INSTITUTO DE ECONOMÍA

TESIS de DOCTORADO

2009

Empirical Essays on the Behavior of Firms under Credit Constraints

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Empirical Essays on the Behavior of Firms under Credit Constraints

por

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Esta tesis se presenta como requerimiento parcial
para optar al grado de

Doctor en Economía

Instituto de Economía
PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE

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2009

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01 de junio de 2009

Abstract

Empirical Essays on the Behavior of Firms under Credit Constraints

by

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I study the behavior of firms with credit constraints in two dimensions: (i) the incentives of firms to evade or avoide taxes when external financing conditions worsen; and (ii) the effect that monetary conditions have on investment of firms with heterogeneous degrees of access to external financing. In my first essay I use a model to relate firms tax evasion or avoidance with the cost of credit. My main hypothesis is that firms evade more taxes when the costs of credit rises. I present empirical evidence of my hypothesis using a sample of chilean firms. In my second essay, I develope a model in the context of the credit channel literature, that predicts larger investment responses to monetary conditions among firms with better access to credit, which is the opposite to the common view that smaller firms with a poor access to credit are more sensitive to monetary conditions. I also present supporting empirical evidence that firms with better access to credit markets are also more sensitive to monetary conditions, using a sample of chilean firms, and four different measures of access to credit.

Finally, in my third essay I show with Monte Carlo simulations that when having

several subsets of instruments available to estimate linear models with time series or panel data, there is a large chance to find significant false evidence. My suggestion is to complement evidence based on p-values with theoretical arguments and the estimation of less structured models, like non parametric or semi parametric estimations, as I do in essays one and two.

Francisco Gallego
Chair

Resumen

Empirical Essays on the Behavior of Firms under Credit Constraints

por

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Doctor en Economía, Pontificia Universidad Católica de Chile

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Estudio el comportamiento de firmas con restricciones de crédito en dos dimensiones: (i) los incentivos a evadir o eludir impuestos cuando empeoran las condiciones de financiamiento externo; y (ii) el efecto que tiene las condiciones monetarias sobre la inversión de firmas heterogéneas en su acceso a financiamiento externo. En mi primer ensayo, uso un modelo para relacionar la evasión o elusión de impuestos con el costo del crédito. Mi hipótesis es que las firmas aumentan sus niveles de evasión cuando aumenta la tasa de interés. Presento evidencia empírica para apoyar mi hipótesis usando una muestra de firmas chilenas. En mi segundo ensayo, desarrollo un modelo en el contexto del canal de crédito, que predice una mayor sensibilidad de la inversión entre las firmas con mejor acceso al crédito, lo contrario a la visión común de que las firmas con un peor acceso al crédito son las más sensibles a las condiciones monetarias. También respaldo mi hipótesis con evidencia empírica usando una muestra de firmas chilenas. Finalmente, en mi tercer ensayo, muestro usando simulaciones de Monte Carlo que cuando se tienen varios subconjuntos de

instrumentos disponibles para estimar modelos lineales en series de tiempo o datos de panel, existe una alta probabilidad de encontrar evidencia significativa falsa. Mi sugerencia es complementar la evidencia empírica basada en valores p con argumentos teóricos y estimando modelos menos estructurados, como las estimaciones no paramétricas o semi paramétricas, como hago en mis ensayos uno y dos.

Francisco Gallego
Profesor Guía

a mi familia.

Contents

Acknowledgments

I wish to express my gratitude to my adviser, Francisco Gallego for all his helpful comments and support during the developement of this dissertation. The experience he shared with me has been of great importance for my professional career. I also want to thank the members of my committee, Rodrigo Vergara and Borja Larraín for their time and wise advice, as well as Roberto Álvarez for his time and goodwill.

I want to thank my family, specially my parents Celso and Elena for unconditional support and patience. I am also grateful to my beloved girlfriend Jennyffer who gave me energy and motives to finish this enterprise.

I thank my colleagues and friends for all their time, concern and advice. Among them I would like to mention Ricardo Guzmán, Louis de Grange, Carmen Garcés and my classmates, many of them now distinguished practitioners.

Finally, I want to thank José Manuel Robles for giving me the possibility to continue my studies, as well as his support to finish this dissertation.

Chapter 1

Essay 1: Credit Restrictions and Corporate Tax Avoidance: Evidence from Chile

1.1 Introduction

Theoretical models on corporate tax evasion link different corporate governance problems with the decision to evade taxes (Crocker and Slemrod, 2005; Chen and Chu, 2005; Joulfaian, 2000; Wang and Conant, 1988). Empirical literature on tax evasion has focused more on personal tax evasion rather than corporate tax evasion, mainly due to the availability of micro data. Slemrod (1985) finds that personal tax evasion in the United States is significant, but fairly small, while Joulfaian (2000) finds a significant corporate tax evasion and, furthermore, that evasion is related to the managerial preferences related to evasion. Slemrod (2007) offers a review of the theoretical and empirical literature of the economics of tax evasion. In this paper I explore a new dimension of tax evasion or tax avoidance that has not been addressed in previous literature. It is the relationship between corporate tax evasion or avoidance and firm's financial needs. Firm's cash flows belong to share holders, bond holders and the State through taxes. Corporate finance has widely focused on how firms find financing from share holders and bond holders, but, not from the State by means of evasion. Using a sample of Chilean firms, I find that there is a significant relationship between the financial conditions that firms are facing, and their tax payments. Despite the nature of my data do not allow to distinguish between tax evasion or tax avoidance, the nature of both are similar and even conceptually difficult to differenciate. Besides, Jorrat and Serra (1999) find that corporate tax evasion in Chile is widespread, thus my findings are likely to consist in a combination of both evasion and avoidance. Hereafter, I treat both concepts indistinctly. My sample of firms include firms that are relatively large compared to firms not included in the sample, but it does not imply that firms in my sample are less prone to evade, indeed, international evidence finds that larger firms evade more than smaller firms (Slemrod, 2007).

Using a simple model of tax evasion, I pose two new hypothesis for the behavior of the relationship between interest rates and tax evasion. The first hypothesis is that the interest rate - tax evasion relationship should be stronger when firms have a better access to credit markets, and it should be weaker when firms have a better cash position.

I confirm the raw evidence of figure 1 and find some supporting evidence of the two hypothesis derived from the model, using three econometric approaches. I first estimate the marginal effect of the interest rate on firms' taxes, including controls as sales and financial expenditures among others, and find a significant negative response for most specifications. In the second approach, I construct counterfactuals for taxes that each firm would pay if it were not evading, and use them to construct measures of evasion. Again, for most specifications, I find that there is a significant positive response of evasion to the interest rate, confirming the previous findings. Last, I run a type of difference in difference estimation of the effect of credit conditions on for firms with heterogeneous access to credit markets and cash positions around one episode of tight money and one episode of loose money, in the spirit of Feldstein (1995a) and Feldstein (1995b).

1.2 A Model of Credit Restrictions and Tax Evasion

As in other models of tax evasion, in my model, there is trade-off between the benefit of evading and the cost of being caught (Yitzhaki, 1974; Crocker and Slemrod, 2005; Goerke, 2007). In my model the benefit of evading is to have more liquidity available, allowing the firm to increase its profits and also the cash flow to the owners. The cost is given by a fine, which is increasing in the amount evaded, and the probability of being caught.

A firm's cash flow depends on the amount of working capital or investment performed during the period. Let us assume that the net margin generated by the firm is described by the function $M(I)$, with $M' > 0$, $M'' < 0$ and $\lim_{I \to 0} M'(I) = \infty$, which is similar to traditional production functions.

Firms need to find funds to finance their working capital or investment I. Firms can not borrow all the funds they would like to, due to the information problems, characteristics in credit markets (Bernanke, Gertler and Gilchrist, 1996; Stiglitz and Weiss, 1981 and 1992). It means that firms are credit rationed, in the sense that at the equilibrium interest rate, the marginal benefit of borrowing is larger than the marginal cost for firms, but for lenders it is not convenient to raise the interest rate of the loans, but, instead they limit the size of the credit. I consider that the credit restriction is given by the amount of fixed capital. Similar to Bernanke, Gertler and Gilchrist (1996) or Kiyotaki and Moore (1997) let us consider that the credit constrain is given by:

$$B \leq \frac{K}{1+i}$$

where i is the interest rate. I consider the case where the firm is credit constrained, and the above restriction is active. One feature of a credit constrained firm is that marginal investment within the firm is more profitable than marginal investment outside of it:

$$M'(\cdot) > 1+i \tag{1.1}$$

Firms have one further source to raise funds from: borrowing from the government by reducing their tax payment. Cash flows of firms have three types of owners: shareholders, creditors and the government through taxes. Literature on corporate governance has focused mainly on how firms raise funds from shareholders and creditors. I consider a third mandatory party, which is the State, and how the decision to evade may be motivated by the firm's need to raise funds. Let us call E the amount of funds raised evading taxes. Considering evasion, the total funds available to invest is now given by:

$$I = \frac{K}{1+i} + E + C \tag{1.2}$$

where C are the funds raised internally by firms.

As in previous work on tax evasion, there is a cost of evading. There is a fixed probability P of being caught evading, and a fine $F(E)$, with $F' > 0$, If the firm is caught evading taxes. Because of condition (1.1), I assume that firms would rather invest the evasion E, instead of distributing it as cash to shareholders. Firms decide the optimal evasion solving the following maximization problem:

$$\max_{\{E\}} M(I)(1-P) + (M(I) - F(E))P$$

$$s.t.$$

$$I = \frac{K}{1+i} + E + C$$

where $M(I)$ is the cash flow for shareholders if the firm is not caught evading, while $M(I) - F(E)$ is the cash flow if it is found evading. The first order condition of the problem is:

$$\frac{\partial}{\partial E} = M'(I)(1-P) + \left(M'(I) - F'(E)\right)P = 0$$

solving, we get the well know condition that the marginal cost to evade must equal the marginal benefit:

$$M'(I) = PF'(E) \tag{1.3}$$

where the LHS of equation (1.3) is the marginal benefit, while the RHS represents the marginal cost of evading.

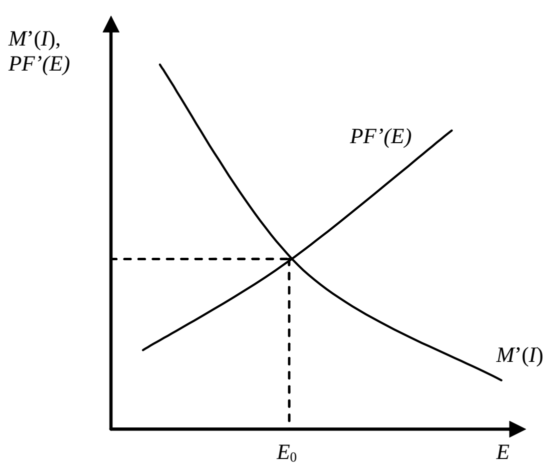

Figure 2

Figure 2 shows the equilibrium implied by condition (1.3). Note that an internal solution requires that $PF'(0) < M'\left(\frac{K}{1+i}\right)$, otherwise, the firm would decide not to evade. This framework is also consistent with tax avoidance, as long as there is an increasing cost to avoid further taxes, which is indeed, a sensible assumption.

1.2.1 Evasion and Credit Conditions

From the model, we can obtain a link between credit conditions and the rate of evasion. Let us consider for instance, a raise in the interest rate i. When the interest rate increases, the credit conditions for firms worsen and their credit constrain becomes tighter. In terms of the model, curve $M'(I)$ moves up to $M'(I')$ due to the reduction of the value of I to, say $I' > I$, for each level of E. As shown in Figure 3, the new equilibrium is with a higher evasion $E_1 > E_0$.

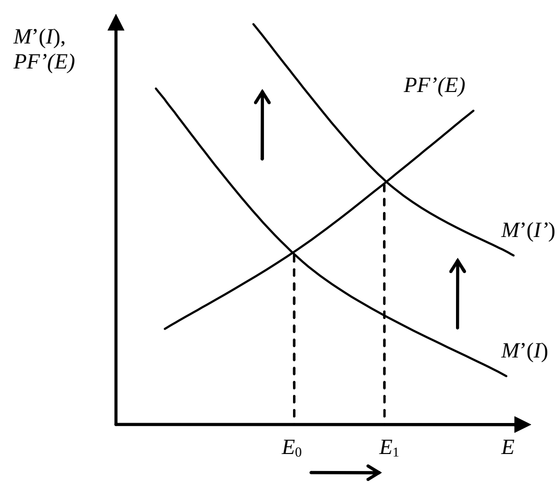

Figure 3

One implication of the model is regarding the relationship between the sensibility of evasion to the interest rate and the level of internal funds C. With other things remaining equal, firms with lower values of C, face tighter credit restrictions (1.2) and will also have an evasion more responsive to the interest rate because $M'' < 0$. It means than an equal change in C has a larger impact on the value of M' when C is lower, for equal levels of B and E in equation (1.2).

In my second essay, I develop a model where the external credit restriction of the firms, B, are given by:

$$B = \frac{K}{(1+i) - \gamma(1+r)} \tag{1.4}$$

where $0 < \gamma < 1$ is the seizable portion of the project's cash flow, while r is the real expected return of the project. According to this specification, credit restricted firms have a more sensitive value of B, the larger the value of γ. As parameter γ is higher for firms with a better access to the credit markets, I expect that firms with better access to credit markets will have a more sensitive external credit restriction to the interest rate, and thus will have and evasion E which is also, more sensitive to the interest rate.

I test for three empirical implications of my evasion model. The first is that evasion has a positive relationship with the interest rate. The second is that the relationship between evasion and the interest rate should be decreasing in the cash position of the firm. That is, firms with a better cash position should have a weaker relationship between evasion and the interest rate. And last, the relationship between evasion and the interest rate should be increasing in the degree of access to the credit markets. It is, that among firms facing credit restrictions, those firms with better access to the credit markets will present a stronger relationship between evasion and the interest rate.

1.3 Evidence

It is difficult to test corporate tax evasion, in general. Even though, I can test for a behavior consistent with evasion (or avoidance) related to credit conditions faced by the firms. Indeed, I find a significant relationship between credit conditions and both taxes paid by firms, and measures of evasion that I construct, suggesting that firms also use the State as a source of financing. For the case of Chile Jorratt and Serra (1999) estimate that corporate tax evasion is 41.7% of the theoretical tax collection. It means that corporate tax evasion is widespread in Chile, supporting my interpretation of the findings, that firms evade when they face tighter financial needs.

The data consists of earnings reports of stock companies listed at Superintendencia de Valores y Seguros from 1991 to 2005. I removed from the sample, firms in the following sectors, according to the ISIC sector classification: Financing, Insurance, Real Estate and Business Services; Community, Social and Personal Services; and Activities not Adequately Defined. The reason to remove these sector is that firms within them may not be expected to behave according to my model when facing rises in the interest rates. Firms in the financial sector are subject to a close monitoring from the IRS, and higher interest rates also mean higher incomes for them, thus they do not have a clear incentive to evade taxes. On the other hand, most firms among the Community, Social and Personal Services sector do not pay income taxes for beeing non for profits. I also removed not classified firms from the sample. It left 85 firms out of 175 firms that survived the entire period. Firms in the sample are relatively large compared to smaller business that do not report public balance sheets. The size of the firms in the sample is not a drawback for my evidence for two reasons: first, large firms are also those with the higher rates and frequency of evasion. Slemrod (2007) and Hanlon, Mills and Slemrod (2007) show that firms above \$10 millions of assets represent 83.3 percent of corporate tax evasion in the U.S. while the largest companies (those with assets greater than \$5 billions) had the greatest percentage of firms with tax deficiency (74 percent); and second, to validate my hypothesis I do not need that firms necessarily evade. Avoidance is also consistent with my hypothesis as long as avoidance is costly.

I use three econometric approaches to test the implications of my model. The first approach, takes firms' taxes as the dependent variable and estimates the marginal effect of the interest rate on taxes, for different controls and specifications. In the second approach, I construct measures of evasion, and estimate the marginal effect of the interest rate on these measures of evasion, again including different controls and several specifications. Last, I estimate the difference in the effect of the interest rate on taxes among firms with heterogeneous access to credit markets and cash positions.

For all the econometric strategies arises the problem of the scale in which the variables are measured. Large firms are several orders of magnitude larger than smaller firms in the sample. It can be a problem when estimating linear relationships. One common solution to the scale problem is to measure variables in logarithms. The problem of doing so is that my dependent variable (tax) takes both positive and negative values. For this reason I use, for each estimated equation, three measures of the variables: (i) in levels, measured in real 1998 CL\$ 100,000; (ii) normalized variables by firm level mean and variance, such that for each firm in the panel, the variables have zero mean and unit variance; and (iii) in logarithms, dropping the observations with negative values of tax. I do not consider normalizing by total assets or by sales, because the normalized variable may not represent the behavior of taxes. Both assets and sales are expected to be negatively related to the interest rate, thus even if my hypothesis were true, the ratio of taxes to assets or sales may not be negatively related to the interest rate or the relationship is expected to be weaker.

For the interest rate, I use the yearly average real interest rate of the financial system for investments between 90 to 365 days published by the Central Bank of Chile (Tasas Medias De Interés Del Sistema Financiero, Colocaciones, 90 - 365 días, Reajustables en U.F.), as the measure of the cost to raise funds for firms from the financial system.

1.3.1 Taxes and Interest Rate

In the first econometric approach, I estimate the relationship between the interest rate and taxes paid by firms, including sets of control variables. The controls consist of the corporate tax rate, the GDP growth and two firm specific controls. The firm specific controls are the level of sales and firms' financial expenses. The reason to include these firm specific controls is that when the interest rate raises, consumption is likely to decline together with firms' sales. As a consequence, profits would decline as well as corporate tax payments. More direct is the effect of financial expenses: if the interest rate raises, firms would have higher costs of financing. As a consequence, both profits and taxes decline. The basic regression model is:

$$Tax_{it} = \beta_0 + \beta_1 Rate_t + \beta_2 X_{it} + \mu_i + v_{it} \tag{1.5}$$

where Tax_{it} is tax payments, $Rate_t$ is the interest rate, X_{it} is the vector with the subsets of control variables, μ_i is a firm specific effect and v_{it} is an *iid* shock. I do not include time dummies because it would wipe the variable *Rate* that does not have between variation, but I include a time trend among the specifications as a control. I also estimate a dynamic version of (**??**):

$$Tax_{it} = \beta_0 + \rho Tax_{i,t-1} + \beta_1 Rate_t + \beta_2 X_{it} + \mu_i + v_{it} \tag{1.6}$$

I estimate the dynamic equations (1.6) by GMM using the collapsed Arellano and Bond (1991) type instrument matrixes (Roodman, 2007).

