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CORPORATE TAX, FIRM DESTRUCTION AND CAPITAL STOCK ACCUMULATION: EVIDENCE FROM CHILEAN PLANTS

Rodrigo A. Cerda
Instituto de Economía
Pontificia Universidad Católica de Chile

Diego Saravia
División de Estudios
Banco Central de Chile

Resumen

Estudiamos empíricamente el impacto que tiene el impuesto a las utilidades en la formación de capital de las empresas teniendo en cuenta que una variación en los impuestos puede afectar la creación y destrucción de empresas y no sólo la decisión de inversión de las empresas existentes. De esta manera estimamos demandas de capital corrigiendo por el potencial sesgo de auto selección que puede estar presente utilizando el método de Heckman-Lee y su contraparte para datos de panel (Kyriadizou method). En nuestras estimaciones usamos datos para plantas chilenas desde el período 1979 al 2002, que es un período que presenta variabilidad en el impuesto estudiado. Encontramos que el impuesto a las utilidades tiene un efecto significativo en la creación y destrucción de empresas como así también en la decisión de invertir de las empresas existentes.

Abstract

We investigate the impact of corporate taxation on capital stock. In the paper, we indicate that corporate taxation might not only distort the decision of each firm to invest but could also destroy firms. With this in mind, we estimate capital demand equations, correcting for self-selection in the decision to produce by using the Heckman-Lee method and its panel data counterpart (Kyriadizou method). We use Chilean plant-level data from 1979 to 2002 hich is a period with large variability in corporate taxation. We find that corporate taxation has a considerable impact on the creation-destruction of firms and in addition, it also has an important impact on the decision of how much to invest for firms that are already involved in production.

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1 Introduction

The impact of corporate tax on capital accumulation has been extensively analyzed in the economic literature since the seminal contributions of Jorgenson (1963), Hall and Jorgenson (1967) and Tobin (1969). The two main arguments by which corporate taxation should affect capital stock in the long run are the following. On the one hand, a larger corporate tax rate decreases the future after-tax marginal product of current investment, producing a substitution effect towards larger current profits and thus depressing investment(Jorgenson (1963)). [1] On the other hand, since capital stock investments are tax-deductible, the negative effect of the corporate tax on capital stock might be offset at least partially by tax deductions arising from depreciation or debt and interest-rate payments.

The above arguments are generally obtained from the case of a representative firm that maximizes its future expected profits. In this paper, we complement this view, by considering the firms´ decision to enter or exit the market such that corporate tax may affect the creation and destruction of firms. In that case, the corporate tax may impact capital stock by two main channels: (i) the intensive margin effect which corresponds to the impact on firms that are in production and will continue producing - these are the arguments stated above- and (ii) the extensive margin effect which corresponds to the possibility that a larger corporate tax rate might lower firms' after-tax profits, providing incentives to firms to exit the market and not invest at all. This second channel is a type of corner solution in investment decisions that results from the extensive margin impact of the corporate taxation, i.e. firms exiting the productive market.

Note that in the traditional context in which there is a unique firm that does not exit the production market, the estimation of the traditional investment equation provides the marginal impact of an increase in corporate taxation on the firm's investment. However, in the context of heterogeneous firms facing outside options and the possibility of exiting the production market, the estimation of the same structural regression might be biased. In fact, if firms self-select in their decision to enter or exit the production market, conditional on the corporate tax rate, then the sample selection will provide inconsistent estimates of our impacts of interest.

Our paper tests for this transmission channel and its potential importance using panel data of Chilean firms during the period 1979-2004. To highlight the importance of firm

[1] A similar argument follows from the Tobin's model in which a larger corporate tax rate reduces the after-tax market value of business capital assets and, thus, lowers both Tobin's q and investment.

selection we initially provide estimates of simple OLS and panel data models that do not account for selection and later take account of the entry-exit decision by using the two-step Heckman method (Heckman (1974), Heckman (1976), Heckman (1979)), and the Kyriazidou panel data selection procedure (Kyriazidou (1997)).

Our data is interesting to our exercise due to different reasons. First, it consists of a detailed panel of firms in the Chilean manufacturing sector during the period 1979 to 2004 which is quite an interesting period concerning corporate taxation in Chile due to a large fiscal reform that took place in 1984. The aim of the reform was to remove potential distortions that were depressing savings and investment. The reform focused on income taxes. Before 1984, firms were taxed by a corporate tax that was set at 10% plus an additional tax of 40% on after-corporate-tax profits. In total, firms paid a 46% tax on their profits. Individuals were allowed to reduce the 40% tax if they received firm's dividends from their tax base. The 1984 reform eliminated the additional 40% tax on after-corporate-tax profits, which produced a significant decrease in overall corporate tax rate. In 1990, this tax scheme was modified by establishing different tax rates for distributed and undistributed profits, the tax rate being 10% in the case of distributed profits and 0% in the case of undistributed. This differentiated scheme was eliminated in 1991 when the corporate tax rate was set at 10%. In 1992, the corporate tax rate increased to 15% and in 2004 it was increased to 17%. Second, we have available detailed data on the effective amount of corporate taxes paid by firms which provides us with a measure of the effective corporate tax rate when including tax deductions and potential tax evasion. In addition, our data set contains a large fraction of small firms that are more likely to be destroyed when the economic environment becomes more stringent, as could be the case of a large corporate tax rate.

In this paper, we find that if we do not correct for self selection, the coefficient of corporate tax in the intensive margin decision is generally not significant. However when we correct for self selection, the intensive margin impact is economically significant, as we find that a 1% increase in corporate tax might depress capital stock accumulation by between 1 and 2%. We also find that the impact of corporate taxation on a firm's decision to become involved in production is large; in fact our estimates indicate that a 1% increase in corporate tax rate might depress the participation of firms by almost 1.2% .

This paper is developed in the following way. Section (2) discusses related studies on corporate taxation, firm destruction and business investment. Section (3) provides a theoretical model of business investment when firms may exit production and provides a testable equation for desired capital stock in this case. Section (5) describes the data while sections (4) and (6) explain the methodology and discuss the results. Section (7) concludes.

2 Related Literature

The empirical literature on the relationship between tax policy and capital stock is extensive and contains mixed evidence as to whether or not changes in tax policy does not affect investment expenditure.

The study of investment builds mainly on the work of Jorgenson (1963) and Tobin (1969). While the theoretical studies developed in the neoclassical vein of Jorgenson (1963) proved useful in developing a conceptual framework, their empirical validation is more controversial and many times outperformed by ad-hoc empirical models.

The work of Tobin (1969) is closely related to the neoclassical theory of Jorgenson (1963). In his framework, managers decide how much to invest based on expected profitability, e.g. the investment rate depends on the ratio of the market value of business capital assets to their replacement value. This ratio is usually known as q. In this case, a larger corporate tax rate reduces the after-tax market value of business capital assets and, thus, lowers both q and investment. This model has been estimated using least squares on aggregate data (eg., Summers, Bosworth, Tobin, and White (1981)) or a panel of firms (eg., Fazzari, Hubbard, Petersen, Blinder, and Poterba (1988)). Estimations typically assume there is some adjustment cost in the investment function, generally written as a quadratic functional form. Empirical results are rarely consistent with these theoretical assumptions. Such a finding may reflect a rejection of the q-theory, the existence of q measurement error, an indication of negative correlation between adjustment costs and tax adjusted q, or just a rejection of the assumed quadratic functional form. Further, it must be noticed that tax-adjusted q explains investment somewhat better than q by itself, especially for the dramatic tax adjustments associated with corporate-income-tax-law changes (eg., Cummins, Hassett, and Hubbard (1996)). This, in turn, may suggest that q measurement error is serious enough that the effect of q on investment is best detected when the tax adjustment is more dramatic than is the measurement error. See Chirinko (1993) and more recently Hasset and Hubbard (2002) for discussions on this issue.

Our work is more related to the one of Jorgenson (1963) as we estimate capital demand based on the user cost theory. We extend the usual approach by allowing entry and exit of firms at it will be explained later.

Our work is also related to the literature on creative destruction which is extensive in theoretical and empirical contributions. Several papers find that plants' entry and exit decisions play a significant role in the process of reallocation, see Foster, Haltiwanger, and Krizan (2001) for a detailed discussion. For example, Davis, Haltiwanger, and Schuh (1996) find entry and exit explain 20 percent of job destruction and 15 percent of job creation. Other studies (e.g. Olley and Pakes (1996) and Dwyer (1995)) report that productivity is important for explaining exit, such that firms with low productivity levels are more likely to exit even after controlling for other factors as size and age. In our paper we analyze the entry and exit of plants in order to study their joint investment and participation decisions presenting evidence related to these studies.

Studies of investment and corporate taxation in Chile are recent. Hsieh and Parker (2007) argue that corporate tax reform was a significant and direct cause of Chile´s investment boom. Bustos, Engel, and Galetovic (2004) study the investment process using an annual panel of 83 firms, with data ranging from 1985 to 1995, and report no significant impact of the corporate tax rate on the long run capital stock. Vergara (2008) investigates empirically the link between the income tax reform in the 1980s and Chile´s investment performance since the reform using macro data. Cerda and Larraín (2005) contribute in analyzing corporate taxation and investment in small, medium and large firms.

