includes questions about the inflation adjustment of both values and depreciation (in order to have an estimate of the asset value at replacement costs). However, the information for these adjustments has never been used by the INEGI due to important failures to comply with validation of the data. Previous studies that have used the EIA create the capital stock series using the perpetual inventory method.[43] However, the perpetual inventory method can only generate reliable estimates if the panel is considerable long (many time periods) to erode the bias created by using book values of assets, instead of market values of assets, as the initial capital stock.

Moreover, the distinction between information at gross book value (also called historic cost) and information at net book value (also called Book Value) has been often ignored. The gross

due to inflation, less the accumulated depreciation, i.e., the value of all allowances due to physical damage and obsolesce.

[41]There exist other considerations that allow for this special tax treatment. For example, even if a plant is located inside the 3MMA the investment can still qualify for OAD if the plant in question and the technology implemented are both labor intensive.

[42]According to the Decree to reform the Income Tax Law. (Diario Oficial de la Federación, December 12th, 2004): The MA of Mexico City includes all jurisdictions of the D.F. and the following municipalities of the State of México: Atizapán de Zaragoza, Cuautitlán, Cuautitlán Izcalli, Chalco, Ecatepec de Morelos, Huixquilucan, Juchitepec, La Paz, Naucalpan de Juárez, Nezahualcóyotl, Ocoyoacac, Tenango del Aire, Tlalnepantla de Baz, Tultitlán, Valle de Chalco-Solidaridad and Xalatlaco. Guadalajara MA includes the following municipalities of the State of Jalisco: Guadalajara, Tlaquepaque, Tonalá and Zapopan. The MA of Monterrey includes the following municipalities in the State of Nuevo León: Monterrey, Cadereyta Jiménez, San Nicolás de los Garza, Apodaca, Guadalupe, San Pedro Garza García, Santa Catarina, General Escobedo, García and Juárez.

[43]For example, Verhoogen (2004), Gelos and Isgut (2001a,b), Gelos and Werner (1999), López-Córdova and Mesquita-Moreira (2003), Hernández-Laos and del Valle-Rivera (2000), Pérez-González (2005).

book value is the actual payment made at the time of purchase, without any adjustment (neither for inflation, nor depreciation). The net book value is equal to the purchase payments minus the value of depreciation allowances, but without inflation adjustments.

The information for asset values in the EIA is reported at gross book value or historic cost (no adjustment for depreciation), and thus if used as the initial capital stock in the perpetual inventory method induces a bias, since the stock can still include assets for which depreciation has reduced their value.

I overcome this problem by merging the data of the EIA with data from the XIV Industrial Census of 1994. In the census, the information for asset values is reported at market (replacement) values. That means that I can actually use the perpetual inventory method with the information of the EIA, but having as the initial capital stock a true market valuation of the assets in each plant.

Another common assumption of previous studies that use the EIA is to assume a fixed depreciation rate for different asset categories. However, since the capital stock is one of the most important variables in my analysis, this simplification can be very costly in terms of measurement error.

I take advantage of the fact that both asset prices and depreciation are reported in the EIA at historic cost. Thus, for each asset category in each year I created a plant specific depreciation rate by dividing the reported depreciation by the value of assets. Since the value of assets has not been adjusted for any depreciation nor inflation, and depreciation has not been adjusted for inflation, this depreciation rate is quite precise.

The actual computation for the capital stock is described in Equation A.1. Finally, before using any of the actual figures in the survey, all quantities were transformed to 2002 pesos using the average (annual) Producer Price Index for Investment in Fixed Assets, published by Banco de México. In the next equation, j defines each type of asset (machinery and equipment, constructions and facilities, land, transportation equipment and other assets), i defines each manufacturing plant, and t defines each year from 1994 to 2002.

$$\begin{aligned} K_{jit} &= MVA_{jit}, t = 1994, \\ K_{jit} &= (1 - \delta_{jit})K_{jit-1} + I_{jit}, t = 1995, ..., 2002, \end{aligned} \tag{A.1}$$

where K is the capital stock; MVA is the market value of assets (from the Industrial Census); I is investment (including retirements; its construction is explained in Section A.7); and δ is the depreciation rate (defined in equation A.2):

$$\delta_{jit} = \frac{D_{jit}}{A_{jit-1}}, \tag{A.2}$$

where, D is the total depreciation (at historic cost) and A is the historic cost value of the asset.

Finally, whenever equation A.1 generated a negative capital stock, that year K was set to zero, and continue the same recursion.

A.7 Construction of expenditures, investment and retirement variables

The following expenditure, investment and retirement variables are used in the empirical analysis:

$$GE_{jit} = new_{jit} + used_{jit} + import_{jit} + ownuse_{jit}, \tag{A.3}$$

where, GE is gross expenditures, new is acquisition of domestic new assets; $used$ is acquisition of domestic used assets; $imports$ imports of assets; and $ownuse$ the value of assets produced by the plant for its own use.

$$NE_{jit} = GE_{jit} - \delta_{jit}K_{jit}, \tag{A.4}$$

where, NE is net expenditures.

$$R_{jit} = assetsales_{jit} \tag{A.5}$$

where, R is the value of retirements, $assetsales$ is the value of the sale of assets.

$$I_{jit} = GE_{jit} - R_{jit}, \tag{A.6}$$

where, I is investment.

A.8 Construction of cash flow variable

Unfortunately, the data on EIA is available only at the manufacturing plant level, and cannot be properly aggregated at the firm level. Financial information is thus not available, and a measure of cash flow is absent in the questionnaire. However, since the profit sharing rate is calculated at the firm level, the reported profit sharing amount contains information on firm pre-tax income. I thus follow Gelos and Werner (1999) in multiplying the reported profit sharing by 10 to get an estimate of pre-tax cash flow.