The effect of financial expenses on the tax base is direct. For this reason, I also run a version of equation (1.5) but where the dependent variable, tax, is net of financial expenses. Financial expenses are among the cost items considered to calculate firms' revenues:

$$Tax = \tau \left(Incomes - Costs \right)$$

where τ is the corporate tax rate. In this version of equation (1.5) I use the dependent variable *Taxes Without Financial Expenses*:

$$TWFE_{it} = Tax_{it} + \tau_t * FinancialExpenses_{it}$$

I also test for the behavior of the marginal effect of interest rates on taxes among heterogeneous firms. According to my model, I expect the effect of the interest rate to be smaller when the firm has a better internal financing position, and it should be larger when the firm has a better access to credit markets. I use two measures of internal financing position and two measures of access to the credit markets. For internal financing position I use the ratio of cash balances to total assets (*Liquidity*) and the ratio of retained earnings to total assets (*Ret.Earn.*). For the measures of access to credit markets I use a variable of bank dependence and the size of the firm, measured as the logarithm of fixed assets, plus cumulated depreciation (*Size*). The variable of bank dependence is related to the possibility that firms have to obtain financing from sources different from banks. In particular I defined a firm as *bank independent* (*Bank*) if during the sample period the firm issues bonds, and as bank dependent if the firm does not issue any bond. The regression equations is:

$$Tax_{it} = \beta_0 + \beta_1 Rate_t + \beta_2 Rate_t * Interaction_{it} + \beta_3 X_{it} + \mu_i + v_{it} \tag{1.7}$$

where the interaction variable may be *Liquidity*, *Ret.Earn.*, *Bank* or *Size*. For an easier interpretation of the estimates of parameter β_1 of equation (1.7), I measure variables *Liquidity*, *Ret.Earn.* and *Size* in deviations from their overall sample means.

I estimate equations (1.5), (1.6) and (1.7) using fixed effects regressions when using variables measured in real CL$ or in logarithms, while when using variables normalized by mean and variance I used the random effect estimator, because there is no variance between group means by construction. Tables 1 through 3 show the estimates of equations (1.5) through (1.7). The first and main hypothesis of the model predicts a negative relationship between taxes and the interest rate. All specifications of tables 1 through 3 support my first and main hypothesis. The estimates suggest the a one percent rise in the interest rate, produces a nearly ten percent decrease in firms' tax payments.

With respect to the relationship of the marginal effect of interest rates on taxes and firms' cash position and access to credit (my other two hypothesis), the estimates of tables 1, 2 and 3 in columns 5 through 8 show the results. First, regarding the interaction of the interest rate-tax relationship, with the two measures of cash position, I find that the interaction of the interest rate with retained earnings is significant and has the expected sing in all estimations, while the interaction with variable *Liquidity* is not significant when measuring variables in levels, but it is significant and has the expected sign in the other two specifications. On the other hand, the interaction of the interest rate - tax relationship with the measures of access to credit, has the expected sing most of the time, but it is only significant (with the expected sign) in one specification of table 3.

The estimates of the relationship between interest rates and tax payments using variables measured in constant CL$, imply that after a one percent increase in the interest rate, each firm reduces its tax payments, on average, in nearly 100.000.000 CL$ of year 2000. The average tax payment in the sample is around 900.000.000 CL$ of year 2000, thus tax payments decrease an average of 11.11% according to estimates of table 1, after a 1% increase in the interest rate. The estimates using normalized variables in table 2 of the same parameter are nearly 4% of tax payment's standard deviation, which corresponds to 120.000.000 CL$, or a 13.33% of average tax payments. Last, the estimates in logarithms of table 3, are interpreted as percentage changes and range between 11% to 13%. The estimates are consistent, and imply similar marginal effects of the interest rate on tax payments.

A marginal effect of around 12% on tax payments after a 1% change in the interest rate may seem too large. But, the volatility of the dependent variable is large indeed. The standard deviation of tax payments is 3.34 times its mean. Even when considering only within variation of the dependent variable, it is 2.67 times its mean value. In this context, the estimated response of taxes to the interest rate is not particularly large. In fact, the estimates of table 2, indicate a response of only 4% of the standard deviation of tax payments.

I also run regressions to estimate the marginal effect of the interest rate on operational and nonoperational margins. It would give an idea of how firms may be understating their margins to pay lower taxes. The regression equation is:

$$M_{it} = \beta_0 + \beta_1 Rate_t + \beta_2 X_{it} + \mu_i + v_{it} \tag{1.8}$$

where M may be the operation or nonoperation margins and X_{it} is a control variable. When the dependent variable is the operational margin, the control variable is the GDP growth, to control for the level of activity. When the dependent variable is the nonoperational margin, the control variable is the level os sales. As before I measure variables in constant CL$, normalized by mean and standar deviation and in logs. Table 4 shows the estimates of equation (1.8). As expected, the estimates of β_1 in equation (1.8) indicate that the nonoperational margin is more responsive to the interest rate than the operational margin when the variables are measured in constant CH$ and in logs, but not with normalized variables (columns 3 and 4 of table 4). The estimates of β_1 using normalized variables are fairly similar. But, since the standar deviation relative to the mean of the nonoperational margin is nearly three times larger than the same ratio for the operational margin, the estimates in rows 3 and 4 of table 4 imply that the proportional response, relative to the mean, of the nonoperational margin is three times larger than the response of operational margin. Accounts related to nonoperational margins are more difficult to audit, and it is likely that the marginal evasion occurs mainly through these accounts. Note, that it does not mean that most of total evasion occurs via understating nonoperational margins, it may be the case that most of the evasion occurs understating operational margins, but most marginal evasion occurs through nonoperation margins.

1.3.2 Constructing a Measure of Evasion

To build a measure of evasion I first constructed a measure of the taxes that each firm would pay if it were not evading taxes. I made the estimation of the taxes that would pay the firm that does not evade based on firms' industrial sector, the year and firms' performance. I constructed two types of counterfactuals for tax payments, all of them based on the taxes paid by firms when behaving as if they were not evading. The first counterfactual (counterfactual 1) is based on the following equation:

$$Tax_{it} = \gamma_t D_t + \delta_s D_s + \phi_{ts} D_t D_s + v_{it} \tag{1.9}$$

where D_t are time dummies and D_s are sector dummies (based on the ISIC Rev. 2 first digit sectors). This measure does not consider firm characteristics, but is exogenous. The second counterfactual (counterfactual 2) is based on the estimation of:

$$Tax_{it} = \gamma_t D_t + \alpha_t D_t M_{it-1} + \delta_s D_s + \beta_s D_s M_{it-1} + v_{it} \tag{1.10}$$

where M_{it-1} is the operational margin of firm i in period $t-1$. I normalize variable M the same way as the other variables in each equation correspondingly. I use the lagged value of M to avoid the endogeneity problem. If I use the contemporaneous value of M, the predicted tax would be endogenous, because it is a function of a contemporaneous variable, highly related to effective taxes.

Note that conterfactuals (1.9) and (1.10) control for any macroeconomic condition, captured by the set of time dummies. To make the prediction of the tax that the firm would pay when not evading, I selected the firms that seemed to behave as if they were not evading to estimate the parameters of equations (1.9) and (1.10), based on the ratio of sales to direct costs. A similar measure is used by the chilean IRS as an indicator of evasion (Jorratt 2002; Barra and Jorratt 1999). The nature of this measure is that firms in Chile evade corporate taxes mainly under reporting their operational margins (Barra and Jorratt 1999; Jorratt and Serra, 1999). To understand the measure, we can decompose sales as a function of the costs, the VAT and the gross margin:

$$Sales = Costs\,(1 + VAT)\,(1 + \mu)$$

where VAT is the VAT rate and μ is the margin. Then, the ratio of sales to direct costs is:

$$\frac{Sales}{Costs} = (1 + VAT)\,(1 + \mu)$$

One way to evade taxes, which is widely used in Chile is by declaring sales by a lower value than they actually had, and indeed it is also a way to evade corporate taxes in Chile (Jorratt and Serra, 1999)[1]. Because the margin μ should be positive, the sales

[1] One common way for small firms to under report incomes is by not issuing invoice. Jorratt and Serra (1999) point out that it is unlikely that larger firms, as the ones in my sample, evade by not issuing invoices. Larger firms may use more complex ways to evade.

to costs ratio should be larger than the VAT rate. In fact, it should be fairly larger than $(1 + VAT)$ if the firm is not evading.

To estimate equations (1.9) and (1.10) I used two sample selection criteria:

Let us define:

$$\xi = \frac{Sales}{Costs\,(1 + VAT)}$$

Sample selection 1: To include all firms, but only for the periods when the value of ξ was larger than each firms' sample average of this measure.

Sample selection 2: To include observations with the value of ξ larger than the year - sector sample average.

Both sample selection criteria include observations in the times when firms seem less likely to be evading taxes. Indeed, Joulfaian (2000) argues that the decision of tax evasion is related to the preferences of the managers. Similarly, Goerke (2007) links manager's characteristics with the tax evasion decision. It means that the decision to evade every type of tax is expected to be related. When firms evade the VAT, they also end up evading corporate taxes, because evading VAT, firms under report their operating margins, appearing with lower earnings. It poses the question of whether I should study the evasion or avoidance of VAT together with corporate taxes. The problem is that there is no information about VAT payments in firms' balance sheet reports (FECU). Anyway, the relationship between corporate tax payments or corporate tax evasion with external financing conditions is still supporting evidence to my hypothesis. The fact that the marginal corporate tax evasion may come from the evasion of VAT does not invalidate my findings.

I constructed the measure of evasion based on the fitted values obtained from equations (1.9) and (1.10) using both sample selection criteria.

$$Evasion_{it} = \widehat{Tax}_{it} - Tax_{it}$$

I do not show the estimates of equations (1.9) and (1.10) due to the large number of parameters and the scarce relevance of the individual parameters from these equations. I then estimated the relationship between evasion and the interest rate by estimating:

$$Evasion_{it} = \beta_0 + \beta_1 Int.Rate + \eta_i + v_{it} \tag{1.11}$$

and a version of equation (1.11):

$$Tax_{it} = \alpha_0 + \alpha_1 Int.Rate + \alpha_2 \widehat{Tax}_{it} + \eta_i + v_{it} \tag{1.12}$$

that does not restrict the value of α_2 to be equal to one. Note that if there is evasion motivated by financial reasons, β_1 is expected to be positive while α_1 negative, in equations (1.11) and (1.12). As in the estimates in tables 1 through 3 I also include a dynamic version of the equations and a version of (1.11) including the interaction of β_1 with my measures of cash position and credit access:

$$Evasion_{it} = \beta_0 + \beta_1 Rate_t + \beta_2 Rate_t * Interaction_{it} + \eta_i + v_{it} \tag{1.13}$$

where, as before, the interaction variable may be $Liquidity$, $Ret.Earn.$, $Bank$ or $Size$. According to my hypothesis, I expect the value of β_2 to be negative when the interaction is $Liquidity$ or $Ret.Earn$, while positive when the interaction variable is either $Bank$ or $Size$.

For each equation I also run the estimations using the variable taxes net of interest expenses ($TWFE$). Adding up all the combinations of counterfactuals, sample selection criteria and variables measures, it results in 24 versions of the estimates (there are 7 equations for each case, so there are 168 versions of the estimates using the counterfactuals). Tables 5 through 10 show the estimates of equations (1.11) through (1.13) for each case. Table 13 shows a summary of the results.

Summing up the results and their implications for each of my three hypothesis, I find that for the hypothesis of the relationship between evasion and the interest rate, I find that 73% of the estimations are significant with the expected sign, while the remaining estimates are not significant (see table 13). It is worth noting that I did not find significant wrong sings of the estimate of the marginal effect of interest rates on evasion, in any of the specifications. The estimates indicate that a one percent rise in the interest rate increases evasion by nearly a five percent, but the value of this estimate if uneven among the different specifications.

Regarding the relationship between the interest rate - evasion relationship and the firm's cash position, I find that in 22 of the 24 cases, at least one of the interactions is significant with the right sign (indicating that the relationship is weaker when the firm has a better cash position). Similarly, for the hypothesis of the relationship between access to credit and interest rate - evasion relationship, I find that in 11 of 24 cases, at least one of the measures have a significant and expected sign, but in 3 cases I find a significant wrong sign, thus the evidence of my third hypothesis is weaker this time.

1.3.3 One Money Tightening and One Money Loosening

As a final exercise, I study the behavior of tax payments during two events: The monetary tightening of 1998 and the monetary loosening of 2003. I perform a type of difference in difference estimation of the effect in order to test my hypothesis regarding the relationship between the effect of credit conditions on taxes, with firms' characteristics. In particular, that the interest rate - tax relationship is weaker in firms with better cash position, and it is stronger in firms with better access to credit markets. As before, I use variables $Liquidity$ and $Ret.Earn.$ as measures of a firm's cash position, and variables$Bank$ and $Size$, as measures of access to credit. For each event I compare the two years before the event with the two following years. I estimate the following equation:

$$Tax_{it} = \beta_0 + \beta_1 D_t + \beta_2 \cdot D_t \cdot Interaction_{it} + u_{it} \tag{1.14}$$

where D_t is a dummy variable that is zero the two years before the event, and one the year of the event and the year after. I am interested in the value of β_2 in equation (1.14). Note that β_2 is a type of difference in difference estimator, because it measures the heterogeneous effect of the event on firms with different values of the interaction variable. For the case of variable $Bank$, β_2 corresponds to the more traditional difference in difference estimator, because $Bank$ is a dummy variable. I am not interested in the value if β_1 which corresponds to the before after estimator of the money tightening or loosening. The reason for that is that this measure is likely to be biased because I am not taking further controls for changes in conditions during the period.

For the hypothesis that taxes are less sensitive to credit conditions when firms have a better cash position, I expect β_2 to be negative during the credit contraction and positive, during the credit expansion. While, for the hypothesis that taxes are more sensitive in firms with a better access to credit markets, β_2 should be positive during the credit contraction, and negative during the credit expansion.

Table 10 shows the estimates of (1.14) for the monetary tightening of 1998, including also the estimates using taxes without interests expenses as dependent variable. In table 11 are similar estimates for the monetary loosening of 2003. Regarding the effect of the cash position, I find significant estimates with the expected sings in some of the specifications, but there is no wrong significant sign in any of the regressions. For the hypothesis related to the access to credit markets, I find significant supporting results in almost all regressions using $Size$ as the measure of access to credit. Nevertheless, there is no significant estimates for the regressions with the variable of bank dependence. In general, I find some supporting but not conclusive evidence of my hypothesis about the behavior evasion among heterogeneous firms.

1.4 Conclusion

Previous literature on tax evasion and corporate finance has not yet linked financial needs or the cost of financing with tax evasion or tax avoidance. I present a model that links firms' financing costs with the decision of tax evasion. The implication of the model is that when the interest rates rises, firms will find more attractive to evade. I test three hypothesis derived from my model: (i) firms evade more when the interest rate rises; (ii) the interest rate-evasion sensitivity is weaker when firms have a better cash position; and

(iii) the interest rate-evasion sensitivity is stronger when firms have a better access to the credit markets. I use three econometric approaches to test my hypothesis using a sample of Chilean firms between 1991 and 2005. I find strong supporting evidence of my first and main hypothesis that there is a relationship between evasion and credit conditions. Regarding my other two hypothesis I find supporting, but not conclusive evidence in all my econometric approaches. There is still place for more research on these topics.

My estimates indicate that firms reduce their tax payments by nearly ten percent after a one percent rise in the interest rate. Constructing measures of evasion, I find that evasion increases nearly five percent after a one percent rise in the interest rate. Most estimates of the marginal effect of interest rates on my measures of evasion are significant, but are also uneven.

Bibliography

[1] Arellano, Manuel and Bond, Stephen "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *The Review of Economic Studies*, Vol. 58, No. 2. (1991), pp. 277-297.

[2] Barra, Patricio and Jorratt, Michael "Estimación de la Evasión Tributaria en Chile." Servicio de Impuestos Internos, Chile, Mimeo (1999).

[3] Bernanke, Ben; Gertler, Mark and Gilchrist, Simon "The Financial Accelerator and the Flight to Quality," *The Review of Economics and Statistics*, Vol. 78, No. 1 (1996), pp. 1-15.

[4] Chen, Kong-Pin and Chu, C. Y. Cyrus "Internal Control versus External Manipulation: A Model of Corporate Income Tax Evasion." *The RAND Journal of Economics*, Vol. 36, No. 1 (2005), pp. 151-164.

[5] Cobham, Alex "Tax Evasion, Tax Avoidance and Development Finance." *QEH Working Paper Series*, No. 129 (2005).

[6] Crocker, Keith J. and Slemrod, Joel "Corporate Tax Evasion With Agency Costs." *Journal of Public Economics*, Vol. 89 (2005), pp. 1593-1610.

[7] Feldstein, Martin (a) "Behavioral Responses to Tax Rates: Evidence from the Tax Reform Act of 1986," *The American Economic Review*, Vol. 85, No. 2 (1995), pp. 170-174.

[8] Feldstein, Martin (b) "The Effect of Marginal Tax Rates on Taxable Income: A Panel Study of the 1986 Tax Reform Act," *The Journal of Political Economy*, Vol. 103, No. 3 (1995), pp. 551-572.

[9] Feldstein, Martin "Tax Avoidance and the Deadweight Loss of the Income Tax," *The Review of Economics and Statistics*, Vol. 81, No. 4 (1999), pp. 674-680.

[10] Goerke, Laszlo "Corporate and Personal Income Tax Declarations." *International Tax and Public Finance*, Vol. 14, No. 3 (2007), pp. 281-292.

[11] Goerke, Laszlo "Bureaucratic Corruption and Profit Tax Evasion." *Economics of Governance*, Vol. 9 (2008), pp. 177-196.

[12] Gruber, Jon and Saez, Emmanuel "The Elasticity of Taxable Income: Evidence and Implications," *Journal of Public Economics*, Vol. 84 (2002), pp. 1-32.

[13] Hanlon, Michelle; Mills, Lillian and Slemrod, Joel "An Empirical Examination of Corporate Tax Noncompliance," In *Taxing Corporate Income in the 21st Century*, ed. Alan Auerbach, James R. Hines Jr., and Joel Slemrod, Cambridge: Cambridge University Press (2007).