Our paper re-examines the evidence on corporate taxation and the firm's investment from a different perspective. While the papers generally focus on an intensive margin effect, i.e. the impact of corporate taxation on investment of firms involved in production, they do not consider potential extensive margin effects, i.e. the potential destruction of firms due to higher corporate taxes. This is obviously a dimension that is of considerable concern, even if there is no impact on the intensive margin. In addition, the exclusion of the selection decision (between being involved in production or exiting the market) in the empirical studies might bias the coefficients of the intensive margin effects of the different variables considerably. This bias might occur as our data set includes firms that self-select into production and in which the selection decision depends on some of the variables considered in the intensive margin decision, such as the case of the corporate tax. Our paper extends the analysis in this direction. That line of work is related to the study by Pratap and Rendon (2003) in which they estimate a dynamic structural model of firms' investment, allowing for borrowing constraint and firms exit, using data from the Standard and Poor Industrial Compustat database. In contrast to that study, our work focuses on the impact of corporate taxation on firms' desired capital stock and we use data from a developing country.

3 The model and estimable equation

3.1 Setup

In this section, we sketch a model of firm's investment in which we allow for firm exit with the objective of motivating the empirical analysis in section (4). The model, similar to Chavas (1994) and Hayashi (1982), is a partial equilibrium model as firms face interest and wage rates.

Consider the case of a firm i that maximizes its net receipts which are written as after-tax profits minus purchases of investment plus investment tax credits:

$$\max_{\{l_{i,s},I_{i,s}\}_{s=t}^{\infty}} \mathbb{E}_t \sum_{s=t}^{\infty} R_s \left\{(1-\tau_t)\left[F(k_{i,t},l_{i,t},\epsilon_{i,t}) - w_t l_{i,t}\right] - (p_t I_{i,t})\right\}$$

where τ_t is the government corporate tax profits; $F(k_{it}, l_{it}, \epsilon_{i,t})$ is the production function the firm has available; k_{it} is the capital stock; $l_{i,t}$ is labor; w_t is the wage rate which is common to all firms; $I_{i,t}$ is investment. The price of capital goods is denoted with p_t while $\epsilon_{i,t}$ is an iid shock.

We assume that $F(k_{i,t}, l_{i,t}, \epsilon_{i,t})$ exhibits decreasing returns to scale and is strictly increasing, strictly concave and satisfies Inada conditions on $k_{i,t}$ and $l_{i,t}$. Also $F(k_{i,t}, l_{i,t}, \epsilon_{i,t})$ is linear homogeneous in both inputs and $F(0, l_{i,t}, \epsilon_{i,t}) = 0, \quad \forall l_{i,t}$. This last assumption indicates that a firm holding zero units of capital produces zero output.

Firm heterogeneity arises from the parameter $\epsilon_{i,t}$, which is distributed across firms with probability density function $\theta(\epsilon_{i,t})$, cumulative distribution $\Theta(\epsilon_{i,t})$ and support $[\epsilon_l, \epsilon_u]$, where $0 < \epsilon_l < \epsilon_u < \infty$. Finally capital stock evolves according to:

$$k_{i,t+1} = (1-\delta_{i,t})k_{i,t} + I_{i,t}$$

The firm's problem can be resumed by the following dynamic programming problem:

$$
\begin{aligned}
V_t(k_{i,t}, \epsilon_{i,t}) &= \max_{l_{i,t}, I_{i,t}} (1-\tau_t)\left[F(k_{i,t}, l_{i,t}, \epsilon_{i,t}) - w_t l_{i,t}\right] - (p_t I_{i,t}) + \frac{D_{i,t}(I_{i,t})}{1+r_t} \mathbb{E}_t V_{t+1}\left(k_{i,t+1}, \epsilon_{i,t+1}\right) \\
s.t. & \qquad (1) \\
& k_{i,t+1} = I_{i,t} + (1-\delta_{i,t}) k_{i,t} \\
& I_{i,t} \geq -(1-\delta_{i,t}) k_{i,t}
\end{aligned}
$$

where $V_t(k_{i,t}, \epsilon_{i,t})$ is the value of holding k_{it} units of capital at time t which depends on the shock ϵ_{it}. We have placed restrictions on investment by including a lower bound that corresponds to the maximum amount of capital available after depreciation and therefore corresponds to the case of an idle firm. Also, $D_{i,t}(I_{i,t})$ is an indicator function equal to one if $I_{i,t} > -(1-\delta_{i,t})k_{i,t}$ and equal to zero when the firm decides to close, i.e. $I_{i,t} = -(1-\delta_{i,t})k_{i,t}$. The optimality conditions for investment decision are:[2]

$$
\frac{1}{1+r_{i,t}} \frac{\mathbb{E}_t \delta V_{t+1}\left(k_{i,t+1}, \epsilon_{i,t+1}\right)}{\delta k_{i,t+1}} = p_t \quad if \quad I_{i,t} > -(1-\delta_{i,t}) k_{i,t} \qquad (2)
$$

$$
\frac{1}{1+r_{i,t}} \frac{\mathbb{E}_t \delta V_{t+1}\left(k_{i,t+1}, \epsilon_{i,t+1}\right)}{\delta k_{i,t+1}} < p_t \quad if \quad I_{i,t} = -(1-\delta_{i,t+1}) k_{i,t} \qquad (3)
$$

Equations (2) to (3) show the marginal benefit from accumulating capital stock vis-*à*-vis the marginal cost. Equation (2) shows that in the case of a firm that decides to invest, the marginal benefit is the impact on the expected discounted future value of the firm, while its marginal cost is the price of the investment. Equation (3) shows the condition that determines that a firm sells out the available capital stock. The associated envelope condition of this problem is:

$$
\frac{\delta V_t\left(k_{i,t}, \epsilon_{i,t}\right)}{\delta k_{i,t}} = (1-\tau_t) F_k(k_{i,t}, l_{i,t}, \epsilon_{i,t}) + p_t(1-\delta) \qquad (4)
$$

[2]The optimality condition with to respect to labor is:

$$
[l_{i,t}] \quad F_l(k_{i,t}, l_{i,t}) = w_t
$$

We plan to obtain an estimable equation of the desired stock of capital as a function of the components of the user cost of capital. Following Bustos, Engel, and Galetovic (2004), we assume a CES production function, where we set $\epsilon_{i,t}$ as the distribution parameter and where $\sigma > 0$ is the constant elasticity of substitution of the i^{th} firm at time t. Further, using (2) to (4), we obtain the following estimable equation:

$$ln(k_{i,t+1}) = log(Y_{i,t+1}) - \sigma\tau_{i,t+1} - \sigma ln(\delta_{i,t} + r_{i,t}) + \sigma ln(\epsilon_{i,t+1}) \quad if \quad I_{i,t} > -(1-\delta_{i,t})k_{i,t} \tag{5}$$

$$k_{i,t+1} = 0 \quad if \quad I_{i,t} = -(1-\delta_{i,t})k_{i,t} \tag{6}$$

Equation (5) corresponds to a capital demand equation for firms that self-select into production[3]. If the firm decides to close, it sells out its remaining capital stock while if it remains in production, it determines its capital demand according to its scale of production and the components of the user cost of capital. Note that the fraction of firms involved in production is:

$$\begin{aligned} Pr\left[I_{i,t} > -(1-\delta_{i,t})k_{i,t}\right] &= Pr\left[k_{i,t} \leq (\frac{v_{i,t}}{\epsilon_{i,t}})^{-\sigma} Y_{i,t}\right] \\ &= Pr\left[ln(\epsilon_{i,t}) \leq ln(v_{i,t}) - \frac{1}{\sigma}ln(Y_{i,t}) + \frac{1}{\sigma}ln(k_{i,t})\right] = \Theta(c_{i,t}) \end{aligned} \tag{7}$$

where $v_{i,t}$ is the user cost of capital, defined as $v_{i,t} \equiv \frac{(r_{i,t}+\delta_{i,t})}{(1-\tau_{i,t})}$ and $c_{i,t} = \frac{ln(v_{i,t}) - \frac{1}{\sigma}ln(Y_{i,t}) + \frac{1}{\sigma}ln(k_{i,t})}{\sigma_\epsilon}$.[4]

In this scenario, corporate taxation has two impacts: (1) it impacts the investment decision of each firm involved in production (intensive margin) and (2) it impacts the fraction of firms involved in production (extensive margin). In fact, an increase in corporate taxation impacts the fraction of firms involved in production as in:

$$\frac{\partial Pr\left[k_{i,t} \leq (\frac{v_{i,t}}{\epsilon_{i,t}})^{-\sigma} Y_{i,t}\right]}{\partial \tau_{t+1}} = \frac{\partial \Theta(c_{i,t})}{\partial \tau_{t+1}} = \frac{\theta(c_{i,t})}{\sigma_\epsilon} \tag{8}$$

where σ_ϵ is the standard deviation of $ln(\epsilon_{i,t})$. The impact on equation (8) corresponds

[3]In equation (5), we use the approximation $ln(1-\tau_{i,t+1}) \approx -\tau_{i,t+1}$.

[4]Where we assume a constant investment price, p_t.

to the marginal effect of corporate taxation on the extensive margin decision while $-\sigma$ in equation (5) corresponds to the marginal impact of corporate taxation on business investment, conditional on the firm being involved in production.