A.9 Construction of cost of capital variable

The cost of capital variable was created using Income Tax Laws (Ley del Impuesto Sobre la Renta) for the years of study, and was assigned to each plant according to whether the Accelerated Depreciation Option was applicable. It was calculated separately for each of the asset categories and assigned to each plant at the 4-digit industry level. The exact procedure is outlined below.

1. Each plant was classified as located in one of two zones: 3MMA-region if inside one of the three major metropolitan areas where OAD was not allowed, and OAD-region, otherwise.
2. The cost of capital for each asset category in each plant and year was calculated using Equation 2. The inputs for this calculation come from the following sources. Table 1 shows the behavior of some of these parameters.
   - The capital-output price ratio was created using two sources: The numerator is the output deflator for each 2-digit industry from the Mexican National Income and Product Accounts. The denominator is the price index for fixed capital formation, as reported by Banco de México. The ratio was set equal to 1 in 2002.

- The Corporate Tax Rate was directly obtained from the Income Tax Laws for various years, and was adjusted to include the burden of the profit sharing rate.[44]
- The required rate of return was assumed equal to the real riskless interest rate (UDIBONOS),[45] plus a time varying risk premium equal to the difference between the short term interest rate on private commercial paper and the short term interest rate on government bonds (CETES).
- The present value of depreciation allowances for each plant was calculated based on Equation 1 using the normal depreciation rates allowed for each type of asset in the Income Tax Law for plants in the 3MMA region. For plants in the OAD region, it was calculated using the maximum optional accelerated depreciation allowed. This procedure implicitly assumes that all plants that qualify for OAD actually choose this option. Table A-1 shows the depreciation rates for selected assets and industries applicable in 2002.
- Economic depreciation rates were estimated at the 6-digit industry level using aggregate information about asset values and depreciation (both at historic cost) from the previous EIA panel (1984-1994). These depreciation rates were assigned at the 4-digit industry codes to each plant in the EIA panel used in the study (1994-2002).

A.10 Treatment of extreme and missing values

Variables were winsorized at the 1% and 99% of the empirical distribution. Observations for which the capital stock was zero were eliminated. Plants with incomplete information were not included in the analysis, thus the panel is balanced.

Tables and Figures

[44] An alternative Asset Tax was enacted in 1989 to prevent firms from tax evasion. This tax is totally deductible from the Corporate Income Tax, and thus functions as a minimum tax. This paper does not consider the impact this provision might have on investment rates.

[45] UDIBONOS are government bonds issued at a fixed real interest rate for 3, 5 and 10 years. They started in 1996; the rate for 1994 and 1995 was extrapolated using other nominal interest rates on government bonds.

Table 1: Corporate Tax Rates and Depreciation Allowances, 1993-2007

Year	Corporate Tax Rate*	OAD system**	Real interest rate***
1993	35%	Yes (5%)	10.83%
1994	34%	Yes (5%)	12.89%
1995	34%	Yes (5%)	18.72%
1996	34%	Yes (3%)	12.78%
1997	34%	Yes (3%)	8.67%
1998	34%	Yes (3%)	8.51%
1999	35%	No	10.29%
2000	35%	No	8.67%
2001	35%	No	8.12%
2002	35%	Yes (6%, w/deferral)	6.64%
2003	34%	Yes (3%, w/deferral)	5.38%
2004	33%	Yes (3%, w/deferral)	5.41%
2005	30%	Yes (3%)	5.74%
2006	29%	Yes (3%)	5.74%
2007	28%	Yes (3%)	5.74%

Example of tax parameters: Automobile parts industry

	z		ETR		COC	
Region	3MMA	OAD	3MMA	OAD	3MMA	OAD
1994	0.617	0.730	0.361	0.284	0.263	0.245
1995	0.608	0.730	0.330	0.253	0.259	0.240
1996	0.617	0.824	0.361	0.207	0.220	0.192
1997	0.672	0.824	0.372	0.242	0.190	0.172
1998	0.651	0.824	0.389	0.244	0.198	0.177
1999	0.616	0.616	0.397	0.397	0.243	0.243
2000	0.650	0.650	0.397	0.397	0.240	0.240
2001	0.663	0.663	0.397	0.397	0.243	0.243
2002	0.669	0.653	0.422	0.444	0.228	0.232

*In 1999-2001, the tax rate on Retained Earnings was 30%. The (5% × Taxable Income) tax liability was paid upon distribution. **The number in parenthesis is the discount rate applicable to calculate the PDV of depreciation allowances under the Optional Accelerated Depreciation system. See Section 3 for deferral rules in 2002-2004. ***See Section 4.3 for a description of the calculations. Source: Federal Income Tax Law (Ley del Impuesto Sobre la Renta) and author's calculations. z is the present value of future depreciation allowances, ETR is the effective tax rate and COC is the cost of capital. 3MMA stands for the region including the three main metropolitan areas. OAD stands for the region outside these metropolitan areas, where the accelerated depreciation applied.