[14] Jorrat, Michael and Serra, Pablo "Estimación de la Evasión en el Impuesto a las Empresas en Chile." Mimeo (1999).

[15] Jorrat, Michael"Los instrumentos para la medición de la evasión tributaria." in *La función de fiscalización de la administración tributaria y el control de la evasión*, (Ed.) Ministerio de Hacienda, Instituto de Estudios Fiscales, Spain (2002), pp. 99-118.

[16] Joulfaian, David "Income Tax Evasion and Managerial Preferences," *The Review of Economics and Statistics*, Vol. 82, No. 4 (2000), pp. 698-701.

[17] Kiyotaki, Nobuhiro; Moore John, "Credit Cycles," *The Journal of Political Economy*, Vol. 105, No. 2. (1997), pp. 211-248.

[18] Niepelt, Dirk "Timing Tax Evasion." *Journal of Public Economics*, Vol. 89 (2005), pp. 1611 - 1637.

[19] Roodman, David, "A Short Note on the Theme of Too Many Instruments," Center for Global Developement Working Paper No. 125 (2007).

[20] Slemrod, Joel "Cheating Ourselves: The Economics of Tax Evasion," *Journal of Economic Perspectives*, Vol. 21, No. 1 (2007), pp. 25-48.

[21] Slemrod, Joel "An Empirical Test for Tax Evasion," The Review of Economics and Statistics, Vol. 67, No. 2 (1985), pp. 232-238.

[22] Stiglitz, Joseph and Weiss, Andrew, "Credit Rationing in Markets with Imperfect Information", The American Economic Review, Vol. 71, N^o 3 (Jun., 1981), pp. 393-410.

[23] Stiglitz, Joseph and Weiss, Andrew, "Asymmetric Information in Credit Markets and Its Implications for Macro-Economics", Oxford Economic Papers, New Series, Vol. 44, No. 4, Special Issue on Financial Markets, Institutions and Policy. (Oct., 1992), pp. 694-724.

[24] Yitzhaki, Shlomo "Income tax evasion: A theoretical analysis," *Journal of Public Economics*, vol. 3(2) (1974), pp. 201-202

Appendix

Variables In Constant 1998 CL$ 100.000

Dep. Var	Tax	Tax	Tax	Tax	TWFE	Tax	Tax	Tax	Tax
Lagged Dep.			0.603						
			(1.142)						
Rate	-960.975*	-893.172*	-1333.355*	-974.562*	-1567.47**	-906.036*	-1362.82*	-495.337	-918.533*
	(547.164)	(514.431)	(775.99)	(545.082)	(620.716)	(511.525)	(704.932)	(561.776)	(540.219)
Rate*Liquidity						3027.813			
						(2194.365)			
Rate*Ret.Earn.							3277.231**		
							(1224.561)		
Rate*Bank								-1066.315	
								(865.578)	
Rate*Size									-246.485
									(155.984)
Sales	0.005	0.005	0.019	0.005	0.012*	0.005	0.004	0.004	0.007
	(0.008)	(0.008)	(0.053)	(0.008)	(0.007)	(0.008)	(0.009)	(0.008)	(0.008)
Financial Exp.	-0.017	-0.018	-0.41**	-0.016		-0.016	-0.015	-0.02	-0.024
	(0.057)	(0.058)	(0.173)	(0.058)		(0.057)	(0.06)	(0.058)	(0.06)
GDP Growth				81.727					
				(190.111)					
Tax Rate	-1705.553	-2070.052	-1361.095	-1692.127	-2162.013	-1638.406	-2474.194	-1681.167	-1668.698
	(2070.138)	(2362.404)	(1360.26)	(2075.759)	(2214.784)	(2024.479)	(2606.316)	(2071.879)	(2102.211)
Trend		45011.17							
		(38567.29)							
Const.	40865.76	125.519	41270.53	40282.66	54530.42	39473.73	58259.22	41043.61	39455.7
	(35328.82)	(212.331)	(34560.06)	(35544.02)	(38952.16)	(34353.94)	(44669.01)	(35216.43)	(35832.91)
N° Observations	1266	1266	1255	1266	1266	1263	1049	1266	1250
N° Groups	85	85	85	85	85	85	80	85	85
Sargan p			0.685						

Table 1: (*) indicates significance at the 10% level and (**) indicates significance at the 5% level

Variables Normalized by Mean and Standar Deviation

Dep. Var	Tax	Tax	Tax	Tax	TWFE	Tax	Tax	Tax	Tax
Lagged Dep.			0.131						
			(0.092)						
Rate	-0.039*	-0.038*	-0.038**	-0.039*	-0.038*	-0.035*	-0.049**	-0.04**	-0.036*
	(0.02)	(0.021)	(0.018)	(0.02)	(0.019)	(0.02)	(0.021)	(0.021)	(0.021)
Rate*Liquidity						0.098**			
						(0.036)			
Rate*Ret.Earn.							0.041**		
							(0.017)		
Rate*Bank								0.003	
								(0.006)	
Rate*Size									-0.001
									(0.002)
Sales	0.475**	0.475**	0.451**	0.476**	0.518**	0.486**	0.553**	0.475**	0.497**
	(0.027)	(0.027)	(0.047)	(0.027)	(0.025)	(0.028)	(0.03)	(0.027)	(0.028)
Financial Exp.	-0.192**	-0.193**	-0.177**	-0.194**		-0.187**	-0.196**	-0.191**	-0.192**
	(0.027)	(0.028)	(0.029)	(0.028)		(0.027)	(0.028)	(0.027)	(0.027)
GDP Growth				-0.002					
				(0.008)					
Tax Rate	-0.122*	-0.129*	-0.145**	-0.123*	-0.135**	-0.114*	-0.185**	-0.122*	-0.121*
	(0.066)	(0.072)	(0.059)	(0.066)	(0.063)	(0.066)	(0.069)	(0.066)	(0.067)
Trend		2.251*							
		(1.191)							
Const.	2.176*	0.002	2.536**	2.194*	2.366**	2.023*	3.23**	2.174*	2.139*
	(1.149)	(0.01)	(1.025)	(1.152)	(1.096)	(1.15)	(1.209)	(1.15)	(1.164)
N° Observations	1200	1200	1120	1225	1200	1192	1036	1200	1180
N° Groups	80	80	80	82	80	80	78	80	80
Sargan p			0.242						

Table 2: (*) indicates significance at the 10% level and (**) indicates significance at the 5% level

	Variables in Logs								
Dep. Var	**Tax**	**Tax**	**Tax**	**Tax**	**TWFE**	**Tax**	**Tax**	**Tax**	**Tax**
Lagged Dep.			0.484** (0.068)						
Rate	-0.125** (0.032)	-0.111** (0.033)	-0.057* (0.034)	-0.125** (0.032)	-0.072** (0.02)	-0.124** (0.032)	-0.128** (0.03)	-0.09** (0.033)	-0.116** (0.032)
Rate*Liquidity						0.248** (0.069)			
Rate*Ret.Earn.							0.334** (0.065)		
Rate*Bank								-0.07** (0.034)	
Rate*Size									-0.018 (0.011)
Sales	0.941** (0.152)	0.951** (0.151)	-1.259 (0.821)	0.938** (0.151)	0.565** (0.059)	0.925** (0.149)	1.038** (0.193)	0.948** (0.154)	1.033** (0.166)
Financial Exp.	-0.135** (0.039)	-0.15** (0.04)	-0.101 (0.09)	-0.132** (0.039)		-0.121** (0.039)	-0.128** (0.037)	-0.139** (0.04)	-0.144** (0.038)
GDP Growth				0.006 (0.014)					
Tax Rate	-0.12 (0.097)	-0.205* (0.108)	0.04 (0.059)	-0.118 (0.098)	-0.106 (0.075)	-0.119 (0.097)	-0.2** (0.087)	-0.118 (0.096)	-0.119 (0.097)
Trend		1.32 (2.582)							
Const.	0.318 (2.479)	0.027* (0.016)	19.975** (9.723)	0.263 (2.517)	3.653** (1.442)	0.38 (2.45)	0.508 (2.822)	0.241 (2.485)	-0.723 (2.527)
N° Observations	896	896	824	1082	896	896	838	896	893
N° Groups	79	79	77	82	79	79	75	79	79
Sargan p			0.183						

Table 3: (*) indicates significance at the 10% level and (**) indicates significance at the 5% level

	Constant 1998 CL$ 100.000		Normalized by Mean and S.D.		Variables in Logs	
Dep. Variable	Operational Margin	Nonoperational Margin WFE	Operational Margin	Nonoperational Margin WFE	Operational Margin	Nonoperational Margin WFE
Rate	-2593.8* (1359.322)	-6567.906** (2440.56)	-0.045** (0.012)	-0.043** (0.012)	0.009 (0.013)	-0.062** (0.016)
Sales		-0.063* (0.037)		-0.136** (0.028)		-0.015 (0.046)
GDP Growth	251126.5** (123970.1)		0.2 (0.882)		1.372* (0.819)	
Constant	141401.3** (10913.26)	141078.7** (32078.55)	0.32** (0.095)	0.315** (0.09)	10.67** (0.118)	10.242** (0.567)
N° Observations	1266	1266	1245	1230	1073	846
N° Groups	85	85	83	82	82	82

Table 4: (*) indicates significance at the 10% level and (**) indicates significance at the 5% level

Table 5

Raw Tax - Constant 1998 CL$ 100.000 - Counterfactual 1 - Sample Selection 1

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		0.453					
		(0.443)					
Rate	1004.64**	803.967**	-711.762**	971.211**	1156.957**	400.503**	997.621**
	(314.468)	(333.483)	(321.193)	(311.807)	(393.921)	(116.19)	(305.526)
Rate*Liquidity				-2959.905			
				(1993.905)			
Rate*Ret.Earn.					-3254.113**		
					(1082.798)		
Rate*Bank						1337.4*	
						(689.54)	
Rate*Size							174.29
							(133.761)
Estimated Tax			0.404**				
			(0.188)				
Constant.	-7415.015**	-6165.517**	10621.75**	-7195.607**	-9934.685**	-7391.621**	-7385.947**
	(2710.757)	(2594.563)	(2842.443)	(2684.106)	(3398.658)	(2691.237)	(2645.749)
N° Observations	1266	1255	1266	1263	1049	1266	1250
N° Groups	85	85	85	85	80	85	85
Sargan p		0.137					

Raw Tax - Constant 1998 CL$ 100.000 - Counterfactual 1 - Sample Selection 2

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-1.265					
		(0.864)					
Rate	581.723*	662.802**	-539.414*	554.913*	689.955*	183.395*	582.091*
	(313.289)	(301.234)	(311.02)	(310.795)	(395.385)	(111.313)	(304.72)
Rate*Liquidity				-2331.384			
				(1994.049)			
Rate*Ret.Earn.					-2406.614**		
					(1093.47)		
Rate*Bank						881.793	
						(688.585)	
Rate*Size							100.623
							(132.433)
Estimated Tax			0.384**				
			(0.163)				
Constant.	-4589.034*	-5536.915**	9643.583**	-4415.339*	-6822.082**	-4573.61*	-4621.418*
	(2695.421)	(2422.295)	(2854.893)	(2670.195)	(3403.888)	(2680.936)	(2635.155)
N° Observations	1266	1255	1266	1263	1049	1266	1250
N° Groups	85	85	85	85	80	85	85
Sargan p		0.124					

Raw Tax - Constant 1998 CL$ 100.000 - Counterfactual 2 - Sample Selection 1

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.105					
		(0.421)					
Rate	530.185*	613.961**	-510.106	494.871	641.986	469.749**	477.979
	(322.162)	(251.817)	(312.437)	(318.675)	(407.379)	(74.681)	(310.79)
Rate*Liquidity				-2945.088			
				(2210.615)			
Rate*Ret.Earn.					-2229.661*		
					(1204.966)		
Rate*Bank						132.78	
						(706.35)	
Rate*Size							282.781**
							(142.113)
Estimated Tax			-0.016				
			(0.429)				
Constant.	-3240.627	-3827.298*	12998.37**	-3011.031	-4530.71	-3237.08	-2881.931
	(2795.788)	(1974.195)	(5363.508)	(2763.331)	(3529.848)	(2778.925)	(2715.406)
N° Observations	1255	1243	1255	1252	1041	1255	1239
N° Groups	85	85	85	85	80	85	85
Sargan p		0.116					

Raw Tax - Constant 1998 CL$ 100.000 - Counterfactual 2 - Sample Selection 2

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.636					
		(0.626)					
Rate	-111.631	-74.485	-330.976	-146.236	-85.377	120.093	-162.903
	(326.818)	(230.706)	(336.462)	(323.197)	(412.678)	(88.193)	(316.026)
Rate*Liquidity				-2804.413			
				(2163.874)			
Rate*Ret.Earn.					-1685.708		
					(1230.943)		
Rate*Bank						-509.104	
						(715.896)	
Rate*Size							211.4
							(142.178)
Estimated Tax			0.288				
			(0.277)				
Constant.	1869.122	1954.246	8597.436*	2092.572	1229.038	1855.523	2233.265
	(2787.481)	(1904.567)	(4760.074)	(2754.197)	(3517.236)	(2767.895)	(2720.095)
N° Observations	1255	1243	1255	1252	1041	1255	1239
N° Groups	85	85	85	85	80	85	85
Sargan p		0.101					

(*) indicates significance at the 10% level and (**) indicates significance at the 5% level

Table 6

Without Financial Expenses - Constant 1998 CL$ 100.000 - Counterfactual 1- Sample Selection 1

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		0.197 (0.252)					
Rate	1773.049** (331.79)	1509.838** (450.398)	-1270.179** (326.064)	1742.464** (329.878)	2033.205** (410.031)	432.815** (134.955)	1751.15** (320.107)
Rate*Liquidity				-2768.093 (1985.737)			
Rate*Ret.Earn.					-4427.349** (1145.469)		
Rate*Bank						2966.922** (721.077)	
Rate*Size							357.164** (137.993)
Estimated Tax			0.209 (0.178)				
Constant.	-14314.33** (2845.514)	-12330.64** (3538.789)	21070.87** (3216.969)	-14117.49** (2823.785)	-18075.61** (3513.15)	-14262.43** (2798.807)	-14211.45** (2752.145)
N° Observations	1266	1255	1266	1263	1049	1266	1250
N° Groups	85	85	85	85	80	85	85
Sargan p		0.142					

Without Financial Expenses - Constant 1998 CL$ 100.000 - Counterfactual 1 - Sample Selection 2

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		0.218** (0.023)					
Rate	1180.015** (323.071)	1517.524** (574.24)	-1150.839** (317.671)	1156.26** (321.179)	1423.094** (403.605)	97.939 (115.854)	1164.637** (312.747)
Rate*Liquidity				-2121.49 (2014.194)			
Rate*Ret.Earn.					-3271.828** (1151.438)		
Rate*Bank						2395.43** (706.754)	
Rate*Size							279.327** (135.101)
Estimated Tax			0.319* (0.174)				
Constant.	-11551.83** (2766.907)	-13699.39** (4312.065)	19248.13** (3345.909)	-11404.55** (2745.001)	-15227.43** (3454.497)	-11509.93** (2733.644)	-11516.2** (2686.309)
N° Observations	1266	1255	1266	1263	1049	1266	1250
N° Groups	85	85	85	85	80	85	85
Sargan p		0.157					

Without Financial Expenses - Constant 1998 CL$ 100.000 - Counterfactual 2 - Sample Selection 1

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.02 (0.311)					
Rate	953.923** (349.265)	1016.507** (345.547)	-1167.61** (338.976)	925.455** (346.486)	1224.768** (439.634)	298.036** (78.338)	881.998** (333.688)
Rate*Liquidity				-2404.306 (2225.041)			
Rate*Ret.Earn.					-2468.078* (1259.841)		
Rate*Bank						1440.999* (763.72)	
Rate*Size							473.014** (152.692)
Estimated Tax			-0.155 (0.384)				
Constant.	-7709.558** (3003.91)	-8234.447** (2716.516)	25345.07** (7109.281)	-7528.368** (2977)	-10042.43** (3771.992)	-7671.066** (2977.019)	-7253.608** (2888.463)
N° Observations	1255	1243	1255	1252	1041	1255	1239
N° Groups	85	85	85	85	80	85	85
Sargan p		0.147					

(*) indicates significance at the 10% level and (**) indicates significance at the 5% level

Without Financial Expenses - Constant 1998 CL$ 100.000 - Counterfactual 2 - Sample Selection 2

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.18 (0.558)					
Rate	349.727 (340.616)	404.406 (344.005)	-1052.873** (400.517)	321.183 (337.414)	510.243 (428.515)	34.16 (91.088)	280.613 (327.462)
Rate*Liquidity				-2367.906 (2166.438)			
Rate*Ret.Earn.					-1791.851 (1266.024)		
Rate*Bank						693.309 (745.85)	
Rate*Size							381.844** (147.737)
Estimated Tax			0.109 (0.317)				
Constant.	-3592.758 (2898.297)	-4207.576 (3152.842)	20862.61** (6922.094)	-3413.358 (2868.465)	-5187.95 (3642.458)	-3574.239 (2881.842)	-3150.947 (2813.465)
N° Observations	1255	1243	1255	1252	1041	1255	1239
N° Groups	85	85	85	85	80	85	85
Sargan p		0.113					

Table 7

Raw Tax - Norm. Mean and S.D. - Counterfactual 1 - Sample Selection 1

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.079 (0.317)					
Rate	0.022* (0.011)	0.029** (0.01)	-0.032** (0.011)	0.021* (0.011)	0.036** (0.012)	0.023* (0.012)	0.022* (0.011)
Rate*Liquidity				-0.09** (0.04)			
Rate*Ret.Earn.					-0.077** (0.023)		
Rate*Bank						-0.002 (0.007)	
Rate*Size							-0.002 (0.001)
Estimated Tax			0.569** (0.072)				
Constant.	-0.016 (0.088)	-0.059 (0.067)	0.151* (0.09)	-0.015 (0.089)	-0.176* (0.099)	-0.016 (0.088)	-0.015 (0.09)
N° Observations	1230	1148	1230	1222	1049	1230	1209
N° Groups	82	82	82	82	80	82	82
Sargan p		0.45					