4 Methodology

In this section, we explain the methodology used to estimate the model developed in section (3). In the spirit of the above discussion, we consider a model characterized by three main equations. The first equation, see (9) below, corresponds to a firm's capital demand function when it is involved in production. In this case, corporate taxation affects the firm's extensive margin investment decision. The second and third equations -equations (10) and (11)- relate to the firm's participation decision: this is the decision concerning whether the firm remains idle or the firm engages in production. Equation (10) explains the behavior of a latent index, $d^*_{i,t}$, which determines the firm's extensive margin decision. In our notation i indexes firms while t indexes years. We will assume that the latent index is not observable. Instead, the econometrician observes an indicator function d_{it} which is equal to one when the firm decides to produce and zero if it closes. Equation (11) shows that the indicator function is equal to one when the unobservable latent index d^*_{it} is larger than zero.

$$
\begin{aligned}
ln(k^*_{i,t}) &= x_{i,t}\beta + \alpha_i + \mu_{i,t}; \qquad i = 1, .., N; \quad t = 1, ..., T && (9)\\
d^*_{i,t} &= z_{i,t}\gamma + \eta_i + u_{i,t} && (10)\\
d_{i,t} &= 1(z_{i,t}\gamma + \eta_i + u_{i,t} \geq 0) && (11)
\end{aligned}
$$

Since our data corresponds to a panel of firms starting in 1979, we allow potential individual fixed effects in (9) to (11). Also we allow additional factors -the control variables (x_{it}, z_{it}) - that might affect the firm's decisions concerning the intensive and extensive margin. These control variables are assumed to be strictly exogenous and may contain common elements while $(\mu_{i,t}, u_{i,t})$ are unobserved disturbances and (α_i, η_i) are individual effects per firm.

Our goal is to estimate the parameters (β, γ) consistently, specifically the parameters corresponding to the impact of corporate taxation. When estimating the model we may face sample selection bias. The sample selection arises because we observe investment decision only for firms involved in production, which means that we observe $ln(k_{i,t}{}^*)$ only when $d_{i,t} = 1$. This characteristic poses a probable selection bias in our estimators if we estimate by traditional least-squares methods or traditional panel data methods. In fact, firms with larger capital accumulation are typically more productive, and thus more likely to be involved in production. As a result, unobservable controls would influence both the investment margin and the extension margin equations, probably producing bias in our estimates if we do not consider the selection problem.

To address this problem we follow two procedures. Firstly, we follow the methodology elaborated by Heckman (Heckman (1974), Heckman (1976)) and Lee (Lee (1978)) to correct selectivity bias. The identification of our parameter is based on two main assumptions: (1) there are no individual fixed effects by pooling our data and (2) there is at least one instrument available to estimate the participation equation. Secondly, to address the panel structure of our dataset we follow the procedure elaborated by Kyriazidou (1997) and applied by Charlier, Melenberg, and van Soest (2001) and Askildsen, Baltagi, and Holmas (2003) among others to other economic questions. In this case, and by contrast to the Heckman-Lee methodology, we allow fixed effects and we control for their potential correlation with the error term or the exogenous variables.

We will present estimates using both methods to test whether there is consistency in our results under different assumptions. While we are able to provide estimates of the selection equation and the intensive margin equation, in both procedures the methodology differs. As indicated above, under the Heckman-Lee procedure we assume no fixed-effects and assume normality of the error terms. In that case we may provide results by estimating equation (11) using a probit specification, and then using the inverse mills ratio to correct for self-selection in equation (9). As a result, in this case we provide estimates under quite a standard parametric estimable equation. In contrast, when we provide estimates using the Kyriazidou procedure, we allow for fixed effects both in the selection and the intensive margin equations. In the case of the selection equation, we use a conditional logit procedure while in the intensive margin equation, our estimates rely on a semi-parametric methodology which allows us to drop the selection term out of equation (9) to provide consistent estimates of that equation. Appendix (B) provides a detailed discussion concerning the methodological procedure.

5 Data

5.1 Data description

The source of data in this paper is the Encuesta Nacional de Industrias Anual (Annual National Survey of Industries in English, its Spanish acronym is ENIA). This is an annual survey of Chilean manufacturing firms which has been conducted yearly since 1979. Our data ranges from 1979 to 2004. This survey is elaborated by the Chilean Instituto Nacional de Estadísticas (National Institute of Statistics in English, its Spanish acronym is INE) at the end of every year. The survey is collected on manufacturing firms and includes all the firms with more than 10 employees -it does not consider plants that hired less than 10 employees or plants that have exited the market. Data contain detailed information of the firms that compose the manufacturing sector at the 4-digit ISIC classification. The survey collects information on sales, investment, value added, employment and firm inputs.

The survey reports nominal variables, not real figures, and does not report plant level output prices which would allow us to convert them. We constructed output prices to generate constant price variables -see the Data Appendix for details about the deflators used. That said, all the variables used in the empirical analysis are expressed in 1992 Chilean pesos.

As in Bergoeing, Hernando, and Repetto (2003), we excluded the information of plants that report no employment, no blue-collar workers, zero wages, zero value added, gross production value lesser than their value added, gross product sales lesser than their exportation value, no ISIC code and negative value added. Moreover, to avoid the effect of outliers in the estimation, firms with costs of capital in the lower and upper 2% of the distribution were dropped. Similarly, we dropped the 3% of plants that reported outliers on the variable investment to capital ratio. The database ended up with 17.990 plants.

Next we describe the way we constructed the main variables in our empirical analysis. The dependent variable in our analysis is the logarithm of capital stock. Capital stock accounts for all types of capital. Our measure of corporate tax is denominated the "Effective Corporate Tax". If the firm is involved in production, it corresponds to the effective amount of corporate tax paid by the firm divided by the firm's value added. We could instead have used the corporate tax rate set in the Chilean tax code, called the "First Category Tax" which is an ad-valorem tax.[5] However, since we have the effective amount of corporate tax paid by firms available, we prefer to use it for two reasons. Firstly, some

[5]In other words, it is a percentage that applies on the net firm's profits.

firms might evade corporate taxes and thus the real corporate tax rate paid by firms would differ from the tax set by the tax code. Secondly, the law allows to subtract past firm's losses from the current base used to calculate the corporate tax , as a way of providing incentives to firms to remain in production when they incur that losses. In that case, a firm might also face a smaller corporate tax rate than that set in the tax code. If the firm is currently closed, we use the tax rate set in the Chilean code, i.e the "First Category Tax" that affects the net profits of firms as a measure of "Effective corporate Tax".

The variable "Interest rate" is calculated as the ratio of financial expenses to value added, and is a measure of the opportunity cost of investment. The variable "Depreciation rate" corresponds to the sum of depreciation on different types of capital (machinery, cars, buildings, etc..) divided by the sum of the different types of capital stock. We also construct other variables related to the firm's characteristics. The variable "Firm's Age" represents the age of the firm in period t. It was assumed that while the firm is out of the market, the firm does not get older because it does not operate, such that when the firm reappears in the sample, it keeps the age it had in the last period before it decided to exit. The variables "Size" are a series of dummy variables intended to capture the size of the plant as a function of the number of individuals that the firm employs. The first size category corresponds to firms with the number of employees ranging between 10 and 19 workers, the second category corresponds to 20 to 49 workers, the third category to 50 to 99 workers, the fourth to 100 to 199 workers, the fifth to 200 to 499 workers, the sixth to 500 to 999 workers and the seventh to 1000 or more workers.

Next, we describe additional variables included in the selection equation. As might be obvious by now, the selection equation requires an indicator variable that signals when the plant is producing and when it is not. This variable is "Participation" which is equal to 1 if the firm was participating in the market that year and 0 otherwise. It was assumed that the firm was present if it reported employment data, because INE takes that information into account when deciding whether to include that plant in the survey -for more details about this, see Appendix (A).

In the estimation of the selection equation, we include similar variables in the investment equation but we also incorporate a couple of additional regressors: (1) the Herfindahl Index and (2) the Minimum Efficient Scale. These additional regressors, which are traditionally used in the industrial organization literature, were used by Görg and Strobl (2003) in the study of plant survival. These variables act as exogenous instruments that affect the participation decision but do not affect the investment decisions of firms involved in production (equation (9)).

The Herfindahl Index (HI) is a measure of a sub-sector 's concentration and it is defined as the sum of the squares of the market shares of each individual firm. The effect of market concentration on the entry decision could be positive if one thinks that a sub-sector with a higher HI implies high margins, and could be negative if one suspects that the competition is wild in that sub-sector.

The Minimum Efficient Scale (MES) corresponds to median plant size in terms of employment, calculated for each industry at the 4-digit ISIC classification (Revision 2) and for each year of the sample. According to Görg and Strobl (2003), –and references therein–, this variable might be important to the entry/exit decision, but it might have an ambiguous impact on firm survival. One argument which would be in line with a negative impact of MES on plant survival is that small firms entering into industries with large MES might not be able to attain the efficient level of production and thus face a lower probability of survival. Conversely, industries with large MES are generally associated with high margins (price minus cost), which would augment the likelihood of survival of entrant firms.

We also include some national aggregate control variables to capture changes at the macroeconomic level that might affect the plants' decision to invest. In addition, our econometric estimations include foreign aggregate variables to control for external shocks that might influence firms' entry/exit decisions or their investment decisions.

Table (1) provides a summary of the definition of the variables while table (2) provides summary statistics of the database. As can be seen in the table, there is a large dispersion on the variables. In our sample new and old plants coexists. The mean payment of financial expenses on value added is large -almost 20% in our sample. Also approximately 18% of plants in the sample are involved in production. The majority of plants correspond to plants with size ranging from 20 to 200 workers.

INSERT TABLES (1) AND (2) ABOUT HERE

5.2 Raw data

To get a sense of the relation between corporate taxes and the creation of firms, we next analyze some raw data concerning both variables.