Table 2: Summary Statistics, 1994-2002

	Mean	Std. Dev.	25%	50%	75%	N
COC	0.253	0.044	0.226	0.249	0.276	33,678
GE/K	0.168	0.378	0.000	0.032	0.159	33,678
NE/K	0.072	0.359	-0.081	-0.042	0.062	33,655
R/K	0.005	0.026	0.000	0.000	0.000	33,678
I/K	0.162	0.371	0.000	0.029	0.153	33,678
CF/K	0.623	1.838	0.000	0.043	0.422	32,443
Y/K	25.213	302.202	2.510	5.843	14.426	33,339

	3MMA	OAD	Difference	
	(Means)		3MMA-OAD	Std. Err
COC	0.257	0.249	0.007***	0.000
GE/K	0.174	0.163	0.010**	0.004
NE/K	0.075	0.068	0.007*	0.004
R/K	0.006	0.005	0.001***	0.000
I/K	0.166	0.158	0.009**	0.004
CF/K	0.787	0.452	0.335***	0.020
Y/K	28.989	21.300	7.689**	3.310

	Multinationals	Domestic	Difference	
	(Means)		Mult.-Dom.	Std. Err
COC	0.254	0.253	0.001	0.001
GE/K	0.204	0.165	0.039***	0.007
NE/K	0.103	0.069	0.035***	0.007
R/K	0.005	0.005	0.000	0.000
I/K	0.199	0.158	0.041***	0.007
CF/K	0.884	0.595	0.289***	0.035
Y/K	18.363	25.936	-7.574	5.630

COC is the user cost of capital, GE and NE are gross and net capital expenditures, respectively; R are retirements, I is investment, Y is output, CF is cash flow and K is the capital stock. *,**,*** significant at 10%, 5% and 1%, respectively. 3MMA stands for the region including the three main metropolitan areas. OAD stands for the region outside these metropolitan areas, where the accelerated depreciation applied.

Table 3: Differences-in-Differences regressions

$\frac{I_{it}}{K_{it-1}} = \alpha_i + \beta_1 OAD_{it}^{period} + \beta_2 OAD_{it}^{region} + \beta_3 (OAD_{it}^{period} \times OAD_{it}^{region}) + \eta_t + \epsilon_{it}$

	(1)	(2)	(3)	(4)	(5)	(6)
	1994-2002		1996-2002		1997-2002	
OAD^{period}	0.026***		0.021***		0.017***	
	(0.006)		(0.006)		(0.006)	
OAD^{region}	-0.036	-0.01	-0.084**	-0.05	-0.063	-0.018
	(0.037)	(0.037)	(0.042)	(0.042)	(0.048)	(0.048)
$OAD^{period} \times OAD^{region}$	0.015*	0.015*	0.014*	0.015*	0.015*	0.016*
	(0.008)	(0.008)	(0.009)	(0.008)	(0.009)	(0.009)
Constant	0.158***	0.123***	0.182***	0.143***	0.171***	0.127***
	(0.019)	(0.019)	(0.021)	(0.022)	(0.024)	(0.024)
Observations	33,678	33,678	26,194	26,194	22,452	22,452
R-squared	0.161	0.17	0.202	0.211	0.224	0.236
Plant FE	Y	Y	Y	Y	Y	Y
Year FE	N	Y	N	Y	N	Y

I is investment, K is the capital stock . Robust standard errors in parentheses. All variables winsorized at the 1% and 99% of the empirical distribution. *,**,*** significant at 10%, 5% and 1%, respectively. 3MMA stands for the region including the three main metropolitan areas. OAD stands for the region outside these metropolitan areas, where the accelerated depreciation applied.

Table 4: Investment response to changes in the user cost
$\frac{I_{it}}{K_{it-1}} = \alpha_i + \beta COC_{it} + \gamma \frac{CF_{it}}{K_{it-1}} + \eta_t + \epsilon_{it}$

	(1)	(2)	(3)	(4)	(5)	(6)
	1994-2002		1996-2002		1997-2002	
COC	-0.265	-0.255	-1.021***	-0.986***	-1.074***	-1.028***
	(0.188)	(0.189)	(0.260)	(0.257)	(0.327)	(0.325)
CF/K		0.045***		0.049***		0.049***
		(0.005)		(0.005)		(0.005)
Constant	0.156***	0.154***	0.330***	0.333***	0.342***	0.343***
	(0.045)	(0.049)	(0.062)	(0.066)	(0.077)	(0.083)
Observations	33,678	32,443	26,194	24,959	22,452	21,217
R-squared	0.17	0.193	0.212	0.237	0.237	0.263
Plant FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Elasticity	-0.414	-0.398	-1.572	-1.518	-1.682	-1.610

	(1)	(2)	(3)	(4)	(5)	(6)
	1994-2002		1996-2002		1997-2002	
COC	0.148	0.181	-1.057**	-0.941**	-0.951**	-0.880**
	(0.256)	(0.250)	(0.434)	(0.457)	(0.428)	(0.442)
CF/K		0.056***		0.058***		0.055***
		(0.006)		(0.006)		(0.007)
Constant	-0.014***	-0.012***	-0.017***	-0.015***	-0.017***	-0.014***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Observations	29,936	27,842	22,452	20,358	18,710	16,720
R-squared	0.004	0.029	0.002	0.029	0.001	0.025
Plant FE	FD	FD	FD	FD	FD	FD
Year FE	Y	Y	Y	Y	Y	Y
Elasticity	0.231	0.283	-1.627	-1.449	-1.489	-1.378

I is investment, K is the capital stock , COC is the user cost of capital and CF is cash flow. Robust standard errors in parentheses (clustered at the "4-digit industry × region (3MMA or OAD)" level). FD: Model estimated in first differences. All variables winsorized at the 1% and 99% of the empirical distribution. *,**,*** significant at 10%, 5% and 1%, respectively. 3MMA stands for the region including the three main metropolitan areas. OAD stands for the region outside these metropolitan areas, where the accelerated depreciation applied.