Raw Tax - Norm. Mean and S.D. - Counterfactual 1 - Sample Selection 2

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.398 (0.5)					
Rate	0.013 (0.011)	0.02* (0.011)	-0.029** (0.011)	0.013 (0.011)	0.03** (0.012)	0.016 (0.012)	0.014 (0.012)
Rate*Liquidity				-0.075* (0.04)			
Rate*Ret.Earn.					-0.065** (0.022)		
Rate*Bank						-0.005 (0.007)	
Rate*Size							-0.003* (0.001)
Estimated Tax			0.509** (0.06)				
Constant.	-0.049 (0.089)	-0.084 (0.072)	0.187** (0.088)	-0.052 (0.089)	-0.219** (0.099)	-0.049 (0.089)	-0.052 (0.09)
N° Observations	1230	1148	1230	1222	1049	1230	1209
N° Groups	82	82	82	82	80	82	82
Sargan p		0.65					

Raw Tax - Norm. Mean and S.D. - Counterfactual 2 - Sample Selection 1

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.202 (0.246)					
Rate	0.029** (0.011)	0.039** (0.01)	-0.034** (0.011)	0.027** (0.011)	0.035** (0.012)	0.032** (0.011)	0.028** (0.011)
Rate*Liquidity				-0.153** (0.042)			
Rate*Ret.Earn.					-0.058** (0.022)		
Rate*Bank						-0.005 (0.007)	
Rate*Size							0.001 (0.002)
Estimated Tax			0.692** (0.057)				
Constant.	-0.097 (0.085)	-0.142** (0.07)	0.172** (0.085)	-0.081 (0.085)	-0.143 (0.094)	-0.097 (0.085)	-0.081 (0.087)
N° Observations	1134	1053	1134	1126	967	1134	1114
N° Groups	81	81	81	81	78	81	81
Sargan p		0.533					

(*) indicates significance at the 10% level and (**) indicates significance at the 5% level

Raw Tax - Norm. Mean and S.D. - Counterfactual 2 - Sample Selection 2

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-1.039* (0.63)					
Rate	0.008 (0.011)	0.015 (0.011)	-0.019* (0.011)	0.005 (0.011)	0.012 (0.012)	0.01 (0.011)	0.006 (0.011)
Rate*Liquidity				-0.159** (0.042)			
Rate*Ret.Earn.					-0.052** (0.022)		
Rate*Bank						-0.004 (0.007)	
Rate*Size							0.001 (0.002)
Estimated Tax			0.692** (0.054)				
Constant.	-0.004 (0.085)	-0.023 (0.08)	0.108 (0.086)	0.013 (0.085)	-0.049 (0.094)	-0.004 (0.085)	0.015 (0.086)
N° Observations	1134	1053	1134	1126	967	1134	1114
N° Groups	81	81	81	81	78	81	81
Sargan p		0.439					

Table 8

Without Financial Expenses - Norm. Mean and S.D. - Counterfactual 1 - Sample Selection 1

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.144 (0.276)					
Rate	0.025** (0.011)	0.031** (0.01)	-0.031** (0.011)	0.023** (0.011)	0.042** (0.012)	0.025** (0.011)	0.024** (0.011)
Rate*Liquidity				-0.096** (0.039)			
Rate*Ret.Earn.					-0.024 (0.019)		
Rate*Bank						-0.001 (0.007)	
Rate*Size							-0.002 (0.001)
Estimated Tax			0.663** (0.066)				
Constant.	-0.06 (0.086)	-0.091 (0.062)	0.147* (0.087)	-0.052 (0.086)	-0.207** (0.096)	-0.06 (0.086)	-0.052 (0.087)
N° Observations	1266	1179	1266	1263	1049	1266	1250
N° Groups	85	85	85	85	80	85	85
Sargan p		0.545					

Without Financial Expenses - Norm. Mean and S.D. - Counterfactual 1 - Sample Selection 2

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.226 (0.482)					
Rate	0.023** (0.011)	0.027** (0.013)	-0.03** (0.011)	0.022** (0.011)	0.043** (0.012)	0.022* (0.011)	0.023** (0.011)
Rate*Liquidity				-0.096** (0.039)			
Rate*Ret.Earn.					-0.036* (0.019)		
Rate*Bank						0.003 (0.007)	
Rate*Size							-0.002 (0.001)
Estimated Tax			0.658** (0.066)				
Constant.	-0.136 (0.086)	-0.16* (0.085)	0.198** (0.086)	-0.127 (0.086)	-0.312** (0.095)	-0.136 (0.086)	-0.129 (0.087)
N° Observations	1266	1179	1266	1263	1049	1266	1250
N° Groups	85	85	85	85	80	85	85
Sargan p		0.496					

Without Financial Expenses - Norm. Mean and S.D. - Counterfactual 2 - Sample Selection 1

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.049 (0.26)					
Rate	0.031** (0.011)	0.035** (0.011)	-0.033** (0.011)	0.029** (0.011)	0.049** (0.011)	0.031** (0.011)	0.03** (0.011)
Rate*Liquidity				-0.113** (0.041)			
Rate*Ret.Earn.					-0.042** (0.021)		
Rate*Bank						-0.001 (0.007)	
Rate*Size							0 (0.001)
Estimated Tax			0.73** (0.05)				
Constant.	-0.14* (0.082)	-0.168** (0.073)	0.187** (0.082)	-0.13 (0.082)	-0.268** (0.091)	-0.14* (0.083)	-0.131 (0.083)
N° Observations	1157	1073	1157	1154	967	1157	1142
N° Groups	83	83	83	83	78	83	83
Sargan p		0.837					

Without Financial Expenses - Norm. Mean and S.D. - Counterfactual 2 - Sample Selection 2

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.307 (0.437)					
Rate	0.026** (0.011)	0.031** (0.013)	-0.03** (0.01)	0.025** (0.011)	0.043** (0.011)	0.026** (0.011)	0.025** (0.011)
Rate*Liquidity				-0.123** (0.041)			
Rate*Ret.Earn.					-0.029 (0.019)		
Rate*Bank						0.001 (0.007)	
Rate*Size							0.001 (0.001)
Estimated Tax			0.741** (0.05)				
Constant.	-0.167** (0.082)	-0.197** (0.087)	0.206** (0.081)	-0.156* (0.082)	-0.291** (0.09)	-0.167** (0.082)	-0.155* (0.083)
N° Observations	1157	1073	1157	1154	967	1157	1142
N° Groups	83	83	83	83	78	83	83
Sargan p		0.25					

(*) indicates significance at the 10% level and (**) indicates significance at the 5% level

Table 9

Raw Tax - Variables in Logs - Counterfactual 1 - Sample Selection 1

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		1.168 (0.742)					
Rate	0.074** (0.024)	0.077** (0.028)	-0.09** (0.021)	0.071** (0.024)	0.074** (0.023)	0.006 (0.033)	0.084** (0.025)
Rate*Liquidity				-0.405** (0.124)			
Rate*Ret.Earn.					-0.494** (0.077)		
Rate*Bank						0.14** (0.048)	
Rate*Size							-0.003 (0.013)
Estimated Tax			0.172** (0.054)				
Constant.	-0.564** (0.196)	-0.676** (0.232)	7.038** (0.475)	-0.54** (0.194)	-0.692** (0.187)	-0.556** (0.194)	-0.636** (0.196)
N° Observations	942	855	942	942	875	942	937
N° Groups	82	78	82	82	78	82	81
Sargan p		0.16					

Raw Tax - Variables in Logs - Counterfactual 2 - Sample Selection 1

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		0.11* (0.061)					
Rate	0.049** (0.02)	0.013 (0.017)	-0.084** (0.02)	0.048** (0.02)	0.029 (0.018)	0 (0.025)	0.047** (0.021)
Rate*Liquidity				-0.323** (0.082)			
Rate*Ret.Earn.					-0.27** (0.065)		
Rate*Bank						0.102** (0.041)	
Rate*Size							0.016 (0.013)
Estimated Tax			0.478** (0.077)				
Constant.	-0.326** (0.158)	-0.086 (0.135)	4.714** (0.688)	-0.323** (0.158)	-0.225 (0.139)	-0.329** (0.158)	-0.377** (0.161)
N° Observations	875	746	875	875	834	875	872
N° Groups	80	74	80	80	77	80	80
Sargan p		0.648					

(*) indicates significance at the 10% level and (**) indicates significance at the 5% level

Raw Tax - Variables in Logs - Counterfactual 1 - Sample Selection 2

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.12 (0.16)					
Rate	0.065** (0.024)	0.112** (0.018)	-0.087** (0.021)	0.062** (0.023)	0.064** (0.023)	0.014 (0.032)	0.076** (0.024)
Rate*Liquidity				-0.381** (0.108)			
Rate*Ret.Earn.					-0.479** (0.076)		
Rate*Bank						0.105** (0.047)	
Rate*Size							-0.012 (0.012)
Estimated Tax			0.222** (0.057)				
Constant.	-0.573** (0.191)	-1.031** (0.136)	6.65** (0.501)	-0.551** (0.19)	-0.74** (0.185)	-0.567** (0.19)	-0.624** (0.194)
N° Observations	942	855	942	942	875	942	937
N° Groups	82	78	82	82	78	82	81
Sargan p		0.254					

Raw Tax - Variables in Logs - Counterfactual 2 - Sample Selection 2

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		0.349 (0.406)					
Rate	0.011 (0.02)	-0.029* (0.017)	-0.063** (0.021)	0.01 (0.02)	-0.015 (0.018)	-0.034 (0.024)	0.008 (0.021)
Rate*Liquidity				-0.335** (0.075)			
Rate*Ret.Earn.					-0.275** (0.063)		
Rate*Bank						0.095** (0.041)	
Rate*Size							0.017 (0.013)
Estimated Tax			0.513** (0.075)				
Constant.	-0.065 (0.158)	0.22 (0.141)	4.288** (0.694)	-0.061 (0.158)	0.099 (0.137)	-0.067 (0.158)	-0.11 (0.161)
N° Observations	875	796	875	875	834	875	872
N° Groups	80	74	80	80	77	80	80
Sargan p		0.168					

Table 10

Without Financial Expenses - Variables in Logs - Counterfactual 1 - Sample Selection 1

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		0.202** (0.089)					
Rate	0.069** (0.019)	0.092** (0.013)	-0.035** (0.016)	0.066** (0.019)	0.084** (0.019)	0.058* (0.03)	0.076** (0.019)
Rate*Liquidity				-0.273** (0.104)			
Rate*Ret.Earn.					-0.372** (0.06)		
Rate*Bank						0.024 (0.038)	
Rate*Size							-0.026** (0.006)
Estimated Tax			0.318** (0.06)				
Constant.	-0.566** (0.163)	-0.758** (0.103)	5.759** (0.549)	-0.551** (0.163)	-0.795** (0.158)	-0.565** (0.163)	-0.584** (0.164)
N° Observations	1163	1120	1163	1162	1002	1163	1153
N° Groups	85	83	85	85	78	85	84
Sargan p		0.33					

Without Financial Expenses - Variables in Logs - Counterfactual 1 - Sample Selection 2

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.006 (0.219)					
Rate	0.054** (0.019)	0.262** (0.028)	-0.032* (0.016)	0.052** (0.019)	0.077** (0.018)	0.038 (0.029)	0.062** (0.019)
Rate*Liquidity				-0.27** (0.1)			
Rate*Ret.Earn.					-0.345** (0.061)		
Rate*Bank						0.034 (0.037)	
Rate*Size							-0.026** (0.006)
Estimated Tax			0.355** (0.067)				
Constant.	-0.576** (0.16)	-2.197** (0.229)	5.479** (0.6)	-0.562** (0.16)	-0.893** (0.153)	-0.575** (0.16)	-0.602** (0.161)
N° Observations	1163	1120	1163	1162	1002	1163	1153
N° Groups	85	83	85	85	78	85	84
Sargan p		0.582					

Without Financial Expenses - Variables in Logs - Counterfactual 2 - Sample Selection 1

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.066 (0.096)					
Rate	0.05** (0.015)	0.049** (0.01)	-0.057** (0.014)	0.05** (0.015)	0.042** (0.013)	0.042* (0.022)	0.039** (0.015)
Rate*Liquidity				-0.1 (0.063)			
Rate*Ret.Earn.					-0.182** (0.046)		
Rate*Bank						0.018 (0.03)	
Rate*Size							0.015** (0.006)
Estimated Tax			0.482** (0.076)				
Constant.	-0.366** (0.126)	-0.378** (0.076)	4.71** (0.696)	-0.364** (0.126)	-0.297** (0.106)	-0.366** (0.126)	-0.351** (0.126)
N° Observations	1015	965	1015	1015	926	1015	1011
N° Groups	82	80	82	82	77	82	82
Sargan p		0.52					

(*) indicates significance at the 10% level and (**) indicates significance at the 5% level

Without Financial Expenses - Variables in Logs - Counterfactual 2 - Sample Selection 2

Dep. Var	Evasion	Evasion	Tax	Evasion	Evasion	Evasion	Evasion
Lagged Dep.		-0.094** (0.047)					
Rate	0.015 (0.015)	0.011 (0.01)	-0.039** (0.015)	0.014 (0.015)	0.004 (0.013)	0.004 (0.022)	0.003 (0.015)
Rate*Liquidity				-0.098 (0.06)			
Rate*Ret.Earn.					-0.169** (0.046)		
Rate*Bank						0.024 (0.03)	
Rate*Size							0.018** (0.006)
Estimated Tax			0.5** (0.069)				
Constant.	-0.112 (0.123)	-0.108 (0.075)	4.44** (0.645)	-0.11 (0.123)	-0.005 (0.104)	-0.111 (0.124)	-0.099 (0.122)
N° Observations	1015	965	1015	1015	926	1015	1011
N° Groups	82	80	82	82	77	82	82
Sargan p		0.587					

1998 Monetary Contraction

	Raw Tax			Without Financial Expenses		
Dep. Var	**Tax**	**Norm. Tax**	**Log(Tax)**	**Tax**	**Norm. Tax**	**Log(Tax)**
Contraction	-577.671	-0.051	-0.062	960.836	0.08	0.111
	(746.047)	(0.055)	(0.124)	(670.026)	(0.052)	(0.068)
Cont.*Liq.	4299.871**	1.157**	3.413**	2192.597	-0.005	0.75
	(2152.285)	(0.473)	(1.297)	(2191.384)	(0.394)	(0.955)
Constant.	5127.593**	-0.068	7.271**	7803.114**	-0.113**	7.776**
	(453.965)	(0.045)	(0.082)	(369.711)	(0.044)	(0.042)
N° Observations	763	720	532	763	743	693
N° Groups	191	180	160	191	186	182

Dep. Var	**Tax**	**Norm. Tax**	**Log(Tax)**	**Tax**	**Norm. Tax**	**Log(Tax)**
Contraction	-423.785	-0.053	-0.188	1294.577	0.102*	0.114*
	(964.35)	(0.059)	(0.121)	(882.572)	(0.057)	(0.065)
Cont.*Ret. Earn.	5088.119	0.528**	1.472*	679.513	0.253	-0.017
	(3464.753)	(0.252)	(0.753)	(3215.684)	(0.247)	(0.481)
Constant.	6172.796**	-0.059	7.521**	8985.955**	-0.14**	8.054**
	(524.819)	(0.049)	(0.079)	(458.817)	(0.049)	(0.045)
N° Observations	617	597	490	617	597	569
N° Groups	169	164	153	169	164	160

Dep. Var	**Tax**	**Norm. Tax**	**Log(Tax)**	**Tax**	**Norm. Tax**	**Log(Tax)**
Contraction	267.204	-0.064	0.005	610.272	0.078	0.094
	(380.073)	(0.062)	(0.148)	(382.569)	(0.06)	(0.087)
Cont.*Bank	-2706.624	-0.032	-0.384	1062.193	0.007	0.004
	(2221.013)	(0.092)	(0.258)	(1965.245)	(0.09)	(0.116)
Constant.	5126.738**	-0.068	7.275**	7803.361**	-0.113**	7.775**
	(452.288)	(0.045)	(0.081)	(369.193)	(0.044)	(0.042)
N° Observations	763	720	532	763	743	693
N° Groups	191	180	160	191	186	182

Dep. Var	**Tax**	**Norm. Tax**	**Log(Tax)**	**Tax**	**Norm. Tax**	**Log(Tax)**
Contraction	-547.923	-0.078	-0.068	1028.881	0.073	0.074
	(778.444)	(0.054)	(0.143)	(715.93)	(0.051)	(0.065)
Cont.*Size	-1540.752**	-0.051**	-0.186*	-683.509	-0.055**	-0.042
	(624.941)	(0.018)	(0.101)	(564.603)	(0.017)	(0.042)
Constant.	5337.1**	-0.069	7.304**	8151.815**	-0.111**	7.851**
	(462.932)	(0.045)	(0.082)	(386.88)	(0.044)	(0.037)
N° Observations	728	701	526	728	724	682
N° Groups	184	177	157	184	183	179

Table 11: (*) indicates significance at the 10% level and (**) indicates significance at the 5% level

2003 Monetary Expansion

	Raw Tax			Without Financial Expenses		
Dep. Var	**Tax**	**Norm. Tax**	**Log(Tax)**	**Tax**	**Norm. Tax**	**Log(Tax)**
Expansion	346.68	0.107	-0.199	295.765	0.038	-0.135
	(1674.518)	(0.076)	(0.123)	(1648.55)	(0.072)	(0.099)
Exp.*Liq.	-16656.86	-0.252	-2.501	-16547.99	-0.638	-0.525
	(17807.02)	(0.647)	(1.949)	(17850.11)	(0.506)	(1.381)
Constant.	7573.934**	0.106*	7.903**	13166.35**	0.147**	8.13**
	(1274.783)	(0.061)	(0.068)	(1263.487)	(0.06)	(0.058)
N° Observations	688	652	483	688	668	573
N° Groups	172	163	153	172	167	162

Dep. Var	**Tax**	**Norm. Tax**	**Log(Tax)**	**Tax**	**Norm. Tax**	**Log(Tax)**
Expansion	586.312	0.094	-0.083	615.902	0.066	-0.071
	(2356.796)	(0.084)	(0.093)	(2305.057)	(0.082)	(0.087)
Exp.*Ret. Earn.	-2812.95	-0.962**	-2.276**	-5688.673	-1.36**	-2.212**
	(11746.33)	(0.338)	(1.029)	(11331.1)	(0.328)	(0.897)
Constant.	10932.2**	0.266**	8.277**	17642.39**	0.321**	8.562**
	(1640.376)	(0.069)	(0.055)	(1611.166)	(0.067)	(0.057)
N° Observations	492	492	422	492	492	459
N° Groups	130	130	127	130	130	129