Figure (1) shows the evolution of the presence of firms involved in production by year (this is the variable participation in our data). The initial fraction involved in production is quite low and drops by 1982 with the eruption of the 1982 financial crisis. After 1985, and coinciding with a period of rapid growth in the Chilean economy, the fraction of firms involved in production increased notably until reaching a peak of 22% by the end of 1996. The eruption of the Asian crisis in 1997 decreased the fraction of firms involved in production to its 1980's level in a four year period. After 2000, and once the 1997 crisis was left behind, firms' participation increased once again. Figures (2) and (3) plot the evolution of firm creation and destruction, respectively.[6] In the figures, creation of firms corresponds to the firms that were closed in period $t-1$ but are involved in production in period t while, conversely, destruction corresponds to firms that were involved in production in period $t-1$ but are closed in period t. On the one hand, firms' destruction is larger during both the 1982 the 1997 economic crisis and is almost half of these crisis levels during the expansionary period of 1985-1995. On the other hand, the creation of firms shows generally an upward trend with peaks in specific years, while there is also a period of lower creation of firms after the eruption the 1997 economic crisis.

INSERT FIGURES (1) TO (3) ABOUT HERE

Figures (4) to (6) plot the same three series vis-$\grave{a}$-vis effective corporate tax. In the figures, the effective corporate tax corresponds to the average corporate tax rate faced by firms [7]. The figures show a considerable association between these variables: on the one hand, the larger the corporate tax rate, the smaller the creation of firms and the fraction of firms involved in production while on the other hand, the larger the corporate tax rate, the higher is firm destruction. The figure concerning destruction of firms is not as clear as the other two figures though, but there is still some correlation between the series.

INSERT FIGURES (4) TO (6) ABOUT HERE

These figures showed association between average time series variables. In addition, to reinforce the graphical analysis, we run probit equations concerning the creation and destruction of firms as a function of fundamentals, including the corporate tax rate. Tables

[6]The dummy variable "creation of firms" is equal to one when a firm was not involved in production in year t-1 but it is involved in production in period t and it is equal to zero when a firm was not involved in production in year $t-1$ and remains not involved in production in period t. In another hand, the dummy variable "Destruction of firms" is equal to one when a firm was in production in period $t-1$ but it becomes idle in period t while it is equal to zero when the firm was involved in production in period $t-1$ and it remains involved in production in period t.

[7]For firms that are not in the market in a given period, we use the tax rate set in the Chilean code as discussed in section (5).

(3) and (4) are obtained using the complete data set and show the result from running the probit regressions. The set of controls include the effective corporate tax rate, plus other variables. Table (3) corresponds to regressions concerning the creation and destruction of firms. The first three columns of the table correspond to the creation of firms. The first column of the table controls just for the effective tax rate. The second column includes economic variables relating to the external scenario (terms of trade and the US industrial index) while the third column includes in addition variables relating to the internal economic cycle such as the output gap and the financial intermediation ratio. The results show that the coefficient on the effective corporate tax rate is negative, significant and quite stable. Further, as shown at the bottom of the table, the marginal effect of the effective corporate tax rate is around -0.05 which means that a 1% increase in the effective corporate tax rate should depress the creation of new firms by almost -0.05%. This effect is quite considerable as the average rate of firm creation varies around 1% to 3%. The next three columns of Table (3) show the result in the case of destruction of firms. These regressions use data on firms that in period t-1 were involved in production. The marginal impact of the effective corporate tax rate lies in between 0.1 and 0.52, being significant in all cases. In this case, a 1% increase in the effective corporate tax should increase firm destruction by a number between 0.1% and 0.52%, which are also relevant numbers if the consider that the average destruction of firms lies around 3% per year. Finally, table (4) provides the result in the case of firms involved in production. The result concerning the effective corporate tax rate is quite stable, being its marginal impact significant and around -1.2 which means that a 1% increase in the corporate tax rate should depress the fraction of firms involved in production by 1.2%, which is also a strong result as the average fraction of firms involved in production in our data set is 18.7%.

INSERT TABLES (3) AND (4) ABOUT HERE

6 Results and discussion

6.1 Results

We turn next to the results of the estimates obtained using the Heckman-Lee method and the Kyriazidou method. As a benchmark for our posterior results we initially report results from OLS and fixed effects panel data methods. These estimations do not correct for self selection and results are shown in Table (5). In the table, the first column presents the results when we include value added, the interest rate faced by the firm and depreciation rate plus the effective corporate tax rate as regressors. These variables correspond to the fundamentals in equation (5). Next, we include other aggregate variables that could also impact investment decisions, even when we keep the fundamentals in equation (5)constant. In that spirit, the second column includes business cycle variables while in the third column, rather than including business cycle variables, we include year dummies as controls that should capture any aggregate change in the environment that might impact investment decisions. As expected, value added has a positive and significant sign while the interest rate and the depreciation rate have a negative and significative coefficient. The coefficient on the effective corporate tax is not significant. Columns 4 to 6 of table (5) present results for the FE panel data estimation. These results are consistent with the OLS estimates.

INSERT TABLE (5) ABOUT HERE

Table (6) introduces the idea of potential selection on firms' participation decision and control for it by the use of the Heckman-Lee methodology. The table shows the same three specifications. The initial specifications exclude either business cycle variables, size dummies or year dummies. In the specifications, the second column corresponds to the selection equation while the first column corresponds to the intensive margin decision. In the selection equation, we also report the marginal impact of the effective corporate tax rate.

In our estimation of equation (9), as above, the variables value added, depreciation rate and interest rate are significant and have correct signs. In addition, the effective corporate tax rate is also significant and negative, as expected, and the point estimates indicate that a 1% increase in the corporate tax rate would depress capital accumulation by nearly 2% among firms already involved in production.

The estimates of the participation equation (11) show that the impact of the Herfindahl index and the Minimum efficient scale index on firm participation are positive and significant. As discussed above, the result that the coefficients on the Herfindahl index and the MES are positive may indicate that sub-sectors with larger HI or larger MES are also sub-sectors with higher margins. The corporate tax rate has quite a significant and stable coefficient. In fact, its marginal effect on firm participation is between [-1.2, -2] numbers quite similar to the ones reported in table (4), and indicating that an increase of 1% in the corporate tax rate would depress the fraction of firms involved in production by almost

1.2% and -2%. Finally, the coefficient of the inverse of the mills-ratio is positive and significant, meaning that there is a positive correlation between unobservables in the selection equation and the capital demand equation.

INSERT TABLE (6) ABOUT HERE

Table (7) allows for fixed effects in the estimations and relies on estimations obtained using the procedure by Kyriazidou (1997). The selection (participation) equation was estimated by means of panel data fixed effect logit method. We then present the estimates concerning the selection and the intensive margin equation from the estimation of equation (9). The results are similar to those described in table (6). Two main differences that appear in the table are (i) a smaller coefficient on value added (that ranges in the proximity of 0.3) and (ii) a negative coefficient on the median scale variable in the selection equation. The depreciation rate variable is significant with correct sign, and the effective tax rate is negative and significant, and the coefficient of similar magnitude to those reported in table (6), being in this case between [-0.58, -1.43].

INSERT TABLE (7) ABOUT HERE

Summing up, both methods that correct for self-selection in the firm's decision to participate in production show quite consistent results concerning the corporate tax. The results show that the corporate tax rate has a significant impact on both the firm's participation decision, as well as the capital stock accumulation decision for firms already involved in production.

6.2 Discussion

We have shown using different methods that the corporate tax rate has two different impacts on desired capital demand in the long run; on the one hand, it impacts the accumulation of capital for firms involved in production while on the other hand, it impacts the fraction of firms that might be involved in production. The sum of both effects might have a considerable impact on the long run capital stock of the economy as can be seen in figure (7). The figure shows the aggregate capital demand of the economy, which is equal to the sum of capital demands for all the firms in the economy.

INSERT FIGURE (7) ABOUT HERE

As shown in the figure, the higher is the tax rate the larger could be the user cost of capital that each firm faces, indicated by the movement from ν_1 to ν_2 in the figure.[8] As a result, if there were no change in the fraction of firms involved in production, the new equilibrium would be at ν_2^* and hence the capital stock would be depressed to K_2^*. However, as shown in our results, the larger is the corporate tax, the smaller is the fraction of firms involved in production. As such, the aggregate capital stock demand switches from K_1^d to K_2^d and the negative impact on capital stock is augmented and we end up with capital stock at K_2^{**}.

How large could these effects be? Following our discussion in section (3), let's suppose $ln(\epsilon)$ is distributed according to a cumulative distribution $G(\epsilon)$ with support $[\epsilon_l, \epsilon_u]$, where $\epsilon_l < \epsilon_u$. In that case, aggregate capital stock can be written as in:

$$K_t \equiv \int_{c_{it}}^{\epsilon_u} k_{it}(\tau, \epsilon) dG(\epsilon) \tag{12}$$

where c_{it} is defined as in (7). Note that an increase in the corporate tax rate would impact the capital stock as in [9]:

$$\frac{\delta K_t}{K_t}\frac{1}{\delta \tau} = \underbrace{-\sigma}_{intensive \quad margin} - S_{c_{it}} \underbrace{\frac{\delta c_{it}}{\delta \tau} dG(c_{it})}_{extensive \quad margin} \tag{13}$$

where $S_{c_{it}}$ is the fraction of capital stock in hands of the firm in the margin between production and remaining idle. Expression (13) indicates that the impact on aggregate

[8] Unless tax deductions arising from depreciation or debt and interest-rate payments were large enough to offset that effect.