Table 5: Logarithmic and industry aggregate regressions
$\ln\left(\frac{I_{it}}{K_{it-1}}\right) = \alpha_i + \beta \ln\left(COC_{it}\right) + \gamma \ln\left(\frac{CF_{it}}{K_{it-1}}\right) + \eta_t + \epsilon_{it}$

	(1)	(2)	(3)	(4)
	Plants: 1996-2002			
	Levels		Logs	
COC	-1.021***	-0.986***	-1.186***	-1.143**
	(0.260)	(0.257)	(0.430)	(0.463)
CF/K		0.049***		0.273***
		(0.005)		(0.025)
Constant	0.330***	0.333***	-4.582***	-4.242***
	(0.062)	(0.066)	(0.607)	(0.693)
Observations	26,194	24,959	18,227	11,476
R-squared	0.212	0.237	0.425	0.47
Plant FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Elasticity	-1.572	-1.518	-1.186	-1.143

	(1)	(2)	(3)	(4)
	Aggregate (6-digit industry level): 1996-2002			
	Levels		Logs	
COC	-0.848***	-0.820***	-1.284***	-1.264***
	(0.271)	(0.267)	(0.456)	(0.420)
CF/K		0.036**		0.141***
		(0.016)		(0.033)
Constant	0.357***	0.331***	-4.993***	-4.606***
	(0.059)	(0.072)	(0.681)	(0.628)
Observations	2,667	2,667	2,517	2,363
R-squared	0.291	0.294	0.428	0.445
Industry (6-digit) FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Elasticity	-1.303	-1.260	-1.284	-1.264

I is investment, K is the capital stock , COC is the user cost of capital and CF is cash flow. Robust standard errors in parentheses (clustered at the "4-digit industry × region (3MMA or OAD)" level in the top panel and at the 4-digit industry level in the bottom panel). In the bottom panel all quantities came from aggregates at the "6-digit industry × region" level. All variables winsorized at the 1% and 99% of the empirical distribution. *,**,*** significant at 10%, 5% and 1%, respectively. 3MMA stands for the region including the three main metropolitan areas. OAD stands for the region outside these metropolitan areas, where the accelerated depreciation applied.

Table 6: Instrumental variables estimation: investment response to changes in the user cost
$\frac{I_{it}}{K_{it-1}} = \alpha_i + \beta COC_{it} + \gamma \frac{CF_{it}}{K_{it-1}} + \eta_t + \epsilon_{it}$

	(1)	(2)	(3)	(4)	(5)	(6)
	Instruments: Lagged COC and current z					
	1994-2002		1996-2002		1997-2002	
COC	-1.179***	-1.184***	-1.188***	-1.174***	-1.650***	-1.648***
	(0.319)	(0.313)	(0.426)	(0.417)	(0.540)	(0.521)
CF/K		0.044***		0.049***		0.045***
		(0.004)		(0.005)		(0.006)
Constant	0.436***	0.349***	0.368***	0.379***	0.610***	0.499***
	(0.081)	(0.073)	(0.100)	(0.104)	(0.146)	(0.131)
Observations	29,936	28,701	22,452	21,217	18,710	17,579
Plant FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Hausman test (OLS)	0.002	0.005	0.998	0.995	0.288	0.391
Overid test	0.141	0.102	0.188	0.259	0.141	0.186
Elasticity	-1.841	-1.849	-1.829	-1.807	-2.584	-2.581
	(1)	(2)	(3)	(4)	(5)	(6)
	Instruments: Lagged COC and $(OAD^{period} \times OAD^{region})$					
	1994-2002		1996-2002		1997-2002	
COC	-1.391***	-1.403***	-1.323***	-1.277***	-1.941***	-1.886***
	(0.344)	(0.341)	(0.431)	(0.420)	(0.555)	(0.529)
CF/K		0.044***		0.049***		0.045***
		(0.004)		(0.005)		(0.006)
Constant	0.462***	0.399***	0.445***	0.368***	0.689***	0.558***
	(0.087)	(0.080)	(0.108)	(0.098)	(0.150)	(0.133)
Observations	29,936	28,701	22,452	21,217	18,710	17,579
Plant FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Hausman test (OLS)	0.000	0.001	0.930	0.973	0.035	0.130
Overid test	0.939	0.681	0.994	0.842	0.654	0.948
Elasticity	-2.172	-2.191	-2.037	-1.966	-3.039	-2.953

I is investment, K is the capital stock, COC is the user cost of capital and CF is cash flow. Robust standard errors in parentheses (clustered at the "4-digit industry × region (3MMA or OAD)" level). All variables winsorized at the 1% and 99% of the empirical distribution. *,**,*** significant at 10%, 5% and 1%, respectively. In the bottom panel, instruments are lagged cost of capital and a tax reform dummy (equal to 1 in years in which the OAD system was in effect, but only for those plants that qualified for this preferential treatment, i.e., located outside the main three metropolitan areas). 3MMA stands for the region including the three main metropolitan areas. OAD stands for the region outside these metropolitan areas, where the accelerated depreciation applied.

Table 7: Dynamic Panel IV Model: Response of investment to changes in the user cost
$(\frac{I_{it}}{K_{it-1}} - \frac{I_{it-1}}{K_{it-2}}) = \alpha + \beta(COC_{it} - COC_{it-1}) + \gamma(\frac{CF_{it}}{K_{it-1}} - \frac{CF_{it-1}}{K_{it-2}}) + \eta_t + \epsilon_{it}$

	(1)	(2)	(3)	(4)	(5)	(6)
	1994-2002		1996-2002		1997-2002	
COC	-0.146	0.095	-0.782***	-0.668**	-1.267***	-1.147***
	(0.145)	(0.165)	(0.250)	(0.288)	(0.296)	(0.327)
CF/K		0.057***		0.058***		0.050***
		(0.006)		(0.008)		(0.008)
Constant	0.002	-0.005**	-0.017***	-0.014***	-0.022***	-0.020***
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Observations	26,194	24,100	18,710	16,720	14,968	13,084
Plant FE	FD	FD	FD	FD	FD	FD
Year FE	Y	Y	Y	Y	Y	Y
AR1	0.000	0.000	0.000	0.000	0.000	0.000
AR2	0.507	0.341	0.609	0.701	0.182	0.445
Elasticity	-0.228	0.148	-1.204	-1.028	-1.984	-1.796