Dep. Var	**Tax**	**Norm. Tax**	**Log(Tax)**	**Tax**	**Norm. Tax**	**Log(Tax)**
Expansion	918.665	0.164*	-0.102	265.234	-0.012	-0.206
	(702.251)	(0.089)	(0.139)	(616.671)	(0.085)	(0.127)
Exp.*Bank	-1598.544	-0.144	-0.131	46.66	0.14	0.201
	(4491.306)	(0.122)	(0.207)	(4445.327)	(0.119)	(0.173)
Constant.	7573.934**	0.106*	7.9**	13166.35**	0.147**	8.13**
	(1277.462)	(0.061)	(0.067)	(1266.365)	(0.06)	(0.058)
N° Observations	688	652	483	688	668	573
N° Groups	172	163	153	172	167	162

Dep. Var	**Tax**	**Norm. Tax**	**Log(Tax)**	**Tax**	**Norm. Tax**	**Log(Tax)**
Expansion	233.329	0.108	-0.237*	193.451	0.041	-0.216**
	(1750.867)	(0.077)	(0.123)	(1720.626)	(0.073)	(0.104)
Exp.*Size	2232.322*	0.068**	0.168**	2404.768*	0.111**	0.171**
	(1280.759)	(0.023)	(0.07)	(1251.451)	(0.022)	(0.054)
Constant.	7956.876**	0.108*	7.916**	13804.67**	0.152**	8.234**
	(1332.307)	(0.061)	(0.067)	(1318.305)	(0.058)	(0.058)
N° Observations	657	637	477	657	653	563
N° Groups	166	161	151	166	165	160

Table 12: (*) indicates significance at the 10% level and (**) indicates significance at the 5% level

Approach	Hypothesis	Significant with Expected Sign	Significant with wrong Sign	Not Significant	Total
First Approach: Tax as dependent variable	**Hypothesis 1**: The interest rate has a negative effect on tax payments or a possitive effect on evasion	27	0	0	27
	Hypothesis 2: Liquidity reduces the effect of the interest rate on tax payments or evasion	5	0	1	6
	Hypothesis 3: A better access to credit increases the effect of the interest rate on taxes or evasion	1	0	5	6
Second Approach: Evasion as dependent variable	**Hypothesis 1**: The interest rate has a negative effect on tax payments or a possitive effect on evasion	123	0	45	168
	Hypothesis 2: Liquidity reduces the effect of the interest rate on tax payments or evasion	34	0	14	48
	Hypothesis 3: A better access to credit increases the effect of the interest rate on taxes or evasion	15	3	30	48
Third Approach: Difference in difference estimation	**Hypothesis 1**: The interest rate has a negative effect on tax payments or a possitive effect on evasion	-	-	-	-
	Hypothesis 2: Liquidity reduces the effect of the interest rate on tax payments or evasion	9	0	15	24
	Hypothesis 3: A better access to credit increases the effect of the interest rate on taxes or evasion	9	0	15	24

Table 13: Summary of results

Chapter 2

Essay 2: Credit Channel and Flight to Quality in Emerging Markets: Evidence from Chile

2.1 Introduction

Empirical work on the credit channel considers flight to quality as a cross sectional implication of the so-called financial accelerator theory (see, for instance, Kashyap, Stein and Wilcox, 1993; Bernanke, Gertler and Gilchrist, 1996; Oliner and Rudebusch, 1996; and Nilsen, 2002). Bernanke, Gertler and Gilchrist (1996), Kiyotaki and Moore (1997) and Holmstrom and Tirole (1997) present models where information problems in credit markets work as a mechanism to propagate shocks i.e. the financial accelerator. In their framework, small firms face credit restrictions which worsen after negative shocks, causing flight to quality and a further fall in output. In a similar framework, I present a model with heterogeneous access to credit among constrained firms. In my model, and contrary to previous literature, firms with looser credit constrains are more sensitive to credit conditions than firms severely constrained. The intuition is that when a firm face tight credit constrains, it can not be greatly affected by financial conditions, since it is partly excluded from the financial markets. My model highlights a possible non monotonic effect of monetary conditions on firms' investment, according to their access to credit. Among smaller, constrained firms, those with better access to credit will be more sensitive to monetary conditions, but large unconstrained firms will be less sensitive to credit conditions. In this line, Almeida and Campello (2007) find that investment-cash flow sensitivity is non monotonic in the tangibility of assets. In their model the more tangible the assets of a financing constrained firm, the more sensitive is firm's investment to cash flows.

The empirical literature on the credit channel takes the existence of flight to quality as evidence of the credit channel of monetary policy. I suggest that if most firms within the database are facing credit restrictions, larger less constrained firms will be the more sensitive to monetary conditions, and not the smaller as has been thought in previous literature. I test my hypothesis for a set of firms in an emerging market, i.e. Chile. The convenience of Chile to test my hypothesis is that, first, it is an emerging economy with a developing financial system, thus credit restrictions are expected to be widespread; and second, it is developed enough to include fairly small firms within the data set of stock companies, and not only large corporations as may be the case of less developed countries. The behavior of firms in my sample is consistent with the predictions of my model. I use different measures of the degree of a firm's access to external financing, and I find that the effect of monetary conditions is larger, the better the access to the credit market. After a 1% rise in the monetary policy rate, the fall in firms' investment is 0.5% larger each time that a firm doubles the size of its fixed assets.

Evidence indicates that in the United States, constrained firms are more responsive to monetary conditions than unconstrained firms, i.e. there is flight to quality (Bernanke, Gertler and Gilchrist, 1996). It is not contradictory with my findings, in fact, among constrained American firms, those with better access to credit are also the ones with more sensitive investment (Kaplan and Zingales, 1997; Almeida and Campello, 2007) which is the prediction of my model. I highlight that when studying the credit channel in Emerging Markets, it may be the case that most firm in the samples are facing credit constraints and we should not expect to observe flight to quality among constrained firms.

2.2 Literature Review

The IS/LM model (Hicks, 1937) based on Keynes ideas, gives a mechanism by which money influences real activity, breaking with the classical dichotomy. Further developments complemented the IS/LM analysis with a positively sloped aggregate supply, originated by nominal or informational rigidities (Lucas, 1996; Friedman, 1968, Taylor, 1979; Roberts, 1995; among many others). The IS/LM framework separates all assets in two broad categories: money and bonds. The focus is set on the money market because by the Walras law it is unnecessary to consider the bonds market separately. The money affects real activity through its impact on the aggregate demand, in what is referred to as the *money channel* of monetary policy.

Reexamination of the 1930s episode (Bernanke, 1983; Friedman and Swartz, 1963; Chari, Kehoe and McGrattan, 2002) highlighted the role of the financial markets during the Great Depression. The aggregation of all assets markets in only one broad category, "bonds", does not consider the role of financial markets in the transmission mechanisms of monetary policy (Bernanke and Blinder, 1988; Brunner and Meltzer, 1988). The role of the financial markets in the transmission of monetary policy is referred to as *the credit channel*. Early authors exploited the credit channel as a parallel, independent transmission mechanism of monetary shocks to real activity (Bernanke, 1983; Stiglitz and Weiss 1981). Nowadays most authors consider the credit channel as a mechanism that amplifies and propagates the traditional money channel (Bernanke and Gertler, 1995; Bernanke, 2007).

Later data also show that monetary policy affects real activity (Romer and Romer, 1989 and 1990; Bernanke and Blinder, 1992; Christiano, Eichenbaum and Evans, 1994 and 1998). Despite the agreement among economists about the effects of monetary policy on real activity, there is still an open debate about the transmission mechanisms (Bernanke and Gertler, 1995; Mishkin, 1995). The traditional money channel does not give a satisfactory explanation of the relationship of monetary policy and real activity. In particular, (i) the *magnitude* of the real effect caused by relatively small changes in the real interest rate; (ii) the *timing* of the effects, because the reaction of the aggregate demand stars after the monetary shock, when the interest rate is back to the initial levels; and (iii) the *composition* of the effect, because the short interest rate has significant impact on some long-lived investment (Bernanke and Gertler, 1995).

There are two views on how the credit channel operates: one is the *balance sheet channel* (or broad credit channel), and the other is the *bank lending channel.* According to the balance sheet channel view, firms face information problems with the lenders (Stiglitz and Weiss, 1981 and 1992; Kiyotaki and Moore, 1997; Bernanke, Gertler and Gilchrist, 1996; Holmstrom and Tirole, 1997). During a recession or a monetary tightening, the information problem worsens, amplifying the shock. The smaller firms, with lower levels of collateral are more prone to face information problems with the lenders, and thus to suffer the so called *financial accelerator*. The bank lending channel proponents (Bernanke and

Blinder, 1988; Kashyap and Stein, 1994) sustain that some firms do not have access to open credit markets, and thus depend on banks to obtain financing. A reduction in bank reserves induced by the monetary authority reduces the credit available to bank dependent firms. Bank dependent firms are those without investment grade, which are usually the smaller firms with low levels of collateral.

Empirical studies have found evidence supporting the idea of a balance sheet channel. Bernanke and Gertler (1995) shows two pieces of evidence: 1) the "coverage ratio", that they define as the ratio of interests payment to profits[1], which is a measure of a firms financial position (the higher the coverage ratio, the worse the financial position), covariates positively with the federal funds rate; and 2) firms cash flows and profits negatively covariates with the federal funds rate. Another literature focuses on flight to quality during financial distress as means to identify the effect of the monetary policy through the balance sheet channel, using microeconomic data. Gertler and Gilchrist (1994) find that small firms decelerate while large firms accelerate loan growth during a monetary contraction (flight to quality). Bernanke, Gertler and Gilchrist (1996) offer a review of papers finding flight to quality in credit extensions, consistent with the idea that borrowers with weaker financial position suffer more during economic downturns.

There is less support for the idea of a bank lending channel. Using aggregate data, Kashyap, Stein and Wilcox (1993) find that the mix of bank loans relative to commercial papers falls after a monetary shock. Bank loans are cheaper debt than commercial papers, thus the identification assumption is that firms would only increase the relative use of

[1] The coverage ratio is usually defined as the ratio of profits to interest payments, which is interpreted as the number of times that a firm can afford the interest payments.

commercial papers if banks restrict their offer of credit. In a similar framework, Oliner and Rudebusch (1995) find no evidence of a bank lending channel, using microeconomic data. They include other types of debt, besides bank debt and commercial papers, and separate the sample in large and small firms, finding that there is no evidence of changes in the mix of bank debt relative to other types of debt during monetary shocks, both for large and small firms. But, there is flight to quality of all types of debt from the small to the large firms, which is consistent with the idea of a broad credit channel. Using microeconomic data on banks, Kashyap and Stein (2000) find that banks with lower security to assets ratios (less liquid balances) reduce their lending by more after a monetary policy tightening, which is interpreted by the authors as evidence of the existence of a bank lending channel. Nilsen (2002) studies the behavior firms' relative use of bank versus trade credit during monetary contractions. He finds that both large and small firms replace bank credit with trade credit (which is more expensive, and thus less desirable), supporting the existence of a bank lending channel. He also uses bond ratings as an alternative measure of firms' access to credit different from the size of fixed asstes. When he splits the sample in firms with and without bond ratings (instead of large and small firms), he finds that firms without bond ratings (many of them large) are subject to bank lending restrictions, while firms with free access to open credit markets do not increase the use of trade credit, suggesting that the bank lending channel is broader than previously thought, because it also impacts many large firms.

A central issue for the credit channel is the existence of financial constrains. Fazzari, et al. (1988), Gilchrist and Himmelberg (1999), Harrison et al. (2001), Love (2001) and

Leaven (2002) propose two methodologies to test for the existence of financial restriction: Tobin's q and Euler equation framework. Both methodologies test for the significance of the effect of a firm's cash position on deviations from the investment predicted by the new classical model of investment with a frictionless capital market. Love (2001) and Leaven (2002) find that firms in more financially developed countries tend to be less credit restricted than firms in less developed countries. Forbes (2003) find that during the operation of the capital control *encaje*[2] in Chile, small trade firms were financially constrained, while large firms were not, supporting the assumptions behind the credit channel. Also for Chile, Medina and Valdés (1998) find that firm's investment depends on their cash position, indicating limited access to the credit markets; while Gallego and Loayza (2000) find evidence that firms with investment grade (eligible for investment to pension funds) were less financially constrained than firms without investment grade, which were also the smaller firms in the sample.

Recently, the attention of credit channel's literature has moved towards emerging economies. Edwards and Vegh (1997) study the role of bank credit in Chile and Mexico. They show how world business cycle and shocks to the banking system affect activity through fluctuations in bank credit. Tornell and Westermann (2002) find that the credit market amplifies and propagates the shocks to the national and international interest rates spread, in middle income countries, particularly to the nontradable sector. Caballero and Krishnamurthy (2004) explore the interaction of firm level financial constrains with country level financial constrain, in their "vertical analysis" framework. Arenas, Reinhart and Vásquez (2006) find that both foreign and national banks reduce their loans during adverse

[2] Encaje consisted in non-remunerated reserve requirement to capital inflows.

monetary conditions. Mian and Khwaja (2006) show how a liquidity shock has an asymmetric impact on firms of different sizes in Pakistan, affecting more smaller firms without access to alternative sources of credits. Alfaro et al. (2004) support the existence of a bank lending channel in Chile using VAR regressions of bank loans. They find that small banks reduce their loans by more than large banks during a monetary contraction. They also find that the ratio of high quality bank loans to low quality bank loans (used as a proxy for the bank lending channel) has predictive power over real activity.

The contributions of this essay to the existent literature are: first, a simple model that explains why flight to quality might not be a good identification assumption, specially in emerging markets. My model considers the relative behavior of constrained and not constrained firms; and describes the behavior of constrained firms investment regarding their level of collateral and the quality of investor protection. I suggest a new issue not yet considered in previous literature, which is, that among the constrained firms, those that face tighter credit constrains should also be less responsive to monetary tightenings; second, I contribute with new evidence of the credit channel in Chile using firm level data, finding also supporting evidence to my previous hypothesis.

2.3 The Model

Models of Bernanke, Gertler and Gilchrist (1996) and Kiyotaki and Moore (1997) only consider fixed assets as good collateral. I allow banks to consider a portion of the expected cash flows from investment as seizable collateral. All fixed assets are seizable, but the portion of seizable cash flows depends on the degree of asymmetric information between lender and borrower. The asymmetric information problem depends in turn of the legislation intended to protect investors, which is weaker in less developed economies (La Porta et al., 1998); it also depends on the degree of monitoring on a firms activity, which is more intense in firms with better access to the credit markets.

Similarly to other papers on the credit channel, I construct the model in the context of small and large firms, or more generally speaking, constrained and unconstrained firms. I focus on the behavior of small, constrained firms, since large, unconstrained firms are supposed to behave according more standard investment models operating in perfect financial markets.

Small, constrained firms have a level of fixed capital, K_S. As in Bernanke, Gertler and Gilchrist (1996) and Kiyotaki and Moore (1997), fixed capital is seizable and thus, considered good collateral by lenders. In addition, I assume that lenders also consider a fraction $0 < \gamma < 1$ of the expected cash flows from the project as collateral. The value of γ is a proxy of the quality of investor protection, which is related to the level of financial development of the country (La Porta et al., 1998), and to the degree of monitoring on firm's activities.

Assumption 1 *In case of default, lenders can only seize the firm's fixed capital, and a fraction* $0 < \gamma < 1$ *of the firm's payoff.*

There are also large firms in the economy, with a level of fixed capital K_L which is larger than any credit they would like to hire. Thus, large firms do not face credit constrains in practice and are able to hire credit until the marginal product of investment equals the marginal cost of the credit.

To keep the model simple, I assume that small firms have constant returns to scale in investment. Because small firms are bounded in the amount of credit they want to hire, I do not need decreasing returns to avoid unbounded solutions.

Assumption 2 *Small firms have constant returns to scale in investment up to the level of capital $\bar{K}$, after which they have decreasing returns to scale.*

The upper level $\bar{K}$ is not relevant in the solution of the model, but it helps to argue that both large and small firms may have access to the same technology, but $K_L >> \bar{K}$.

In my model, the credit channel plays the role of an amplifier mechanism of the traditional "money channel". I will take the simplest case where due to sticky prices or sticky information, expected inflation is fixed in the short run. The real interest rate i^r is:

$$i^r \approx i^n - E(\pi)$$

where i^n is the nominal interest rate and is fixed by the monetary authority. Without loss of generality I fix the expected inflation to $E(\pi) = 0$, and thus the monetary authority can choose the real interest rate for one period. I will refer to the interest rate fixed by the Central Bank simply as i, omitting the superscripts.

The definition of the partial equilibrium for firms and lenders, for a given interest rate which is fixed by the Central Bank, is given by:

Definition 2.1 (partial equilibrium) *A set $\{K_S, K_L\}$ such that for a given interest rate i:*

(i) Large firms' marginal product of investment equals the real interest rate of the credits offered.

(ii) Lenders have the same expected return among all their investment opportunities.

(iii) The lender has no incentives to change the interest rate charged on any of their credits.

It is worth noting that I am not interested in modeling the Central Bank's behavior. Instead, my interest is on the behavior of the firms, given the behavior of the Central Bank. My model gives predictions of firms' behavior after monetary policy shocks.

2.3.1 The Agency Problem and Credit Rationing

As in Stiglitz and Weiss (1981 and 1992) there is credit rationing in equilibrium, in the sense that for the equilibrium interest rate, the firm is willing to borrow more, but it is not convenient for the lender either to raise the interest rate, or to extend more credit. The intuition is that if the interest rate is higher or the size of the loan larger, there would be more adverse selection (because only firms that do not expect to pay back the loan will be interested in such an expensive credit), and more moral hazard (because limited liability imply a convex payoff to the firm as a function of the projects payoff, and the firms will act as risk lovers), decreasing the expected return of the credit from the point of view of the lender.