[9] To obtain equation (13) we follow the next steps:

$$\frac{\frac{\delta K_t}{K_t}}{\delta \tau} = \int_{c_{it}}^{\epsilon_u} S_{it} \frac{\frac{\delta k_{it}}{k_{it}}}{\delta \tau} dG(\epsilon) - S_{c_{it}} \frac{\delta c_{it}}{\delta \tau} dG(c_{it})$$

where $S_{it} \equiv \frac{k_{it}}{K_t}$ is the fraction of total capital held by firm type i while $S_{c_{it}}$ is the fraction of capital held by the firm that is indifferent between producing or remaining idle. Also note that $\frac{\delta k_{it}}{k_{it}} \frac{1}{\delta \tau} = -\sigma$ and $\int_{c_{it}}^{\epsilon_u} S_{it} dG(\epsilon) = 1$. Then we obtain

$$\frac{\frac{\delta K_t}{K_t}}{\delta \tau} = -\sigma - S_{c_{it}} \underbrace{\frac{\delta c_{it}}{\delta \tau} dG(c_{it})}_{extensive \quad margin}$$

capital depends on (i) the intensive margin effect, which impacts firms in production, and (ii) the extensive margin effect, which corresponds to firms that exit - the term $\frac{\delta c_{it}}{\delta \tau} dG(c_{it})$-, this last term being weighted by the importance of the firms at the margin, measured by their capital stock holdings.

In economies where the firms at the margin hold a small fraction of capital stock, the impact of corporate taxation on capital stock arises mainly through the intensive margin effect, which would be in line with the general view in the literature. However, even in that case, our approach would be useful. As we have seen above, if we neglect the extensive margin mechanism in the empirical approach the estimates of the relevant effect (the intensive margin) could be biased. On the other hand, in economies in which the firm at the margin holds a considerable share of the capital stock, the importance of the extensive margin effect is twofold: (i) it allows for unbiased estimation of the effects and (ii) it gives an estimate of the impact of corporate taxation on the capital stock quite different than the usual intensive margin effect.

7 Conclusions

There is a large literature on the empirical analysis of capital stock and investment at the firm level. We provide another vision to that problem. Firstly, we focus on the impact of corporate taxation. Generally, the literature focuses on Tobin's q or on the user-cost as main determinants of investment. Obviously, corporate taxation is one of the components of Tobin's q and of a firm's user cost and therefore one would be able to determine the impact of corporate taxation by identifying the respective effects on a firm's investment. In our case, we focus on disentangle the effect of corporate taxation directly, through the use of a reduced form equation obtained from a setup similar to the traditional user cost of capital but in which we allow for the entry and exit of firms.

We follow this identification strategy because we observe a large variation in corporate taxation and in firm creation and destruction that might allow us to disentangle the impacts. Secondly, we incorporate the idea of creation and destruction of firms into the empirical analysis of investment determinants and note that, if we not consider that decision, we might obtain biased estimates. In this context, corporate taxation plays a crucial role as it impacts both the decision to participate in production and the investment decision of firms that have already decided to produce.

Our empirical exercise shows in fact that if we do not correct for self selection, the coefficient of corporate tax in the intensive margin decision is not significant. However when we correct for self selection either by the Heckman-Lee method or the Kyriadizou method, the coefficient becomes negative and significant as expected. In both methods the intensive margin impact is economically significant, as we find that a 1% increase in corporate tax might depress capital stock accumulation by between 1 and 2%.

A second result is that the impact of corporate taxation on a firm's decision to become involved in production is large; in fact our estimates indicate that a 1% increase in corporate tax rate might depress the participation of firms by almost 1.2% . In that sense, the impact of corporate taxation on aggregate investment does not arise simply from the impact on firms' decision to invest but mainly through the decrement in the number of firms involved in production, which depresses aggregate investment even if investment per firm remains relatively constant.

A Data Appendix

We describe next the construction of some of our data.

Deflators:

ENIA does not report plant level output prices, so they must be constructed to generate constant price variables. We used the 3 digit ISIC level deflator from INE's wholesale price indices, elaborated by Bergoeing, Hernando, and Repetto (2003). For robustness purposes, an alternative measure of deflators was built based on Yagui (1989). We then constructed a 4 digit ISIC level deflator, equal to a weighted average of 7 digit ISIC level product prices, using as weights the value added of the respective product at the 4 digits ISIC classification sub-sector over the whole manufacturing sector.

Capital Stock:

ENIA contains three kinds of capital: structures, vehicles and machinery. However, it only reports them since 1992. Therefore, for prior years, the capital series must be constructed. For that purpose, capital was built based on Bergoeing, Hernando, and Repetto (2003). First of all, investment must be generated. ENIA reports several forms of investment: purchases, sales, repairs and own production. Thus, investment expenditure in capital n, for period t, made by plant j is defined as:

$$I_{jt}^{n} = P_{jt}^{n} - S_{jt}^{n} + R_{jt}^{n} + O_{jt}^{n}$$

where I stands for investment, P represents real purchases of capital n, S is real sales of capital n, R corresponds to real repairs and reforms made to the capital n and O stands for real capital of type n produced by the plant itself for its own benefit. All the real variables are expressed in 1992 Chilean pesos.

Once the investment series are obtained, capital series can be constructed. However, the process is less direct than it seems because firms enter and exit the sample constantly, which creates the unbalanced nature of this panel. To deal with this issue, an algorithm was elaborated, using investment and depreciation for the three types of capital. The algorithm is:

1. If the plant was present during the whole period from 1979 to 1992, the law of motion of capital was used to pin down the value of the previous year's stock:

$$K_{j,t}^{n} = K_{j,t+1}^{n} - I_{j,t}^{n} + \Delta_{j,t}^{n}$$

where $K^n_{j,t}$ is the stock of capital n in period t accumulated by the plant j and $\Delta^n_{j,t}$ stands for the depreciation value of stock of capital n, for period t accumulated by plant j.

2. If the firm enters and exits repeatedly in the period 1979 to 1992, the previous step was implemented until the plant disappears at some point between 1979 and 1992. If the firm reappears early in the past, a regression was implemented to estimate the capital stock. Thus, the regression estimated was:

$$k^n_{j,t} = \beta_0 + \beta_1 y_{j,t} + \beta_1 l_{j,t} + \epsilon^n_{j,t}$$

which is a reduced form of a Cobb-Douglas production function.[10] $y_{j,t}$ is the value added by plant j in year t, $l_{j,t}$ is the total number of employees hired by plant j in year t, and $\epsilon^n_{j,t}$ is a random perturbation. The regression above was estimated for each type of capital, for each year from 1979 to 1991 and for each sub-sector at the 4-digit ISIC level, capturing the heterogeneity and the dynamic of the manufacturing sector and minimizing any aggregation effect. So, the capital stock was estimated using data on employment and value added of the missing capital stock firms, along with the estimates obtained. If, in a given year, the plant did not report data needed to estimate the regression above or if the firm did not reappear early in the past within the sample, no capital stock was estimated for that plant that year.

National Aggregate variables:

We also include some national aggregate control variables to capture changes at the macroeconomic level that might affect the plants' decision to invest. Some of these variables deal with domestic cycles and financial sector development. The "Output-gap" is the difference between the actual real GDP and the potential output, which is measured based on the de-trended GDP, calculated using the Hodrik-Prescott filter. This variable controls for the cyclical movements of output and investment. For the econometric implementation, a one period lag of this variable is used to avoid endogeneity issues. The variable "FIR" -Financial Intermediation Ratio- is the sum of bank deposits, mortgage debts and market value of stocks as a fraction of GDP. The source of this series is Díaz, Luders, and Wagner (2008). This variable is a proxy of financial development.

Foreign Aggregate variables:

[10]Hereafter, a lowercase letter means a natural logarithm of that variable.

In addition, our econometric estimations include foreign aggregate variables to control for external shocks that might influence firms' entry/exit decision or their investment decisions. These variables might have an important influence if we consider the fact that the sample is composed of many manufacturing plants involved in the tradable sector. Those influences are not captured by other included variables, so they must be incorporated. The variables intended to capture the foreign business cycle are the "US Industrial Production Index" and the "Chilean Terms of Trade".

B Methodological Appendix

B.1 Heckman-Lee method

We will assume initially that there are no individual effects in the system (9)-(11). In that case, potential correlation between the participation equation and equation (9) arises only through exogenous variables and through correlation between u_{it} and μ_{it}. In this case, our estimations are based upon:

$$ln(k_{it}) \quad = \quad x_{it}\beta + \mu_{it} \quad if \quad z_{it}\gamma + u_{it} \geq 0 \tag{A-1}$$

Following the traditional analysis in Heckman (1974), Heckman (1976), Lee (1978) and Lee (1983), we may write (A-1) as:

$$ln(k_{it}) \quad = \quad x_{it}\beta + \mathbb{E}_{\mu}\left[\mu_{it}|u_{it} > -z_{it}\gamma\right] + \varpi_{is}$$

where $\varpi_{is} = \mathbb{E}_{\mu}\left[\mu_{it}|u_{it} > -z_{it}\gamma\right] - \mu_{it}$. Further, given the distributional properties of (μ_{it}, u_{it}), we get the estimable equation -using Heckman's control function:

$$ln(k_{it}) \quad = \quad x_{it}\beta + \frac{\sigma_{\mu u}}{\sigma_u}\frac{\theta(\mathfrak{d}_{it})}{\Theta(\mathfrak{d}_{it})} + \varpi_{is} \tag{A-2}$$

where $\mathfrak{d}_{it} = \frac{z_{it}\gamma}{\sigma_u}$. Note that in (A-2) correlation between u_{it} and μ_{it} is controlled by the term $\sigma_{\mu u}$ while the set z_{it} might include x_{it}, providing another source of correlation between both equations, which is accounted for by the control function $\mathfrak{d}_{it}$. As it is usual in the application of this methodology, see Görg and Strobl (2003), we include in z_{it} at least one variable not included in x_{it} to improve identification.