I is investment, K is the capital stock, COC is the user cost of capital and CF is cash flow. Robust standard errors in parentheses (clustered at the "4-digit industry × region (3MMA or OAD)" level). FD: Model estimated in first differences. All variables winsorized at the 1% and 99% of the empirical distribution. *,**,*** significant at 10%, 5% and 1%, respectively. The model is estimated in first differences using the Arellano-Bond dynamic panel estimator, including one lag of the dependent variable: the instruments are available lagged levels of the left and right hand side variables. 3MMA stands for the region including the three main metropolitan areas. OAD stands for the region outside these metropolitan areas, where the accelerated depreciation applied.

Table 8: Response of the capital stock to changes in the user cost, 1994-2002

$\frac{I_{it}}{K_{it-1}} = \alpha_i + \sum_{k=0}^{4} \beta_k (\frac{\Delta COC_{it-k}}{COC_{it-k-1}}) + \sum_{k=0}^{4} \gamma_k (\frac{\Delta Y_{it-k}}{Y_{it-k-1}}) + \sum_{k=0}^{4} \psi_k (\frac{CF_{it-k}}{K_{it-k-1}}) + \eta_t + \epsilon_{it}$

	(1)	(2)	(3)	(4)
	OLS		Dynamic Panel	
$\sum \Delta COC/COC$	-0.813*	-0.925	-1.065*	-1.655**
	(0.471)	(0.579)	(0.586)	(0.656)
$\sum \Delta Y/Y$	0.043	0.024	0.002	-0.043
	(0.040)	(0.047)	(0.036)	(0.041)
$\sum CF/K$		0.073***		0.093***
		(0.016)		(0.010)
Constant	0.155***	0.055*	-0.006	-0.009
	(0.020)	(0.030)	(0.014)	(0.015)
Observations	13,882	11,977	10,316	8,508
R-squared	0.332	0.377	na	na
Plant FE	Y	Y	FD	FD
Year FE	Y	Y	Y	Y
Elasticity	-0.813	-0.925	-1.065	-1.655

I is investment, K is the capital stock, COC is the user cost of capital, Y is output and CF is cash flow. Robust standard errors in parentheses (clustered at the "4-digit industry × region (3MMA or OAD)" level). All variables winsorized at the 1% and 99% of the empirical distribution. *,**,*** significant at 10%, 5% and 1%, respectively. In the last two columns, the model is estimated in first differences, using the Arellano-Bond dynamic panel estimator, including one lag of the dependent variable: the instruments are available lagged levels of the left and right hand side variables. 3MMA stands for the region including the three main metropolitan areas. OAD stands for the region outside these metropolitan areas, where the accelerated depreciation applied.

Table 9: Long run response of the targeted capital stock to changes in the user cost, 1994-2002
$\ln\left(\frac{K_{it-1}}{Y_{it}}\right) = \alpha + \beta COC_{it} + \epsilon_{it}$

	(1)	(2)	(3)	(4)	(5)	(6)
	1994-2002		1996-2002		1997-2002	
$COC\times$ Industry31	-3.430***	-3.433***	-3.129***	-3.984***	-2.670***	-3.606***
	(0.623)	(0.811)	(0.720)	(0.994)	(0.782)	(1.071)
$COC\times$ Industry32	-3.888***	-4.362***	-3.499***	-4.697***	-2.957***	-4.633***
	(0.744)	(0.939)	(0.825)	(1.116)	(0.884)	(1.180)
$COC\times$ Industry33	-4.019***	-4.086***	-3.746***	-4.216***	-3.450***	-4.007***
	(0.828)	(1.056)	(0.943)	(1.243)	(1.036)	(1.355)
$COC\times$ Industry34	-2.675***	-3.172***	-2.286***	-3.407***	-1.891**	-2.883**
	(0.782)	(0.968)	(0.859)	(1.150)	(0.919)	(1.241)
$COC\times$ Industry35	-2.533***	-2.561***	-2.203***	-2.863***	-1.768**	-2.110*
	(0.641)	(0.825)	(0.731)	(1.009)	(0.796)	(1.105)
$COC\times$ Industry36	-1.114	-1.279	-0.798	-1.687	-0.542	-1.516
	(0.786)	(1.017)	(0.903)	(1.229)	(0.987)	(1.337)
$COC\times$ Industry37	-0.587	-1.722	-0.003	-2.386*	0.6	-2.183
	(0.980)	(1.158)	(1.041)	(1.314)	(1.081)	(1.364)
$COC\times$ Industry38	-2.993***	-4.094***	-2.560***	-4.711***	-2.045**	-4.912***
	(0.789)	(1.011)	(0.871)	(1.204)	(0.930)	(1.256)
ΔCOC		12.523***		12.586***		19.447***
		(1.158)		(1.260)		(2.324)
$L1\Delta COC$		7.253***		11.944***		15.606***
		(0.688)		(1.147)		(1.549)
$L2\Delta COC$		4.863***		11.714***		12.592***
		(0.483)		(1.133)		(1.271)
Constant	-1.007***	-0.571***	-1.091***	-0.311	-1.197***	-1.101***
	(0.157)	(0.220)	(0.178)	(0.268)	(0.193)	(0.276)
Observations	32,126	21,212	24,835	13,994	21,212	10,414
R-squared	0.038	0.04	0.035	0.039	0.032	0.037
Plant FE	N	N	N	N	N	N
Year FE	Y	Y	Y	Y	Y	Y
COC (pooled)	-3.836***	-2.944***	-3.892***	-3.397***	-3.600***	-4.542***
	(0.525)	(0.673)	(0.622)	(0.773)	(0.673)	(0.929)
Elasticity (pooled)	-3.836	-2.944	-3.892	-3.397	-3.600	-4.542