Small firms have perfectly divisible projects with constant return r, at least up to an upper limit $\bar{I}$ of investment, which by Assumption 2 is:

$$\bar{I} = \bar{K} - K_s$$

Firms contract credits to finance their investment projects. Consider that a firm and a lender engage in a credit for I_S, with an interest rate i. If the small firm pays back the credit, the firm's payoff is:

$$I_S\,(r-i)$$

But the firm can also choose to default the credit, in which case, the firm loses its collateral, and a fraction of the projects payoff. Thus the firm receives:

$$I_S\,(1+r)\,(1-\gamma)-K_S$$

For a small firm, the incentive condition to pay back a credit is:

$$I_S\,(r-i)\geq I_S\,(1+r)\,(1-\gamma)-K_S \tag{2.1}$$

Condition (2.1) holds for any positive values of I_S and i if:

$$\gamma\geq\frac{1+i}{1+r} \tag{2.2}$$

It means that, for a high enough level of investor protection γ, it is never convenient for a firm to default. For lower levels of γ, condition (2.1) can be written as:

$$I_S\leq\frac{K_S}{(1+i)-\gamma\,(1+r)} \tag{2.3}$$

When $\gamma=0$, condition (2.3) becomes the same credit restriction used by Bernanke, Gertler and Gilchrist (1996) and Kiyotaki and Moore (1997). Condition (2.3) is a credit restriction faced by small firms, with a level K_S of capital for a given credit interest rate i. If condition (2.3) holds, the lender receives a safe return i for the credit. Competition leads the interest rate of credit extended to small firms to be equal to other safe investment alternatives.

As long as $r > i$, small firms will hire as much credit as possible, thus, the optimal investment of small firms is given by expression (2.3) holding with equality. Let us consider only the case when $I_S < \bar{I}$ to avoid complex expressions for the credit restriction (2.3).

Heterogeneity Among Constrained Firms

Parameter γ is likely to differ among firms both within a country as well as between different countries. For firms in the same country, those firms with better access to credit markets are also subject to a closer monitoring from lenders and thus, have a larger γ. Within a country, the value of γ for different types of firms can be determined by factors such as: age, credit records, size, transparency, and so on. The value of γ is also determined by the quality of the institutions in a country, the regulation and the development of its financial markets. Thus, between different countries, similar constrained firms should have a larger value of γ in countries with the higher levels of financial development.

Proposition 1 *The semi-elasticity of constrained firms' investment is increasing in γ.*

Proof. Assuming expression (2.3) holds with equality, we calculate the semi-elasticity of constrained firms' investment:

$$\left| \frac{\partial \ln I_S}{\partial i} \right| = \frac{1}{(1+i) - \gamma (1+r)} \tag{2.4}$$

Expression (2.4) is increasing in γ, proving proposition 1. ■

In emerging markets, where a large portion of firms within a sample might be facing credit restrictions, proposition 1 predicts a different cross sectional behavior of firms within a country, compared to the commonly used in most empirical work on the credit channel. It stands that larger, less constrained firms are less sensitive to monetary policy shocks than smaller firms, which is the opposite to the implication considered in previous papers. The commonly used strategy to find flight to quality is to divide the sample of firms in two groups (large and small firms, for instance), and estimate the effect of monetary conditions on each group. There is flight to quality if the group of small firms are more responsive to monetary conditions than the group of large firms. If the effect of monetary policy is non monotonic in size (or in access to credit, more broadly speaking), researchers must take care with the interpretation of their results, when following such strategy, specially when dealing with data from emerging markets.

2.3.2 Large Firms Investment

Let us consider the case when there are also large firms in the sample, in the sense that they do not face credit restrictions. Large firms have large enough levels of capital relative to their levels of investment, the production function of large firms is:

$$F(K_L, I_L) = G(K_L) + AI_L^{\alpha} \tag{2.5}$$

where I_L is the investment of large firms and $0 < \alpha < 1$. I use the production function (2.5), instead of the commonly used $F(K+I)$ only to express the marginal product of investment independently of the value of K_L, in order to obtain simpler equations. The intuition of the results do not rely on the particular form of equation (2.5), but in the more general assumption that investment has decreasing returns of scale. A production function that depends on $K+I$ assumes that old investment is fully reversible, while a function with $\partial^2 I/\partial I \partial K = 0$ like (2.5), assumes that none of the previous investment is reversible. A more realistic production function may be something in between (Caballero and Hammour, 1996). In Appendix 2 I derive conditions for flight to quality using the more conventional $F(K+I)$ production function.

Large firms do not face credit restrictions because of their high level of collateral. Similar to small firms, large firms contract credits to finance their investment. The maximization problem is given by:

$$\max_{\{I_L\}} F(K_L, I_L) - (1+i) I_L$$

The first order condition of the problem is:

$$\frac{\partial}{\partial I_L} = \alpha A I_L^{\alpha-1} - (1+i) = 0$$

As usual, the condition states that marginal product of investment equals its marginal cost. The optimal level of investment is:

$$I_L = \left(\frac{\alpha A}{1+i}\right)^{\frac{1}{1-\alpha}} \tag{2.6}$$

In equilibrium investment of firms is given by equations (2.3) and (2.6) while the interest rate charged on credit for both small and large firms equals the interest rate fixed by the Central Bank. To see that this situation satisfies the definition of equilibrium, note that from the lender's point of view, as long as the restriction (2.3) holds, credits to small firms are risk free and have an expected return equal to the interest rate charged for the credit. Then, if the Central Bank offers risk free bonds that pay the interest rate i, both large and small firms face the same risk free interest rate for their credits, but small firms will be rationed, in the sense that the marginal productivity of investment is larger than the interest rate (evidence on the existence of credit restrictions is provided in Banerjee and Dufflo, 2004). Competition in credit markets assures that no lender has incentives to rise the interest rate of the credits. And finally, lenders do not have the incentive to give larger loans to small firms, because small firms would default and the expected return will be lower than i.

2.3.3 Flight to Quality Condition After Monetary Contractions

To consider the effect of a rise in the interest rate over the investment of small and large firms, we can use the semi-elasticities of investment to interest, using expressions (2.3) and (2.6):

$$\left|\frac{\partial \ln I_S}{\partial i}\right| = \frac{1}{(1+i)-\gamma(1+r)} \tag{2.7}$$

$$\left|\frac{\partial \ln I_L}{\partial i}\right| = \frac{1}{(1-\alpha)(1+i)} \tag{2.8}$$

and introduce a definition of flight to quality, commonly used in the empirical literature:

Definition 2.2 (flight to quality) *There is flight to quality after a rise in the interest rate when small firms reduce their investment proportionally more than large firms, that is* *when* $\left|\frac{\partial \ln I_S}{\partial i}\right| > \left|\frac{\partial \ln I_L}{\partial i}\right|$.

Comparing equations (2.7) and (2.8), the definition of flight to quality implies that there will be flight to quality when credit restrictions are relatively loose:

Proposition 2 *If there are both small (constrained) and large (unconstrained) firms, flight to quality will be observed after a monetary contraction, when* $\frac{1+i}{1+r} > \gamma > \alpha\frac{1+i}{1+r}$. *In words, flight to quality requires a sufficiently large value of* γ.

Proof. Small firms face credit restriction when $\gamma < \frac{1+i}{1+r}$, otherwise there would not be credit constrained firms or a credit channel to worry about. The second inequality comes directly from the definition of flight to quality. ■

To illustrate the implication of proposition 2, let us take the smallest quintil of firms in my sample. Using variables total debt, financial expenditures, sales and fixed assets from the balance sheet, I can construct estimates of i and r. Dividing interests expenditures by total debt, I find that i is close to 15%, while, by using the ratio of sales to fixed assets to make an estimate of r, I find the average product of capital to be close to 24%. Replacing these values, and for a value of $\alpha = 0.5$, proposition 2 suggest that there is expected to be flight to quality when $0.93 < \gamma < 0.46$. Or, in words, there would be flight to quality when more than nearly half of the expected cash flows from the projects can be seized by the lender in case of default. These number are not accurate, given the simple formulation of the model, and can only be taken as an exercise. More generally speaking, proposition 2 states that when there are both constrained and unconstrained firms in the sample, there will be flight to quality as long as the access to credit of the constrained firms is relatively good.

Propositions 1 and 2 imply a non monotonic effect of monetary conditions on investment. By proposition 1, small constrained firms are more responsive to monetary tightenings when they have better access to credit markets. It is likely that among contrained firms, larger firms will also have better access to credit markets (a larger γ), and thus be more responsive to credit markets. According to proposition 2, it is likely that among constrained firms, relatively large firms with better acces to credit, are more responsive to monetary conditions than even larger, unconstrained firms.

In emerging markets it is likely that most firms in the sample are facing credit restrictions. Different is the situation of more developed economies, where it is likely that larger firms in the sample do not face credit restrictions. The main hypothesis of my paper is that among credit constrained firms, those with a better access to credit are also the most responsive to monetary conditions. I use a sample of firm from Chile, an emerging market where I expect that most firms in the sample face credit restrictions, and thus firms with better access to credit markets should be more responsive to firms with worse access to credit. In my empirical strategy, I estimate the heterogeneous response of firms with better and worse access to credit markets, to monetary conditions. I find that indeed, the group of firms with better access to credit are more responsive to monetary conditions than firms with worse access to credit markets, supporting my main hypothesis. It may be the case that amog larger firms in my sample some are indeed unconstrained. Note that in this case, the average response of the group of firms with better access to credit will be attenuated, and not enlarged, thus it would not induce my results in any case. The situation is that I still find the significant larger response of larger firms despite it may be biased downwards in absolute value.

2.4 Evidence

Using firm level data I find supporting evidence of the within country implication of proposition 1: among constrained firms, those with looser credit restriction are also the more sensitive to monetary conditions, while firms with tight credit restrictions are less responsive to credit conditions. It is consistent with the idea of a non monotonic effect of monetary shocks over firms' investment. My findings are in line with the those of Almeida and Campello (2007). Nevertheless, they are concerned with the relationship between the investment-cash flow sensitivities and the tangibility of firms assets and not with the credit channel of monetary policy.

I use four different measures of firm's access to credit, or in terms of my model, proxies of variable γ: the size of their fixed assets; whether the firm depends on banks to obtain financing, or the firm issues bonds to raise funds; whether the firm belongs to an economic group or not; and if the firm classifies as large according its level of sales. In all cases I find that firms prone to have a better access to the credit market, say firms with a larger γ, are also the most responsive to changes in monetary conditions.

2.4.1 Data and the Econometric Approach

The data set consists on firm level balance sheets (FECU) of all chilean stock companies (sociedades anónimas) listed at the Superintendence of Securities and Insurance (Superintendencia de Valores y Seguros). I removed from the sample, firms in the following sectors, according to the ISIC sector classification: Financing, Insurance, Real Estate and

Business Services; Community, Social and Personal Services; and Activities not Adequately Defined. Not classified firms were also removed from the sample. It left a sample of 334 firms, from the original 908 firms that report FECUs to the SVS. The reason to remove these firms, is that firms within these sectors may not behave as profit maximizers, or the behavior of their fixed assets are unlikely to represent the behavior of their investment, as it is the case of firms in the financial sector[3]. To avoid attrition bias, I ran regressions including only the firms that remained in the sample the entire period under analysis, leaving finally 95 firms for the period 1991 - 2001.

To study the response of firms' investment to monetary policy, I estimate dynamic equations, similar to the equations estimated in the so called Euler Equation Framework, frequently used to test the existence of credit constrains (Forbes, 2003; Harrison et al., 2001; and Love, 2001). I regress firms' investment against a measure of monetary conditions; its interaction with firm size and other three measures of firm access to credit markets, say proxies of γ; and sets of control variables. As control variables I include proxies of internal finance conditions and firm productivity, for being closely related to investment, and time dummies as controls for common macroeconomic conditions. The appendix details the construction of all the variables that I include in the regressions.

My measures of the degree of access to credit are: (i) the size of the firm, measured as the logarithm of its fixed assets; (ii) whether the firm obtain financing from sources different from banks or not; (iii) whether the firm belongs to an economic group or not; and (iv) if the firm is considered large according to its level of sales. I use the lagged

[3]Firms in Comunity, Social and Personal Services may not be profit maximizers; while the behavior of fixed assets of firms in Financing, Insurance, Real Estate and Business Services may not represent their investment, which is more related to financial assets.

monetary policy rate fixed by the Central Bank (its official name is TPM, for *Tasa de Política Monetaria*) as the measure of monetary conditions. The sample period goes from 1991 to 2001. Within the sample period, the monetary policy framework was stable, and the monetary policy instrument was the short term real interest rate. After 2001 the Central Bank changed the monetary policy instrument to the short term nominal interest rate, the so called nominalization of monetary policy. The TPM is the chilean equivalent to the federal funds rate in the United States. Bernanke and Blinder (1992) argue that the federal funds rate is a good measure of the stance of monetary policy. Related literature on the credit channel uses the federal funds rate as a measures of monetary conditions, and when using alternative measures besides the federal funds rate (like Rommer dates or term spreads) they find similar results (Kashyap and Stein, 2000; Oliner and Rudebusch, 1995 and 1996; Kashyap, Stein and Wilcox, 1993).

Among my measures of access to credit, probably the most oftenly used variable to build groups of firms in related literature is the firm size of fixed or total assets. One concern with the use of this measure is that it may be related with the tradability of the sector, in particular, it may be the case that larger firms belong to tradable sectors and these sectors are expected to suffer more from monetary tightenings. To control for this, I run regressions controlling for the effect that the tradability of the sector may have on the relationship between monetary conditions and investment.

Last, I include a set of difference in difference style estimates of the heterogeneous effect of a monetary tightening among firms. I use the monetary tightening of 1998 to compare the two years previous to the tightening with the two following years.

Table 1: Summary Statistics

Year		1991	1992	1993	1994	1995	1996
Capital	Mean	124087.8	120569.2	119704.7	122949.2	127813.5	128725.8
	Std. Dev.	323228.7	322163.1	316480.8	317163.3	327123.3	342646.8
Investment	Mean	0.3%	8.1%	8.0%	3.3%	7.0%	2.3%
	Std. Dev.	40.4%	28.3%	22.0%	24.1%	23.6%	64.7%
No. of Firms		86	95	95	95	95	95

Year		1997	1998	1999	2000	2001
Capital	Mean	136394.9	136866.6	139261.2	140046.6	143347.8
	Std. Dev.	363133.1	345582.5	359118.2	356157.2	366164
Investment	Mean	1.2%	5.7%	-11.8%	-5.3%	3.3%
	Std. Dev.	60.2%	17.8%	89.9%	45.4%	13.0%
No. of Firms		95	95	95	95	96

Other Statistics

Bank Independent Firms	43.9%
Firms in Tradable Sector	58.2%
Firms Belonging to Economic Groups	85.7%
Large Firms According to the Level of Sales	88.8%

2.4.2 Dynamic Regressions

To test my hypothesis that firms with better access to credit markets are more sensitive to monetary conditions, I first run a set of regressions based on firms' size of fixed assets as the measure of access to credit:

$$y_{it} = c + \rho y_{it-1} + \beta_1 TPM_{t-1} + \beta_2 TPM_{t-1} * size_{it-1} + x'_{it}\gamma + \lambda_t + \mu_i + v_{it} \qquad (2.9)$$

where TPM is the monetary policy rate, $size$ corresponds to the natural logarithm of fixed assets, x are control variables, λ_t are time dummies; μ_i are random individual effects; and v_{it} is an iid random shock. Control variables, when included, are $Sales/K$ (sales over capital) as a measure of productivity, and $Liquidity/K$ (liquidity over capital), as a measure of internal financial position, both variables are commonly used in the estimation of investment equations (Forbes, 2003; Harrison et al., 2001; and Love, 2001). According to my hypothesis that firms with a better access to credit markets are more sensitive to monetary conditions, I expect parameter β_2 to be negative. I allow the marginal effect of monetary policy rate over the dependent variable to be a linear function of firm size, instead of a quadratic function that has the flexibility to capture a non monotonic effect. The reason is that allowing a quadratic function of size I find similar estimates of the marginal effect of the TPM on investment as in the linear shape of (2.9). I do not report the estimates of the quadratic function of size in this paper. The interpretation of this shape may be that most firms in the sample are indeed facing credit restrictions (in line with Nielsen, 2002).

Some literature interpret the marginal effect of liquidity on investment as evidence of the existence of financing constraints (See Fazzary, Hubbard and Petersen, 1988; and Forbes, 2003)., while Kaplan and Zingales (1997) argue that investment-cash flow sensitivities should no be interpreted as the existence of financing constraints. I do not attempt to interpret the coefficient related to $Liquidity/K$ of equation (2.9) as evidence of financing restrictions. I only include the variable as a control variable related to investment. My interest is to estimate parameter β_2 of equation (2.9).

I estimate equation (2.9) by GMM using Arellano and Bond (1991) style instruments, trying to keep the number of instruments low and the Sargan test with p-values larger than 10% to validate the instruments. I report the first-step estimates to avoid the under-estimation of the variance (see Roodman, 2007 for a review of the problems of GMM estimation of dynamic panels).

I estimate four versions of equation (2.9). The firs two specifications do not include time dummies, while the remaining two do include them. Note that including time dummies wipes away the group invariant variable TPM, but it still allows me to estimate parameter β_2 to test my main hypothesis. The role of the time dummies is to control for any macroeconomic conditions, which are common to all firms.

Table 2 shows the estimates of the four versions of equation (2.9). Estimates of table 2 support my hypothesis in all the specifications. I find significant negative estimates of β_2, which means that the partial derivative of firms' investment to the TPM is larger in absolute value for larger firms. The estimates indicate that, on average, the effect of a 1% rise in the monetary policy rate TPM decreases investment in nearly 3% for the average firm, while for a firm twice as big, the effect would be 3.5%. Considering that larger firms are several times larger than smaller firms (see table 1), the estimates indicate that the effect on the monetary policy rate is highly heterogeneous among firms of different sizes.

Table 2

			Time Dummies	
Dep. Variable	Investment	Investment	Investment	Investment
Lag. Dep.	0.02	0.178**	0.021	0.175**
	(0.221)	(0.054)	(0.158)	(0.055)
Lag. TPM	-3.207**	-2.961**		
	(1.303)	(1.292)		
Lag. TPM*Size	-0.584**	-0.486**	-0.579**	-0.5**
	(0.203)	(0.224)	(0.239)	(0.208)
Sales/K		0.017		0.007
		(0.043)		(0.046)
Liquidity/K		0.03		0.033
		(0.078)		(0.079)
Constant	0.231**	0.183*	0	0.022
	(0.085)	(0.095)	(0.041)	(0.063)
No. Observations	1025	994	1025	994
No. Groups	95	94	95	94
Sargan-p	0.517	0.304	0.74	0.334

Standar errors in parenthesis. * indicates significance at the 10% level and ** at the 5% level.