B.2 Panel data analysis - Kyriazidou Procedure

Next, we will allow for individual effects in our estimations. Note that the conditional expectation of μ_{it} given the selection decision -which is the idea behind the inverse of the ratio mills in the Heckman-Lee method - now depends on the distributional properties of (u_{it}, α_i). Unlike the Heckman-Lee method, this conditional expectation cannot be computed from simple probit regressions and usually requires two-dimensional numerical integration to incorporate the distributional properties of (u_{it}, α_i). Verbeck and Nijman (1996) discuss the use of two control functions in the second step to account for the problem or the use of a maximum likelihood estimator for a random probit model with selection bias.

In our case, to correct for self selection, we will follow the procedure proposed by Kyriazidou (1997). This procedure, rather than using numerical integration, focuses on time differencing the data to remove the individual fixed effects while controlling for the sample selection. Applications of this method are Charlier, Melenberg, and van Soest (2001) and Askildsen, Baltagi, and Holmas (2003).

To consistently estimate our parameter of interest, the procedure relies on time differencing the capital demand equation, (9), for those observations in which $d_{is} = d_{it} = 1, t \neq s$ and for which there are data available.

$$ln(k_{i,t}) - ln(k_{i,s}) \quad = \quad (x_{it} - x_{is})\,\beta + (\mathbb{E}_\mu\left[\mu_{it}|d_{it} = 1, \zeta_i\right] - \mathbb{E}_\mu\left[\mu_{is}|d_{is} = 1, \zeta_i\right]) \quad \text{(A-3)}$$

where $\zeta_i = (x_{it}, z_{it}, x_{is}, z_{is}, \alpha_i, \eta_i)$. This step allows us to remove the individual fixed effect but the sample-selection might still be present and in equation (A-3) it corresponds to the term $(\mathbb{E}_\mu\left[\mu_{it}|d_{it} = 1, \zeta_i\right] - \mathbb{E}_\mu\left[\mu_{is}|d_{is} = 1, \zeta_i\right])$. Note that this term will be equal to zero if (1) the joint distribution of the error terms is time invariant and (2) $z_{it}\gamma = z_{is}\gamma$. Thus, if we were able to apply first differences to equation (9) when $d_{is} = d_{it} = 1, t \neq s$ and $z_{it}\gamma = z_{is}\gamma, t \neq s$, we could remove both the individual fixed effect and the sample selection bias.

In general, $z_{it}\gamma \neq z_{is}\gamma, t \neq s$, thus it might not be possible to apply the procedure. To bypass the problem, Kyriazidou (1997) proposes to weigh the observations to give more importance to those observations for which $z_{it}\gamma$ and $z_{is}\gamma$ are close.

To make the estimator operational , we follow the next steps. Firstly, we estimate equation (11) by a conditional logit model and we obtain consistent estimates γ_n. Secondly, using these estimates, we construct the weights on $(z_{it} - z_{is})\,\gamma_n$, and calculate the parameter of interest, $\widehat{\beta}_n$, by means of a weighted least-squares estimation as in:

$$\widehat{\beta}_n = \left[\sum_{i=1}^{N} \widehat{\Psi}_i (x_{it} - x_{is})'(x_{it} - x_{is}) d_{it} d_{is}\right]^{-1} \left[\sum_{i=1}^{N} \widehat{\Psi}_i (x_{it} - x_{is})'(y_{it} - y_{is}) d_{it} d_{is}\right] \quad \text{(A-4)}$$

where $\widehat{\Psi}_i = \frac{1}{h_n} K\left(\frac{(z_{it}-z_{is})\gamma_n}{h_n}\right)$ are "kernel" weights, that decline to zero as $|\,(z_{it} - z_{is})\,\gamma_n|$ increases and h_n is a sequence of bandwidths with the property $\lim_{n\to\infty} h_n = 0$.

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Figure 1: Fraction of firms involved in production

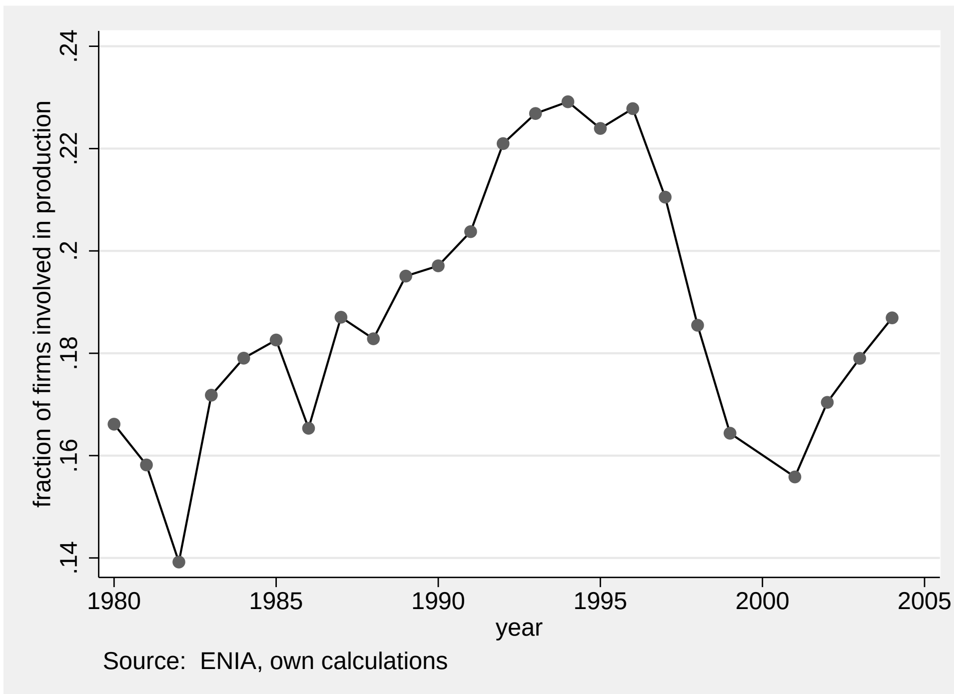
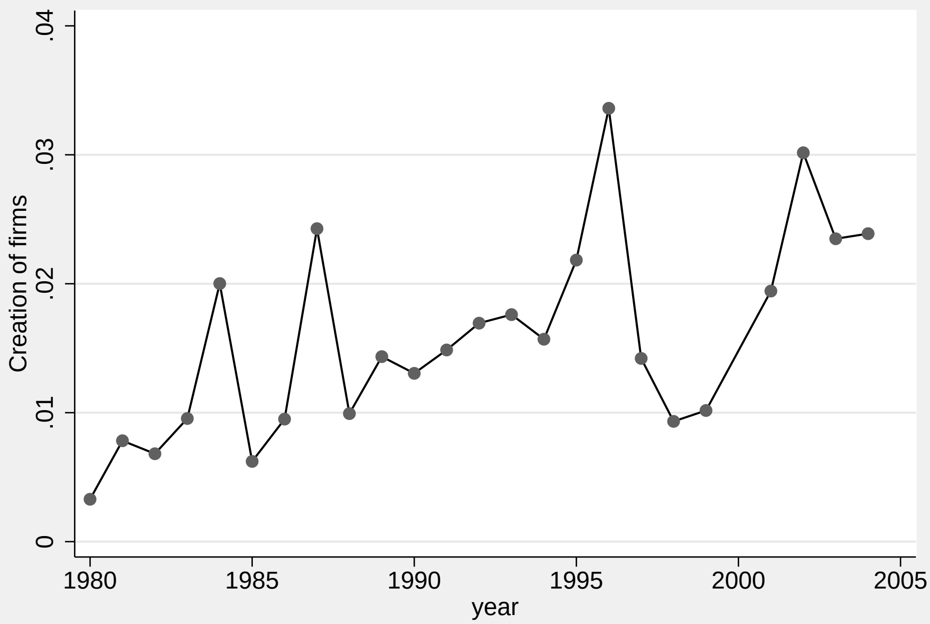
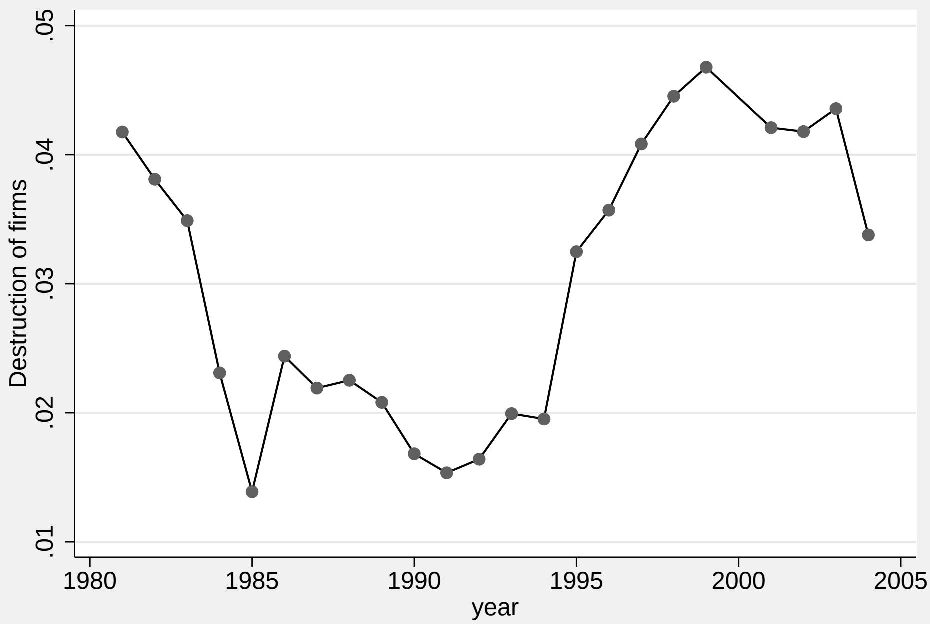