K is the capital stock, Y is output and COC is the user cost of capital. Robust standard errors in parentheses (clustered at the plant level). All variables winsorized at the 1% and 99% of the empirical distribution. *,**,*** significant at 10%, 5% and 1%, respectively. Industry codes: 31 - Food, beverages and tobacco; 32 - Textiles and leather products; 33 - Wood industries and products; 34 - Paper, printing and publishing industries; 35 - Chemicals, petroleum, coal, rubber and plastic; 36 - Nonmetalic minerals; 37 - Basic metal industries; 38 - Machinery and equipment, and other metal products.

Table 10: Investment response to changes in the user cost by Country of Majority Ownership
$\frac{I_{it}}{K_{it-1}} = \alpha_i + \sum_{l=1}^{11} \beta_l (COC_{lit} \times CountryOwnDummy_{il}) + \gamma \frac{CF_{it}}{K_{it-1}} + \eta_t + \epsilon_{it}$

	(1)	(2)	(3)	(4)
	1996-2002	Tax System	1996-2002	Avg. Ownership
$COC\times$ Mexico	-0.985***	W-W	-0.980***	88.4%
	(0.263)	(35%)	(0.263)	
$COC\times$ United States	-1.462**	W-W		6.3%
	(0.578)	(39.3%)		
$COC\times$ United Kingdom	-2.059*	W-W		0.4%
	(1.229)	(30%)		
$COC\times$ Japan	-0.086	W-W		0.4%
	(0.768)	(40.9%)		
$COC\times$ Germany	-1.920***	Terr.		1.1%
	(0.745)	(38.9%)		
$COC\times$ Switzerland	-1.632***	Terr.		0.6%
	(0.619)	(24.4%)		
$COC\times$ France	0.297	Terr.		0.5%
	(1.426)	(35.4%)		
$COC\times$ Netherlands	0.645	Terr.		0.5%
	(1.324)	(34.5%)		
$COC\times$ Canada	-0.962	Terr.		0.3%
	(1.790)	(38.6%)		
$COC\times$ Worldwide Tax			-1.357***	
			(0.511)	
$COC\times$ Territorial Tax			-1.052**	
			(0.525)	
CF/K	0.049***		0.049***	
	(0.005)		(0.005)	
Constant	0.306***		0.305***	
	(0.061)		(0.061)	
Observations	23,779		23,779	
R-squared	0.237		0.237	
Plant FE	Y		Y	
Year FE	Y		Y	

In Column (2), W-W and Terr refer to Worldwide and Territorial taxation of foreign income, respectively; the number in parenthesis is the top statutory corporate tax rate effective in 2002, including state and local taxes (OECD (1991)). Column (4) shows the average ownership percentage across the sample of plants. I is investment, K is the capital stock, COC is the user cost of capital CF is cash flow. Robust standard errors in parentheses (clustered at the "4-digit industry × region (3MMA or OAD)" level). All variables winsorized at the 1% and 99% of the empirical distribution. *,**,*** significant at 10%, 5% and 1%, respectively. 3MMA stands for the region including the three main metropolitan areas. OAD stands for the region outside these metropolitan areas, where the accelerated depreciation applied.

Table 11: Evidence on the reaction of the price of capital goods to changes in the user cost
$\frac{Variable_{it}}{K_{it-1}} = \alpha_i + \beta COC_{it} + \gamma \frac{CF_{it}}{K_{it-1}} + \eta_t + \epsilon_{it}$

	(1)	(2)	(3)	(4)	(5)	(6)
		1994-2002			1996-2002	
	All K	Domestic	Imported	All K	Domestic	Imported
COC	-0.236	0.075	-0.378***	-1.022***	-0.402**	-0.546***
	(0.194)	(0.135)	(0.091)	(0.259)	(0.185)	(0.122)
CF/K	0.046***	0.030***	0.006***	0.049***	0.033***	0.007***
	(0.005)	(0.003)	(0.001)	(0.005)	(0.003)	(0.002)
Constant	0.154***	0.05	0.116***	0.346***	0.165***	0.157***
	(0.050)	(0.035)	(0.021)	(0.067)	(0.047)	(0.029)
Observations	32,443	32,443	32,443	24,959	24,959	24,959
R-squared	0.197	0.207	0.223	0.24	0.248	0.267
Plant FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Elasticity	-0.355	0.172	-2.121	-1.517	-0.899	-3.058

I is investment, K is the capital stock, COC is the user cost of capital and CF is cash flow. Robust standard errors in parentheses (clustered at the "4-digit industry $\times$ region (3MMA or OAD)" level). All variables winsorized at the 1% and 99% of the empirical distribution. *,**,*** significant at 10%, 5% and 1%, respectively. 3MMA stands for the region including the three main metropolitan areas. OAD stands for the region outside these metropolitan areas, where the accelerated depreciation applied. The user cost for imported capital is adjusted to consider changes in the foreign exchange rate.