2.4.3 Alternative Measures of Access to Credit

I also use alternative measures of access to credit different from the widely used size of fixed assets. The regression equation is now:

$$y_{it} = c + \rho y_{it-1} + \beta_1 TPM_{t-1} + \beta_2 TPM_{t-1} * Access_{it-1} + x'_{it}\gamma + \lambda_t + \mu_i + v_{it} \qquad (2.10)$$

where variable *Access* is one of my three other measures of access to credit markets: (i) *Bank* which is a dummy variable equal to one if the firms does not depend on banks; (ii) *Group* is a dummy variables equal to one if the firm belongs to an economic group; and (iii) *Large* is a dummy variable equal to one if the firm is classified as large by its levels of sales, according to the definition of the SVS. As before I also include firm control variables and time dummies as macroeconomic controls.

According to my hypothesis, I expect β_2 to be negative. Tables 3 througt 5 show the estimates of different versions of equation (2.10). The estimates of table 3 show a significant negative value of β_2 in all specifications, indicating that bank independent firms are more sensitive to monetary conditions than bank dependent firms. The estimates of table 3 indicate that a one percent rise in the TPM reduces firm investment in nearly 2.8% in bank dependent firms and in nearly 3.7% in bank independent firms. The effect is one thrid larger in bank independent firms, which have a better access to credit markets than bank dependent firms.

Table 3

Dep. Variable	Investment	Investment	Time Dummies Investment	Investment
Lag. Dep.	0.002	0.185**	0	0.183**
	(0.219)	(0.055)	(0.221)	(0.056)
Lag. TPM	-2.862**	-2.749**		
	(1.367)	(1.311)		
Lag. TPM*Bank	-0.955**	-0.859**	-0.967**	-0.901**
	(0.445)	(0.435)	(0.443)	(0.438)
Sales/K		0.023		0.011
		(0.042)		(0.046)
Liquidity/K		0.032		0.036
		(0.078)		(0.08)
Constant	0.236**	0.182*	0.038	0.041
	(0.087)	(0.096)	(0.041)	(0.067)
No. Observations	1025	994	1025	994
No. Groups	95	94	95	94
Sargan-p	0.52	0.319	0.756	0.343

Standar errors in parenthesis. * indicates significance at the 10% level and ** at the 5% level.

Table 4

Dep. Variable	Investment	Investment	Time Dummies Investment	Investment
Lag. Dep.	0.004	-0.209	0.003	-0.242
	(0.219)	(0.169)	(0.221)	(0.172)
Lag. TPM	-2.781*	-1.89		
	(1.455)	(1.202)		
Lag. TPM*Group	-0.602	-1.133*	-0.625	-1.272**
	(0.619)	(0.61)	(0.609)	(0.623)
Sales/K		0.046		0.019
		(0.031)		(0.033)
Liquidity/K		0.091		0.114
		(0.079)		(0.083)
Constant	0.237**	0.137*	0.045	0.076
	(0.087)	(0.08)	(0.055)	(0.061)
No. Observations	1025	994	1025	994
No. Groups	95	94	95	94
Sargan-p	0.53	0.907	0.765	0.904

Standar errors in parenthesis. * indicates significance at the 10% level and ** at the 5% level.

Table 5

			Time Dummies	
Dep. Variable	Investment	Investment	Investment	Investment
Lag. Dep.	-0.059	-0.09	-0.094	0.092
	(0.228)	(0.159)	(0.152)	(0.063)
Lag. TPM	-3.265**	-0.114		
	(1.438)	(1.752)		
Lag. TPM*Large	0.098	-2.504*	0.338	-3.144*
	(0.702)	(1.487)	(0.638)	(1.842)
Sales/K		0.174**		0.224**
		(0.068)		(0.087)
Liquidity/K		-0.014		-0.01
		(0.035)		(0.041)
Constant	0.23**	-0.01	-0.012	-0.049
	(0.085)	(0.1)	(0.054)	(0.078)
No. Observations	1025	994	1025	994
No. Groups	95	94	95	94
Sargan-p	0.404	0.979	0.992	0.788

Standar errors in parenthesis. * indicates significance at the 10% level and ** at the 5% level.

Estimates of β_2 in tables 4 and 5 are not significant in all specifications. In particular, they turn out to be not significant in the equations that did not include firm specific controls. Even though, the estimates of β_2 from equation (2.10) do not have significant wrong signs.

2.4.4 Including Firms That Did Not Survive the Complete Period 1991-2001

Previous regressions did not include firms that did not survive the complete period from 1991 to 2001 to avoid attrition bias. But, by doing so I may be inducing sample selection bias. To discard that the sample selection bias may be inducing the results I replicate the estimates of tables 2 through 5 including all observations. The results are in tables 6 through 9.

Table 6

			Time Dummies	
Dep. Variable	Investment	Investment	Investment	Investment
Lag. Dep.	0.105**	0.671**	0.109**	0.104**
	(0.03)	(0.288)	(0.03)	(0.031)
Lag. TPM	-3.551**	-3.232*		
	(1.234)	(1.704)		
Lag. TPM*Size	-1.384**	-1.424**	-1.374**	-1.135**
	(0.093)	(0.225)	(0.093)	(0.116)
Sales/K		0.001		0
		(0)		(0)
Liquidity/K		0.004**		0.001
		(0.002)		(0.001)
Constant	0.282**	0.164	0.006	0.01
	(0.083)	(0.125)	(0.039)	(0.037)
No. Observations	1687	1681	1687	1681
No. Groups	244	243	244	243
Sargan-p	0.952	0.24	0.743	0.158

Standar errors in parenthesis. * indicates significance at the 10% level and ** at the 5% level.

Table 7

			Time Dummies	
Dep. Variable	Investment	Investment	Investment	Investment
Lag. Dep.	0.118**	0.118**	0.121**	0.117**
	(0.032)	(0.033)	(0.032)	(0.032)
Lag. TPM	-2.846**	-2.944**		
	(1.31)	(1.253)		
Lag. TPM*Bank	-1.011**	-0.847*	-0.982**	-0.824*
	(0.463)	(0.442)	(0.462)	(0.441)
Sales/K		0		0
		(0)		(0)
Liquidity/K		0		0.001
		(0.001)		(0.001)
Constant	0.28**	0.273**	0.063	0.058
	(0.087)	(0.084)	(0.043)	(0.04)
No. Observations	1687	1681	1687	1681
No. Groups	244	243	244	243
Sargan-p	0.943	0.278	0.783	0.358

Standar errors in parenthesis. * indicates significance at the 10% level and ** at the 5% level.

Table 8

Dep. Variable	Investment	Investment	Time Dummies Investment	Investment
Lag. Dep.	0.118**	0.117**	0.121**	-0.411
	(0.032)	(0.033)	(0.032)	(0.473)
Lag. TPM	-1.834	-2.127*		
	(1.341)	(1.281)		
Lag. TPM*Group	-1.921**	-1.563**	-1.886**	-2.839**
	(0.503)	(0.493)	(0.505)	(1.207)
Sales/K		0		0
		(0)		(0)
Liquidity/K		0		-0.002
		(0.001)		(0.003)
Constant	0.282**	0.275**	0.13**	0.218**
	(0.088)	(0.084)	(0.048)	(0.101)
No. Observations	1687	1681	1687	1681
No. Groups	244	243	244	243
Sargan-p	0.946	0.267	0.803	0.141

Standar errors in parenthesis. * indicates significance at the 10% level and ** at the 5% level.

Table 9

Dep. Variable	Investment	Investment	Time Dummies Investment	Investment
Lag. Dep.	0.118**	0.118**	0.125**	0.117**
	(0.032)	(0.033)	(0.032)	(0.032)
Lag. TPM	-1.598	-1.598		
	(1.447)	(1.421)		
Lag. TPM*Large	-1.813**	-1.857**	-1.842**	-1.815**
	(0.711)	(0.77)	(0.71)	(0.768)
Sales/K		0		0
		(0)		(0)
Liquidity/K		0		0.001
		(0.001)		(0.001)
Constant	0.28**	0.273**	0.135**	0.133**
	(0.088)	(0.084)	(0.055)	(0.056)
No. Observations	1687	1681	1687	1681
No. Groups	244	243	244	243
Sargan-p	0.948	0.265	0.608	0.352

Standar errors in parenthesis. * indicates significance at the 10% level and ** at the 5% level.

The estimates of β_2 in equations (2.9) or (2.10) are all significant with the expected sign for all the specifications and for my four measures of access to credit markets, supporting my hypothesis.

2.4.5 Controlling for Tradable Sectors

One concern is that the results in tables 2 through 9 may be driven by the relationship between my measures of access to credit and the tradability of the economic sector of the firm. Firms in tradable sectors may be more responsive to credit conditions than firms in the non tradable sector. If my measures of access to credit are correlated with the tradability of the firms' sector, my estimates may be biased. To control for the effect that may have the tradability of the sector on the relationship between investment sensibility to the interest rate, and the access to credit, I estimate a version of equation (2.10) allowing the interaction with a dummy variable indicating whether the firm belongs to a tradable sector or not:

$$\begin{aligned} y_{it} = c + \rho y_{it-1} + \beta_1 TPM_{t-1} + \beta_2 TPM_{t-1} * Access_{it-1} \\ + \beta_3 TPM_{t-1} * Trade + x_{it}'\gamma + \lambda_t + \mu_i + v_{it} \end{aligned} \tag{2.11}$$

where $Access$ is one of my four variables of access to credit, $Trade$ is a dummy variable equal to one if the firm belongs to a tradable sector, x are firm specific control variables, λ are time dummies, μ are random individual effect and v is a random shock. Table 10 shows the estimates of equation (2.11) for my four measures of access to credit markets.

Table 10

Dep. Variable	Investment	Investment	Investment	Investment
Lag. Dep.	0.175**	0.183**	-0.242	0.091
	(0.055)	(0.056)	(0.172)	(0.064)
Lag. TPM*Size	-0.516**			
	(0.203)			
Lag. TPM*Bank		-0.948**		
		(0.437)		
Lag. TPM*Group			-1.317*	
			(0.673)	
Lag. TPM*Large				-2.837*
				(1.719)
Lag. TPM*Trade	-0.401	-0.222	0.112	-1.808**
	(0.543)	(0.606)	(0.509)	(0.91)
Sales/K	0.007	0.012	0.019	0.229**
	(0.046)	(0.046)	(0.034)	(0.088)
Liquidity/K	0.032	0.036	0.114	-0.012
	(0.079)	(0.08)	(0.083)	(0.04)
Constant	0.035	0.049	0.074	-0.014
	(0.057)	(0.057)	(0.059)	(0.075)
No. Observations	994	994	994	994
No. Groups	94	94	94	94
Sargan-p	0.333	0.342	0.904	0.841

Standar errors in parenthesis. * indicates significance at the 10% level and ** at the 5% level.
Regressions with dummies (not reported)

Estimates of table 10 still support my main hypothesis of $\beta_2 < 0$ in equation (2.11). Note that the estimates of β_2 remain similar to the previous estimates of tables 2 through 5.

2.4.6 Controlling for Industrial Sector

I also run a regression controlling for the heterogeneous interaction of the TPM on investment according to the industrial sector. The equation is:

$$y_{it} = c + \rho y_{it-1} + \beta_1 TPM_{t-1} + \beta_2 TPM_{t-1} * Size_{it-1}$$
$$+ \sum \beta_k TPM_{t-1} * Sector_k + x'_{it}\gamma + \lambda_t + \mu_i + v_{it} \quad (2.12)$$

where $Sector_k$ are dummy variables that take the value of one if the firm belongs to sector k and zero otherwise, according to the first digit ISIC Rev. 2.

Table 11 show the estimates of equation (2.12). I do not show the estimates of parameters associated to the time dummies or to industrial sector dummies.

Table 11

			Time Dummies	
Dep. Variable	Investment	Investment	Investment	Investment
Lag. Dep.	0.016	0.134**	0.019	0.134**
	(0.221)	(0.042)	(0.162)	(0.042)
Lag. TPM	-5.577**	-5.471**		
	(1.44)	(1.479)		
Lag. TPM*Size	-0.649**	-0.567**	-0.642**	-0.569**
	(0.222)	(0.167)	(0.258)	(0.168)
Sales/K		0.009*		0.009*
		(0.005)		(0.005)
Liquidity/K		0		0
		(0.001)		(0.001)
Constant	0.229**	0.195**	-0.168*	-0.123**
	(0.085)	(0.092)	(0.087)	(0.051)
No. Observations	1025	1025	1025	1025
No. Groups	95	95	95	95
Sargan-p	0.517	0.375	0.547	0.434

Standar errors in parenthesis. * indicates significance at the 10% level and ** at the 5% level.

The estimates of the interaction parameter β_2 in equation (2.12) are significant, have the expected sign and are similar in magnitude to those from table 2.

2.4.7 Using an Alternative Measure of Monetary Conditions

I also used the real interest rate relevant for firms instead of the monetary policy rate. I use the yearly average real interest rate of the financial system for investments between 90 to 365 days published by the Central Bank of Chile (Tasas Medias De Interés Del Sistema Financiero, Colocaciones, 90 - 365 días, Reajustables en U.F.). Table 12 reproduces the results of table 2, but using this new measure of the interest rate. Again I find that the estimates if the interaction term is significant with the expected sign, and similar in magnitude to the estimates of table 2.

Table 12

			Time Dummies	
Dep. Variable	Investment	Investment	Investment	Investment
Lag. Dep.	0.023	0.136**	0.023	0.134**
	(0.222)	(0.042)	(0.163)	(0.042)
Lag. Rate	-1.976**	-1.89**		
	(0.91)	(0.94)		
Lag. Rate*Size	-0.419**	-0.344**	-0.411**	-0.342**
	(0.145)	(0.117)	(0.171)	(0.117)
Sales/K		0.01*		0.009*
		(0.005)		(0.005)
Liquidity/K		0		0
		(0.001)		(0.001)
Constant	0.203**	0.17*	-0.001	0.021
	(0.084)	(0.09)	(0.041)	(0.036)
No. Observations	1025	1025	1025	1025
No. Groups	95	95	95	95
Sargan-p	0.501	0.399	0.743	0.476

Standar errors in parenthesis. * indicates significance at the 10% level and ** at the 5% level.

2.4.8 Expanding the Period of Analisys

I previous regressions I use the period 1991-2001. During this period, the monetary policy instrument TPM was the short real interest rate. After 2001, the intrument was changed to the short nominal interest rate. Despite I do not have the values of the real TPM after 2001, I do have the values of the average real interest rate of the financial system used in table 12. I perform the same regressions, but for the period 1991-2005. Table 13 displays the estimates.

Table 13

			Time Dummies	
Dep. Variable	Investment	Investment	Investment	Investment
Lag. Dep.	-0.073	-0.023	-0.057	0.077
	(0.23)	(0.204)	(0.145)	(0.226)
Lag. Rate	-0.843	-0.714		
	(0.647)	(0.748)		
Lag. Rate*Size	-0.391**	-0.412*	-0.396**	-0.35*
	(0.158)	(0.213)	(0.148)	(0.194)
Sales/K		-0.002		0.003
		(0.008)		(0.01)
Liquidity/K		0.001		0.001
		(0.001)		(0.001)
Constant	0.066	0.055	0.028	0.033
	(0.052)	(0.077)	(0.028)	(0.066)
No. Observations	1225	1225	1225	1225
No. Groups	85	85	85	85
Sargan-p	0.145	0.347	0.172	0.242

Standar errors in parenthesis. * indicates significance at the 10% level and ** at the 5% level.

Again, the estimates of the interaction term are significan with the expected sign, and similar magnitude as in table 2.

2.4.9 Controlling for Other Macroeconomic Variables

It may be the case that the interaction term associated to $TPM * Size$, is driven not by the effect of the TPM but by other macroeconomic variable. To control for the effect of other macroeconomic phenomenon driving the result, I include in equation (2.9) and additional term with the interaction of variable $Size$ with the GDP growth of the period. Table 14 shows the estimates of this version of equation (2.9). As before, the estimates are significant with the expected sign and of similar magnitude as those in table 2.

Table 14

			Time Dummies	
Dep. Variable	Investment	Investment	Investment	Investment
Lag. Dep.	0.019	0.135**	0.021	0.134**
	(0.221)	(0.042)	(0.223)	(0.042)
Lag. TPM	-3.205**	-3.046**		
	(1.302)	(1.358)		
Lag. TPM*Size	-0.507*	-0.601**	-0.498*	-0.593**
	(0.261)	(0.189)	(0.263)	(0.187)
Lag. GDP*Size	-0.099	0.167	-0.105	0.156
	(0.152)	(0.214)	(0.151)	(0.216)
Sales/K		0.01*		0.009*
		(0.005)		(0.005)
Liquidity/K		0		0
		(0.001)		(0.001)
Constant	0.231**	0.196**	0	0.022
	(0.085)	(0.093)	(0.036)	(0.036)
No. Observations	1025	1025	1025	1025
No. Groups	95	95	95	95
Sargan-p	0.524	0.388	0.747	0.482

Standar errors in parenthesis. * indicates significance at the 10% level and ** at the 5% level.

2.4.10 The 1998 Monetary Policy Shock

As a final robustness check, I perform a difference in difference type estimation of the heterogeneous effect of monetary conditions on firms' investment. During the sample period, there is a year with clear tight monetary conditions. During 1998, Chile's Central Bank rose sharply the monetary policy rate, motivated, in part to fast capital outflows that were taking place during the previous year. After the monetary tightening, the production went down and the unemployment rose, consistent with international evidence (See Christiano, Eichenbaum and Evans, 1998; for a review of VAR studies for the United States). Figure (2.1) shows the path of the monetary policy rate, unemployment and a quarterly GDP growth with respect to the same quarter of the previous year.