Figure 2: Creation of firms



Source: ENIA, own calculations

Figure 3: Destruction of firms



Source: ENIA, own calculations

Figure 4: Fraction of firms involved in production vis-à-vis Effective corporate tax rate

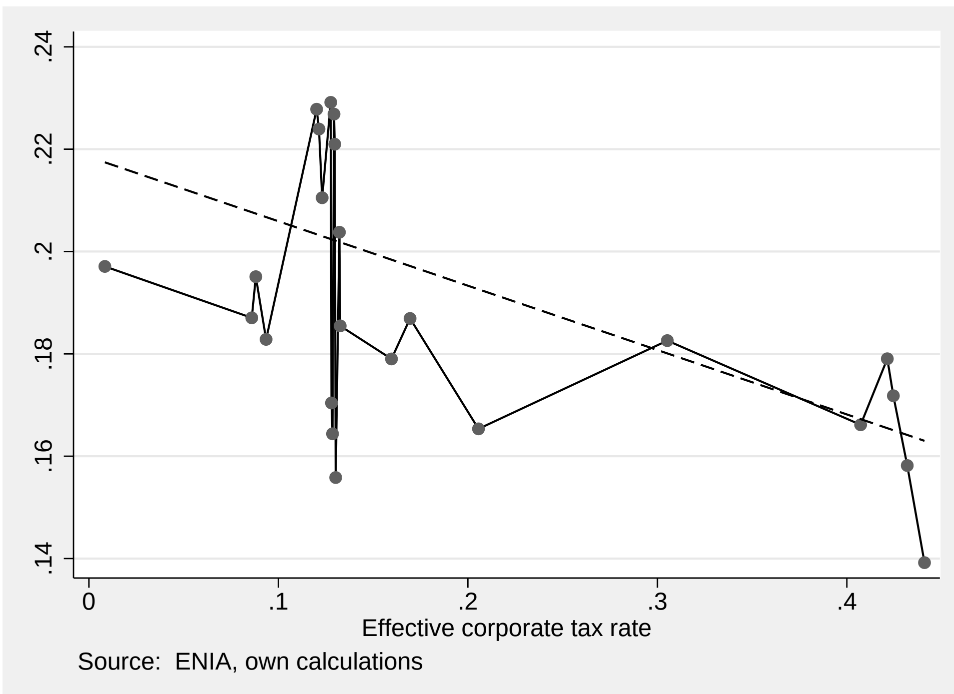


Figure 5: Creation of firms vis-à-vis Effective corporate tax rate

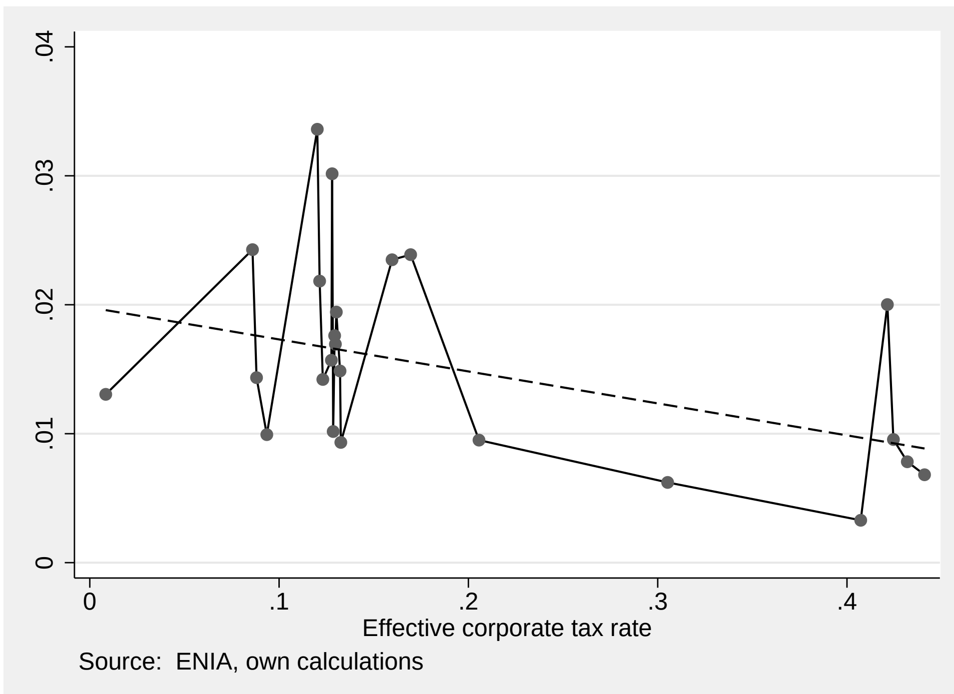


Figure 6: Destruction of firms vis-à-vis Effective corporate tax rate

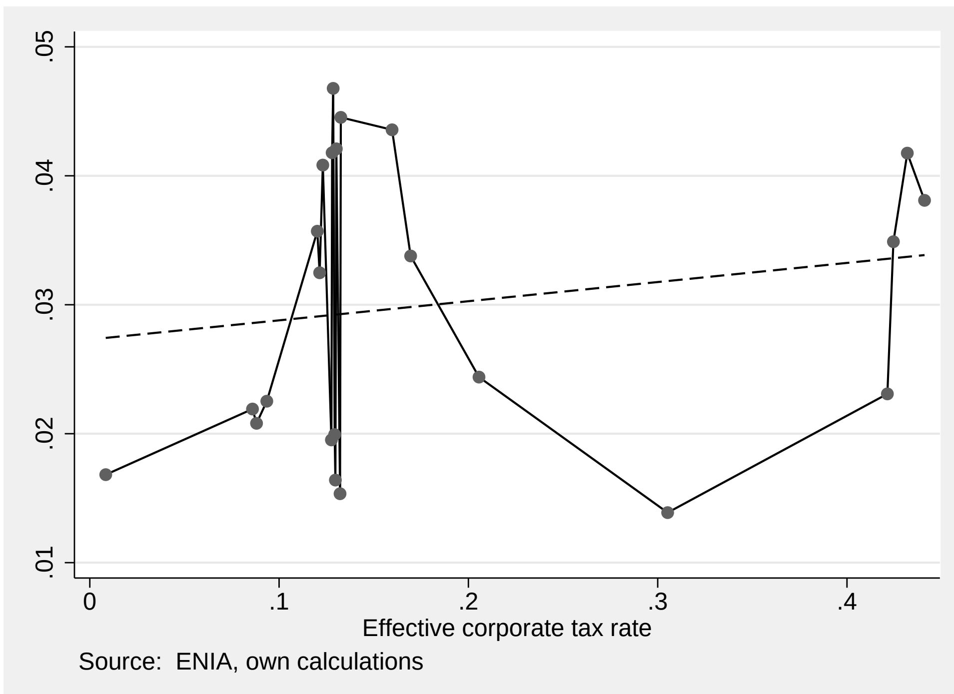


Figure 7: Aggregate Capital Demand

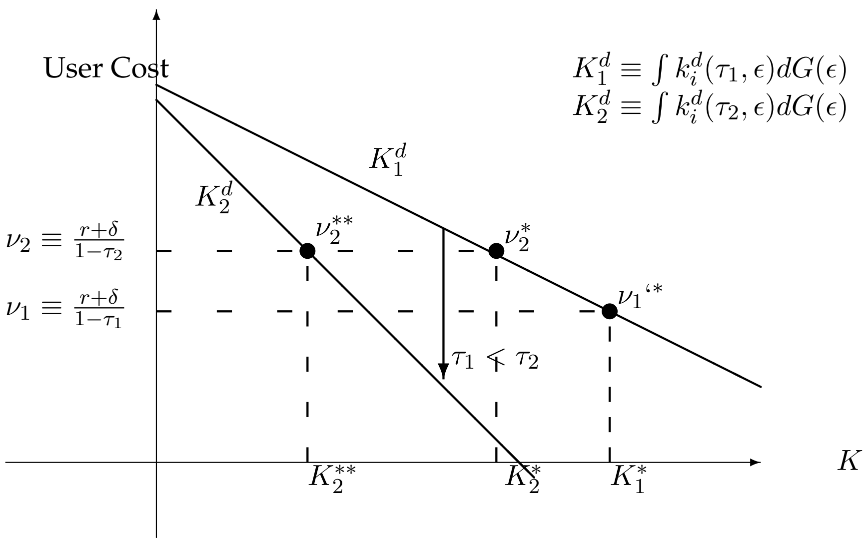


Table 1: Variables Used

Variable		Description	Source
Ln(Capital)		Natural logarithm of capital stock by firm accumulated last year	Own Calculations using ENIA
Effective Corporate Tax		Amount of corporate tax paid over value added	Own Calculations using ENIA and Chilean Code Law
Firm's Age		Age of the firm in the period t.	Own Calculations using ENIA
Size		1 if the number of employees of the plant is inside any of this intervals, 0 otherwise	ENIA
	Size 2	$10 < \text{Employees} < 19$	
	Size 3	$20 < \text{Employees} < 49$	
	Size 4	$50 < \text{Employees} < 99$	
	Size 5	$100 < \text{Employees} < 199$	
	Size 6	$200 < \text{Employees} < 499$	
	Size 7	$500 < \text{Employees} < 999$	
	Size 8	$\text{Employees} > 1000$	
Year		Current Year	Own Calculations
Output gap		Difference between Actual Real GDP and Potential GDP	Own Calculations using GDP data
Financial Intermediation Ratio		Sum of bank deposits, mortgages debts and market value of stocks (Percentage of GDP)	Díaz, Lüders and Wagner (2005)
US Industrial Production		US Industrial Production Index, 1992=100, Annual Totals	IMF's IFS
Federal Funds Rate		Federal Funds Rate (Percent per Annum)	IMF's IFS
Herfindahl Index		Sum of the squares of the market shares of each individual firm	Own Calculations using ENIA
Minimum Efficient Scale		Median plant size in terms of employment, calculated for each industry at the 4 digits ISIC classification Revision 2	Own Calculations using ENIA