Figure 1: Standardized Actual and Mandated Investment Rates

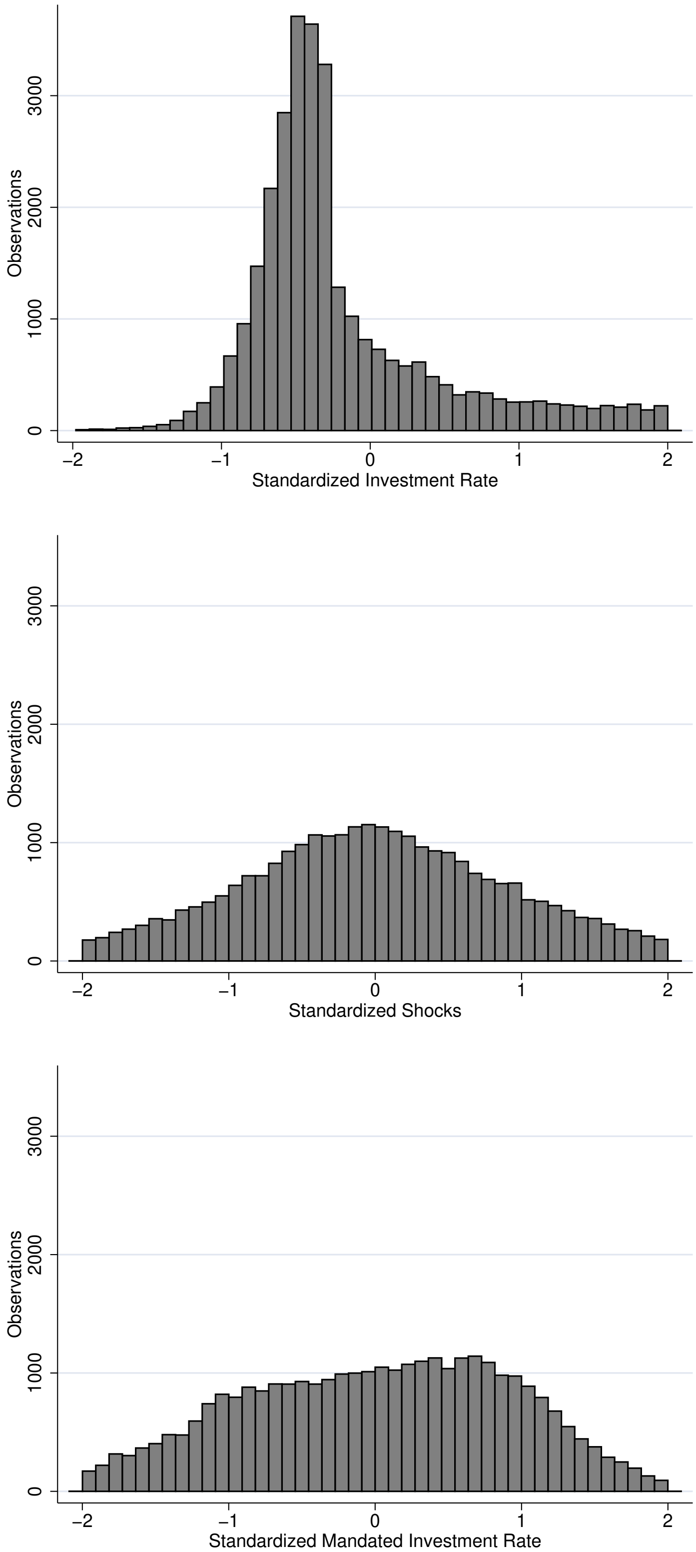

Figure 2: Actual and Mandated Investment Rates and the Average Adjustment Function

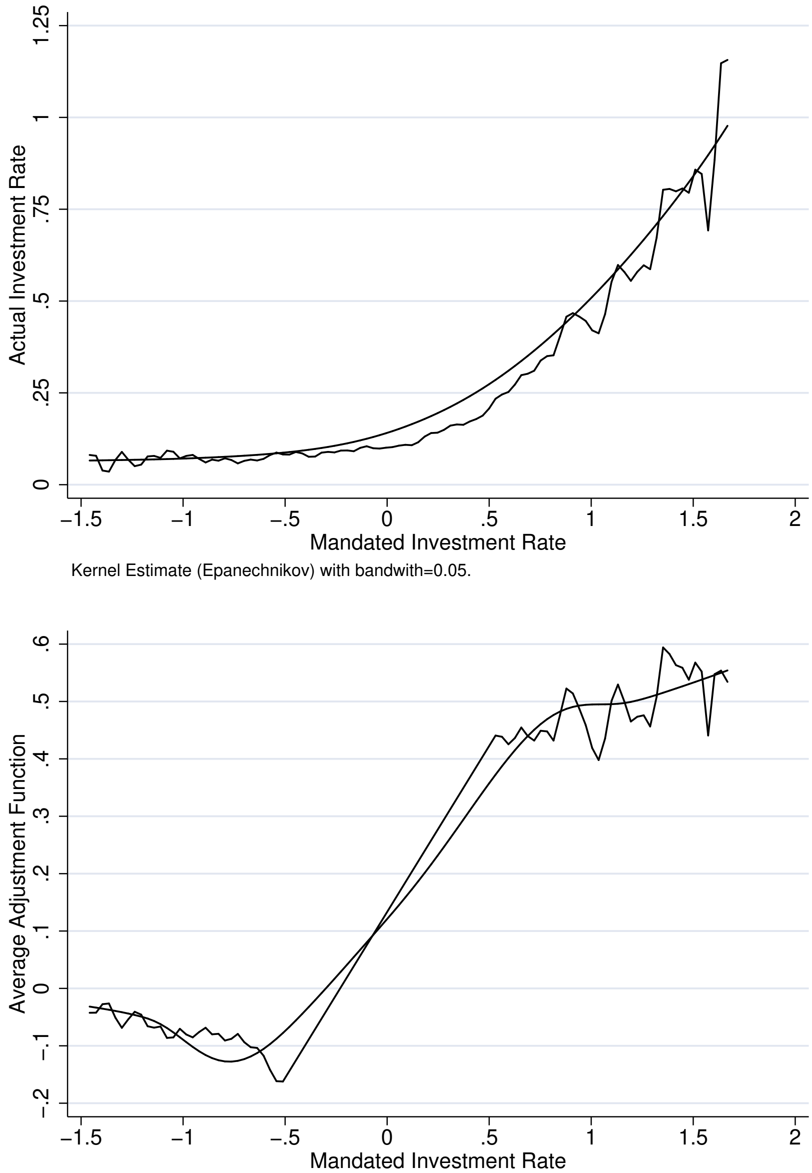

Table 12: Investment response to changes in the user cost by asset type
$\frac{I_{ijt}}{K_{ijt-1}} = \alpha_{ij} + \beta COC_{ijt} + \gamma \frac{CF_{ijt}}{K_{ijt-1}} + \eta_t + \epsilon_{ijt}$