Table 2: Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
Investment Equation Variables				
ln(Capital)	11.48	1.922	-0.500	22.036
Firms' Age	5.157	5.026	1.000	25.000
Corporate Tax	0.219	0.152	0.000	0.510
Size 1	0.002	0.045	0.000	1.000
Size 2	0.044	0.204	0.000	1.000
Size 3	0.059	0.236	0.000	1.000
Size 4	0.025	0.157	0.000	1.000
Size 5	0.015	0.122	0.000	1.000
Size 6	0.010	0.100	0.000	1.000
Size 7	0.002	0.049	0.000	1.000
Size 8	0.001	0.024	0.000	1.000
Selection Equation Variables				
Participation	0.187	0.390	0.000	1.000
Herfindahl Index	0.004	0.044	0.000	1.000
Minimum Efficient Scale	38.781	39.395	9.000	1565.000
National Aggregate Variables				
Output Gap	-533186.600	2076308.000	-3327422.000	3451314.000
Financial Intermediation Ratio	105.384	45.646	38.110	179.480
Foreign Aggregate Variables				
Industrial Production Index	54582.030	29494.320	11637.200	99998.000
Federal Funds Rate	6.738	3.628	1.130	16.380

Standard errors in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3: Creation and destruction of firms

	$\mathbf{1}(Creation)$	$\mathbf{1}(Creation)$	$\mathbf{1}(Creation)$	$\mathbf{1}(Destruction)$	$\mathbf{1}(Destruction)$	$\mathbf{1}(Destruction)$
Effective Corporate Tax	-9.12238***	-9.49416***	-9.61835***	1.32905***	0.54578***	0.52129***
	(0.05666)	(0.05810)	(0.05821)	(0.00601)	(0.00604)	(0.00604)
US Index		-0.00001***	-0.00000***		-0.00000**	0.00000***
		(0.00000)	(0.00000)		(0.00000)	(0.00000)
Terms of Trade		0.00194***	0.00682***		-0.00060***	0.00109***
		(0.00023)	(0.00036)		(0.00014)	(0.00030)
Output Gap			0.00000***			0.00000***
			(0.00000)			(0.00000)
FIR			0.00433***			0.00040
			(0.00033)			(0.00034)
Constant	-1.01934***	-0.89422***	-2.21299***	-1.25203***	-1.10723***	-1.43051***
	(0.00783)	(0.03094)	(0.08667)	(0.00606)	(0.02365)	(0.08132)
Observations	330124	321567	321567	73578	70352	70352
log-L.	-22150.55689	-21612.39478	-21398.92805	-25205.31411	-24896.96820	-24529.86376
Pseudo R^2	0.273	0.282	0.290	0.122	0.0409	0.0550
Marginal effect						
Effective Corporate Tax	-.0429964***	-.0563923***	-.0568285***	0.2718235***	0.1079865***	0.5212863***

Standard errors in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: Firms involved in production

	$\mathbf{1}(Participation)$	$\mathbf{1}(Participation)$	$\mathbf{1}(Participation)$
Effective Corporate Tax	-6.48550***	-6.39517***	-6.47176***
	(0.00489)	(0.00491)	(0.00491)
US Index		-0.00001***	-0.00000***
		(0.00000)	(0.00000)
Terms of Trade		0.00543***	0.01242***
		(0.00008)	(0.00014)
Output Gap			-0.00000
			(0.00000)
FIR			0.00757***
			(0.00014)
Constant	-0.05653***	-0.48152***	-2.39952***
	(0.00264)	(0.01120)	(0.03618)
Observations	405782	392043	392043
Pseudo R^2	0.342	0.351	0.362
Chi^2	135729	132850	137014
log-L.	-1.30492e+05	-1.23038e+05	-1.20956e+05
Marginal effect			
Effective Corporate Tax	-1.145175 ***	-1.26547***	-1.284843***

Standard errors in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5: Capital demand

VARIABLES	(1) Pooled-OLS	(2) Pooled-OLS	(3) Pooled-OLS	(4) FE	(5) FE	(6) FE
Log(Value added)	0.95070***	0.77114***	0.77256***	0.49940***	0.36767***	0.37091***
	(0.00276)	(0.00446)	(0.00445)	(0.00382)	(0.00433)	(0.00432)
Effective Corporate tax	-0.04709	-0.00233	0.01706	-0.06440***	-0.03700*	-0.01961
	(0.01573)	(0.01506)	(0.01500)	(0.02527)	(0.02529)	(0.02440)
depreciation rate	-0.02888***	-0.02711***	-0.02711***	-0.00945***	-0.00837***	-0.00846***
	(0.00407)	(0.00392)	(0.00391)	(0.00247)	(0.00236)	(0.00234)
Interest rate	-0.02400***	-0.02468***	-0.02481***	-0.00859***	-0.00863***	-0.00865***
	(0.00172)	(0.00166)	(0.00165)	(0.00113)	(0.00108)	(0.00107)
Firms' age		-0.00725***	-0.00700***		0.00787***	0.00822***
		(0.00106)	(0.00106)		(0.00155)	(0.00155)
Size Dummies		YES	YES		YES	YES
Business Cycle variables		YES			YES	
Year Dummies			YES			YES
Observations	52757	52458	52458	52757	52458	52458
Number of Groups				8037	7988	7988
Chi-squared				17150	22868	23725
ll	-78184.74962	-75793.42317	-75645.59908			

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05

Table 6: Heckman-Lee method

VARIABLES	(1) log(Capital)	(2) $\mathbf{1}(in)$	(3) log(Capital)	(4) $\mathbf{1}(in)$	(5) log(Capital)	(6) $\mathbf{1}(in)$
Log(value added)	0.78241***		0.78222***		0.77530***	
	(0.00457)		(0.00457)		(0.00446)	
Effective Corporate tax	-2.53399***	-10.97550***	-2.02057***	-10.97550***	-1.75955***	-11.55356***
	(0.24691)	(0.02411)	(0.27162)	(0.02411)	(0.23249)	(0.02364)
depreciation rate	-0.02630***		-0.02632***		-0.02707***	
	(0.00394)		(0.00393)		(0.00390)	
Interest rate	-0.02462***		-0.02475***		-0.02481***	
	(0.00166)		(0.00166)		(0.00166)	
Year Dummies					YES	YES
Firm's age	0.00894***	0.12434***	0.00666***	0.12434***	0.00410*	0.12516***
	(0.00185)	(0.00108)	(0.00197)	(0.00108)	(0.00167)	(0.00113)
Size Dummies	YES		YES		YES	
Business Cycle	YES	YES	YES	YES		
Median Scale		0.00064***		0.00064***		0.00100***
		(0.00015)		(0.00015)		(0.00016)
Herfindahl Index		1.29226***		1.29226***		1.19315***
		(0.11798)		(0.11798)		(0.12111)
Inverse ratio Mills	0.27780***		0.23617***		0.20336***	
	(0.02589)		(0.02851)		(0.02356)	
Marginal Impact Corporate tax		-2.637539***		-2.637539***		-1.24348***
Observations	161709	161709	161709	161709	165346	165346
Chi-squared	350955	350955	357931	357931	387268	387268

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05

Table 7: Kyriadizou Procedure

VARIABLES	(1) log(Capital)	(2) $\mathbf{1}(in)$	(3) log(Capital)	(4) $\mathbf{1}(in)$	(5) log(Capital)	(6) $\mathbf{1}(in)$
Log(value added)	0.42666***		0.34712***		0.31678***	
	(0.00948)		(0.01057)		(0.01048)	
Effective Corporate tax	-0.58136*	-15.41773***	-1.43471***	-6.68508***	-0.95909***	-6.78078***
	(0.22915)	(0.13155)	(0.24036)	(0.13127)	(0.25073)	(0.11687)
depreciation rate	-0.08643***		-0.08610***		-0.08456***	
	(0.01367)		(0.01358)		(0.01338)	
Interest rate	-0.00004		-0.00001		-0.00002	
	(0.00107)		(0.00107)		(0.00105)	
Firm's age		-0.25827***	0.01390***	-0.06744***	0.04131***	-0.00295
		(0.00416)	(0.00127)	(0.00795)	(0.00193)	(0.00719)
Size Dummies			YES		YES	
Business Cycle			YES	YES		
Year Dummies					YES	YES
Median Scale		-0.02685***		-0.00767***		-0.00269*
		(0.00076)		(0.00111)		(0.00109)
Herfindahl Index		0.96621		1.70374*		1.43558
		(0.62415)		(0.80503)		(0.77774)
Observations	27515	141638	27515	133069	27515	141638
Log-Likelihood	-40006.23	-30253.95	-39742.08	-14840.82	-39170.19	-16225.39

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05

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