	(1)	(2)	(3)	(4)
	1996-2002			
	Pooled		Separated	
COC	-1.701***	-1.771***		
	(0.246)	(0.252)		
COC (Mach. & Eq.)			-1.405***	-1.467***
			-0.218	-0.223
COC (Constructions)			-0.925***	-1.021***
			-0.279	-0.275
COC (Land)			-1.816***	-1.981***
			-0.316	-0.326
COC (Transp. Eq.)			-2.297***	-2.351***
			-0.338	-0.348
CF/K		0.003***		0.003***
		0.000		0.000
Constant	0.493***	0.548***	0.499***	0.552***
	(0.056)	(0.062)	(0.055)	(0.060)
Observations	72,765	69,362	72,765	69,362
R-squared	0.196	0.212	0.196	0.213
Plant×Asset FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Elasticity (Mach. & Eq.)	-2.619	-2.419	-2.163	-2.259

I is investment, K is the capital stock, COC is the user cost of capital and CF is cash flow. Robust standard errors in parentheses (clustered at the "4-digit industry × region (3MMA or OAD) × asset" level). All variables winsorized at the 1% and 99% of the empirical distribution. *,**,*** significant at 10%, 5% and 1%, respectively. 3MMA stands for the region including the three main metropolitan areas. OAD stands for the region outside these metropolitan areas, where the accelerated depreciation applied.

Table 13: Implications for Tax Policy

	(1)	(2)	(3)	(4)
		Using 2002 I/K		
			Elasticity	
			-1.5	-2.0
	COC	$\Delta COC/COC$	I/K	
Approved Tax changes:				
2002	0.231	Base	0.0904	0.0904
2003	0.198	-0.141	0.1093	0.1156
2004	0.196	-0.013	0.1115	0.1187
2005	0.195	-0.004	0.1122	0.1197
10% ITC (2003)	0.174	-0.246	0.1240	0.1352
Full Expensing (2003)	0.168	-0.273	0.1266	0.1387
	(1)	(2)	(3)	(4)
		Using average 1994-2002 I/K		
			Elasticity	
			-1.5	-2.0
	COC	$\Delta COC/COC$	I/K	
Approved Tax changes:				
2002	0.231	Base	0.1630	0.1630
2003	0.198	-0.141	0.1974	0.2088
2004	0.196	-0.013	0.2013	0.2144
2005	0.195	-0.004	0.2027	0.2164
10% ITC (2003)	0.174	-0.246	0.2232	0.2433
Full Expensing (2003)	0.168	-0.273	0.2294	0.2516

I is investment, K is the capital stock, COC is the user cost of capital. All numbers are derived from calculations at the 4-digit industry level and separately for each region (3MMA or OAD). The aggregation is done using as weights the capital stock in 2002 in each 4-digit industry. 3MMA stands for the region including the three main metropolitan areas. OAD stands for the region outside these metropolitan areas, where the accelerated depreciation applied.

Table A-1: Depreciation rates for selected assets and industries, 2002

Asset	NDR	OAD
Constructions	0.05	0.57
Railroad tracks	0.05	0.57
Railroad cars and locomotives	0.06	0.62
Office furniture and equipment	0.10	
Boats	0.06	0.62
Airplanes	0.10	
Automobiles, buses and trucks	0.25	
Personal computers, servers, printers, etc.	0.30	0.88
Dices, dies, molds, matrices and toolbox	0.35	0.89
Telephone communication towers and cables	0.05	0.57
Radio systems	0.08	0.69
Telephone transmission equipment	0.10	0.74
Satellite equipment on space	0.08	0.69
Satellite on land equipment	0.10	0.74
Industry	**NDR**	**OAD**
Generation, conduction and distribution of electricity; grain milling, sugar production, oil manufacturing and marine transportation	0.05	0.57
Basic metal production, tobacco manufacturing and production of derivatives of coal	0.06	0.62
Manufacturing of paper; extraction and processing of petroleum and natural gas	0.07	0.66
Manufacturing of motor vehicles and parts, railroads and ships, machinery, professional and scientific instruments; elaboration of nutritional products and beverages	0.08	0.69
Manufacturing of leather, chemical and petrochemical, plastic and rubber products; printing and graphical publishing	0.09	0.71
Electrical transportation	0.10	0.74
Manufacturing of textile products	0.11	0.75
Mining industry, construction of airships, load and passengers motor transportation	0.12	0.77
Aerial transportation and communication services	0.16	0.81
Restaurants	0.20	0.84
Construction; agricultural, cattle, forestry and fishing activities	0.25	0.87
Research and development	0.35	0.89
Manufacturing and assembling of magnetic components and hard disks	0.50	0.92
Production of natural gas and pollution control	1.00	
All other activities	0.10	0.74

Source: Federal Income Tax Laws (Ley del Impuesto Sobre la Renta). NDR: Normal Depreciation Rate (Straight Line Method). OADR: Optional Accelerated Depreciation Rate (First year only).