Alfaro et al. (2004) used VAR regressions on bank loans, and find supporting evidence of a bank lending channel in Chile. They used the term spread as a measure

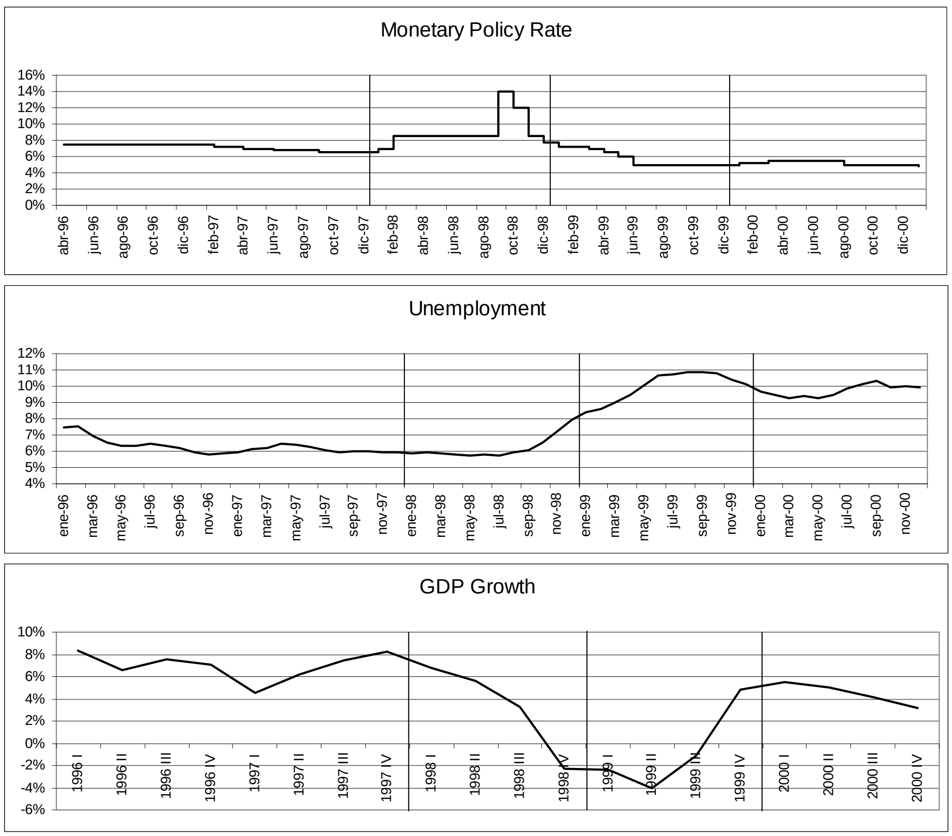

Figure 2.1: Monetary tightening and macroeconomic effects

of monetary tightening, which also classifies 1998 as a year with tight monetary policy. Other measures of monetary policy tightening, as the monetary policy rate, or changes in monetary aggregates, also classifies year 1998 as a year with tight monetary policy.

To perform the difference in difference type estimation of the effect of the policy shock I compare the bevarior of firms investment around the shock. In particular I compare the two years before 1998 with the two following years. I estimate:

$$y_{it} = \beta_0 + \beta_1 D_t + \beta_2 \cdot D_t \cdot Access_i + u_{it} \tag{2.13}$$

where D_t is a dummy thats takes the value of 0 for years 1996 and 1997, and the value of 1 for years 1998 and 1999; *Access* is one of my four measures of access to credit markets. It may be the continuous variable *size*, or one of my oter three dummy variables: *Bank*, *Group* and *Large*.

In (2.13) β_2 is the difference in difference type estimate of the effect of the shock on heterogeneous firms. I am not interested in the estimates of β_1, which would be a before-after estimate of the impact of the monetary contraction on investment, because it does not control for several variables and it is likely to be biased. I rely on the notion that monetary tightenings detriments investment on average. Instead I am interested on the heterogeneous effect of the tightening among firms. Note that in the case when the *Access* variable is continuos, the estimate of β_2 similar to a difference in difference estimator, but that imposes a linear shape of the effect. While, when *Interaction* is a dummy variable, β_2 con be easily interpreted as an ordinary difference in difference estimator.

Table 11 shows the estimates of equation (2.13). As suggested by my model, I find that firms with better access to credit have a larger response to the shock ($\beta_2 < 0$), but it is not significant for two of my measures of access to credit. Evidence of table 11 supports my previos findings and my vision that in emerging markets, where many firms in the data set may be facing credit restrictions, firms with better access to credit markets, usually larger firms, are also the more responsive to monetary conditions.

Table 15

Dep. Variable	Investment	Investment	Investment	Investment
Contraction	0.24	-0.074	-0.054	0.085
	(0.198)	(0.061)	(0.08)	(0.119)
Contrac.*Size	-0.028*			
	(0.016)			
Contrac.*Bank		-0.066		
		(0.081)		
Contrac.*Group			-0.061	
			(0.083)	
Contrac.*Large				-0.205*
				(0.12)
Constant	0.122**	0.122**	0.122**	0.122**
	(0.04)	(0.04)	(0.04)	(0.04)
No. Observations	702	702	702	702

Standar errors in parenthesis. * indicates significance at the 10% level and ** at the 5% level.

2.5 Conclusion

The model of section 1.3 poses the hypothesis that among financially constrained firms, monetary conditions are more important for those with looser credit restrictions, and not those with tighter restrictions as has been treated by most of the literature on the credit channel of monetary policy. I find supporting evidence for this hypothesis, using two alternative econometric approaches and different proxies for the degree of credit rationing. Firms with better access to credit are more affected by monetary conditions than more constrained firms. My result is in line with Almeida and Campello (2007) who find that the investment-cash flow sensitivities are larger for firms with better access to credit, as long as the firms are financially constrained. If unconstrained firms are less affected by monetary conditions, then the presence of credit restriction in Chile is widespread, even among large firms or it may be the only the expected behavior of unconstrained firms during rises in the interest rates.

My evidence doest not support or contradicts the so called bank lending channel of monetary policy (Kashyap, Stein and Wilcox, 1993; Kashyap and Stein, 2000). In Chile, banks play an important role financing firms, in fact, more than 50% of the firms in the sample were considered as bank dependent. According to my hypothesis the differences in the response of bank dependent and bank not dependent firms during changes in monetary conditions, are due to the degree of moral hazard with the lender, rather than to any particular feature of bank lending.

Empirical studies of the credit channel in emerging markets has to be careful when using flight to quality to identify the existence of a credit channel. Similar to what Almeida and Campello (2007) point out, the effect of monetary conditions over firm behavior may not be monotonic, as it seems to be the case for Chile. Grouping firms into two types (large and small), as is widely done in the literature, can be seriously misleading in the presence of non monotonicities.

Bibliography

[1] Alfaro, Rodrigo; Franken, Helmut; García Carlos; Jara, Alejandro "The Bank Lending Channel in Chile," in *Banking Market Structure and Monetary Policy*, ed. Luis Antonio Ahumada and J. Rodrigo Fuentes, Santiago, Chile (2004) Central Bank of Chile.

[2] Almeida, Heitor; Campello, Murillo "Financial Constraints, Asset Tangibility, and Corporate Investment," *The Review of Financial Studies*, Vol. 20, No. 5 (2007) pp. 1429-1460.

[3] Arena, Marco; Reinhart, Carmen; Vásquez, Francisco "The Lending Channel in Emerging Economies: Are Foreign Banks Different?", NBER Working Paper 12340 (2006).

[4] Bernanke, Ben "Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression," *The American Economic Review*, Vol. 73, No. 3 (1983), pp. 257-276.

[5] Bernanke, Ben, Speech at the "The Credit Channel of Monetary Policy in the Twenty-first Century Conference, Federal Reserve Bank of Atlanta, Georgia", June 15 (2007).

[6] Bernanke, Ben; Blinder, Alan "Credit, Money, and Aggregate Demand," *American Economic Review* Vol. 78, No. 2 (1988), pp. 435-439.

[7] Bernanke, Ben; Blinder, Alan "The Federal Funds Rate and the Channels of Monetary Transmission," *The American Economic Review*, Vol. 82, No. 4 (1992), pp. 901-921.

[8] Bernanke, Ben; Gertler, Mark "Inside the Black Box: The Credit Channel of Monetary Policy Transmission," *Journal of Economic Perspectives*, Vol. 9, No. 4 (1995), pp. 27-48.

[9] Bernanke, Ben; Gertler, Mark and Gilchrist, Simon "The Financial Accelerator and the Flight to Quality," *The Review of Economics and Statistics*, Vol. 78, No. 1 (1996), pp. 1-15.

[10] Brunner, Karl; Meltzer, Allan "Money and Credit in the Monetary Transmission Process," *The American Economic Review*, Vol. 78, No. 2, Papers and Proceedings of the One-Hundredth Annual Meeting of the American Economic Association (1988), pp. 446-451.

[11] Caballero, Ricardo "Coping with Chile's External Vulnerability: A Financial Problem," in *Economic Growth: Sources, Trends, and Cycles*, ed. Norman Loayza and Raimundo Soto, Santiago, Chile (2002) Central Bank of Chile.

[12] Caballero, Ricardo; Krishnamurthy, Arvind "A Dual Liquidity Model for Emerging Markets," *The American Economic Review*, Vol. 92, No. 2, Papers and Proceedings of the One Hundred Fourteenth Annual Meeting of the American Economic Association (2002), pp. 33-37.

[13] Caballero, Ricardo; Krishnamurthy, Arvind "Exchange Rate Volatility and the Credit Channel in Emerging Markets: A Vertical Perspective," NBER Working Paper 10517 (2004).

[14] Chari, V. V.; J. Kehoe, Patrick; McGrattan, Ellen R. "Accounting for the Great Depression," *The American Economic Review*, Vol. 92, No. 2, Papers and Proceedings of the One Hundred Fourteenth Annual Meeting of the American Economic Association (2002), pp. 22-27.

[15] Christiano, Lawrence, Martin Eichenbaum, and Charles Evans "Identification and the Effects of Monetary Policy Shocks." Federal Reserve Bank of Chicago Working Paper WP-94-7 (1994).

[16] Christiano, Lawrence, Martin Eichenbaum and Charles Evans "Monetary policy shocks: what have we learned and to what end?," in *Handbook of Macroeconomics*, ed. Michael Woodford and John Taylor, North Holland (1998).

[17] Edwards, S. and C. Végh "Banks and Macroeconomic Disturbances Under Predetermined Exchange Rates," *Journal of Monetary Economics*, Vol. 40 (1997), pp. 239-278.

[18] Fazzari, Steven M.; Hubbard, R. Glenn; Petersen, Bruce C.; Blinder, Alan S.; Poterba, James M. "Financing Constraints and Corporate Investment," *Brookings Papers on Economic Activity*, Vol. 1988, No. 1 (1988), pp. 141-206.

[19] Forbes, Christin "One Cost of the Chilean Capital Controls: Increased Financial Constraints for Smaller Trade Firms", NBER Working Paper 9777 (2003).

[20] Friedman, Milton "The Role of Monetary Policy," *The American Economic Review*, Vol. 58, No. 1 (1968), pp. 1-17.

[21] Friedman, Milton, and Schwartz, Anna J. "A Monetary History of the United States, 1867-1960," Princeton, N.J.: Princeton Univ. Press (for NBER), (1963).

[22] Gallego, Francisco and Hernández, Leonardo "Microeconomic Effects of Capital Controls: The Chilean Experiance During the 1990s," Central Bank of Chile Working Paper No. 203 (2003).

[23] Gallego, Francisco and Norman Loayza "Financial Structure in Chile: Macroeconomic Developments and Microeconomic Effects," World Bank mimeo (2000).

[24] Gertler, Mark; Gilchrist, Simon "Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms," *The Quarterly Journal of Economics*, Vol. 109, No. 2 (1994), pp. 309-340.

[25] Gilchrist, Simon and Charles P. Himmelberg. "Investment: Fundamentals and Finance," NBER Working Paper No. W6652 (1998).

[26] Harrison, Ann E., Inessa Love and Margaret S. McMillan "Global Capital Flows and Financial Constraints," World Bank mimeo (2001).

[27] Hicks, John "Mr Keynes and the Classics: A suggested simplification," *Econometrica*, Vol. 5, No. 2 (1937), pp. 147-159.

[28] Holmstrom, Bengt; Tirole, Jean "Financial Intermediation, Loanable Funds, and the Real Sector," *The Quarterly Journal of Economics*, Vol. 112, No. 3 (1997), pp. 663-691.

[29] Kaplan, Steven and Zingales, Luigi, "Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints?," *The Quarterly Journal of Economics*, Vol. 112, No. 1 (1997), pp. 169-215.

[30] Kashyap, Anil, Owen Lamont, and Jeremy Stein "Credit Conditions and the Cyclical Behavior of Inventories," *Quarterly Journal of Economics*, Vol. 109, No. 3 (1994), pp. 565-592.

[31] Kashyap, Anil; Stein, Jeremy C. "What Do a Million Observations on Banks Say about

the Transmission of Monetary Policy?," *The American Economic Review*, Vol. 90, No. 3 (2000), pp. 407-428.

[32] Kashyap A., J. Stein, and D. Wilcox "Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance," *The American Economic Review*, Vol. 83, No. 1 (1993), pp. 78-98.

[33] Kiyotaki, Nobuhiro and Moore, John "Credit Cycles," *The Journal of Political Economy*, Vol. 105, No. 2 (1997), pp. 211-248.

[34] Lang, William and Nakamura, Leonard "Flight to Quality in Banking and Economic Activity," *Journal of Monetary Economics*, Vol. 36 (1995), pp. 145-164.

[35] Laeven, Luc "Financial Liberalization and Financing Constraints: Evidence from Panel Data on Emerging Economies," World Bank mimeo (2002).

[36] La Porta, Rafael; Lopez-de-Silanes, Florencio; Shleifer, Andrei; Vishny,Robert W. "Law and Finance," *The Journal of Political Economy*, Vol. 106, No. 6 (1998), pp. 1113-1155.

[37] Love, Inessa "Financial Development and Financing Constraints: International Evidence from the Structural Investment Model," World Bank mimeo (2001).

[38] Lucas, Robert "Nobel Lecture: Monetary Neutrality," *The Journal of Political Economy*, Vol. 104, No. 4 (1996), pp. 661-682.

[39] Medina, Juan Pablo and Valdés, Rodrigo "Flujo de Caja y Decisiones de Inversión en

Chile: Evidencia de Sociedades Anónimas Abiertas," *Cuadernos de Economía*, No. 106 (1998), pp. 301-323.

[40] Mian, Atif and Khwaja, Asim Ijaz, "Tracing the Impact of Bank Liquidity Shocks: Evidence From an Emerging Market," NBER Working Paper 12612 (2006).

[41] Mishkin, Frederic S. "Symposium on the Monetary Transmission Mechanism," *The Journal of Economic Perspectives*, Vol. 9, No. 4 (1995), pp. 3-10.

[42] Nilsen, Jeffrey, "Trade Credit and the Bank Lending Channel," *Journal of Money, Credit and Banking*, Vol. 34, No. 1 (2002), pp. 226-253.

[43] Oliner, Stephen and Rudebusch, Glenn "Is There a Broad Credit Channel for Monetary Policy?," *Economic Review* Federal Reserve Bank of San Francisco (1996), pp. 3-13

[44] Oliner, Stephen and Rudebusch, Glenn "Is There a Bank Lending Channel for Monetary Policy?," *Economic Review*, Federal Reserve Bank of San Francisco (1995), pp. 1-20

[45] Rajan, Raghuram; Zingales, Luigi "Financial Dependence and Growth," *The American Economic Review*, Vol. 88, No. 3 (1998), pp. 559-586.

[46] John M. Roberts "New Keynesian Economics and the Phillips Curve," *Journal of Money, Credit and Banking*, Vol. 27, No. 4 (1995), pp. 975-984.

[47] Romer, Christina D. and David H. Romer "Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz," in NBER Macroeconomics Annual 1989,

ed. Olivier Jean Blanchard and Stanley Fischer, pp. 121-170. Cambridge, MA: MIT Press (1989).

[48] Romer, Christina, and David Romer, "New Evidence on the Monetary Transmission Mechanism," *Brookings Papers on Economic Activity*, Vol.21, No. 1 (1990), pp. 149-214.

[49] Roodman, David "A Short Note on the Theme of Too Many Instruments," Center for Global Developement Working Paper No. 125 (2007).

[50] Sofianos, George; Wachtel, Paul; and Melnik, Arie "Loan Commitments and Monetary Policy," *Journal of Banking and Finance*, Vol. 14 (1990), pp. 677-689.

[51] Stiglitz, Joseph and Weiss, Andrew "Credit Rationing in Markets with Imperfect Information," *The American Economic Review*, Vol. 71, N^o 3 (1981), pp. 393-410.

[52] Stiglitz, Joseph and Weiss, Andrew "Asymmetric Information in Credit Markets and Its Implications for Macro-Economics," *Oxford Economic Papers, New Series*, Vol. 44, No. 4, Special Issue on Financial Markets, Institutions and Policy (1992), pp. 694-724.

[53] Taylor, John "Staggered Wage Setting in a Macro Model," *The American Economic Review*, Vol. 69, No. 2, Papers and Proceedings of the Ninety-First Annual Meeting of the American Economic Association (1979), pp. 108-113

[54] Tornell, Aaron; Westermann, Frank "The Credit Channel in Middle Income Countries", NBER Working Paper 9355 (2002).

[55] Vergara, Rodrigo, "Taxation and Private Investment: Evidence for Chile", Applied Economics, forthcoming.

Appendix 1

Variable Construction

Capital: Corresponds to fixed assets plus cumulated depreciation, measured in constant 1998 CH$.

Size: Is the natural logarithm of variable Capital defined above, expessed as deviations from its overall sample mean.

Bank: Dummy variable equal to one if the firm issues corporate bonds during the sample period.

Group: Dummy variable equal to one if the firm reports both individual and consolidated financial statements.

Large: Dummy variable equal to one if the average sales of the firm during the sample period are above 100.000 U.F. according to the definition of the SVS.

Investment: The investment variable is constructed as the logarithmic change of, fixed assets plus the cumulated depreciation, measured in constant 1998 CH$.

TPM: The Monetary Policy Rate corresponds to the yearly average of the daily values of the policy instrument. Before may 28th of year 1995 the TPM corresponded to the 90 days bonds rate of the Central Bank. After that day, and up to august 9th, 2001 the TPM was the one day interbank rate. From the 10th of august of 2001 the policy instrument became the nominal one day interbank rate. To obtain a real rate after august 9th, 2001 I used the expected inflation reported by the Central Bank.

Tradable: Following Gallego and Hernandez (2003) I defined firms in sectors 712 (Water Transport), 713 (Air Transport), 100's (Agriculture, Hunting, Forestry and Fishing) 200's (Mining and Quarrying) and 300's (Manufacturing), according to the ISIS Rev.2, as tradable and the remaining sectors as non tradable.

Liquidity/K: In year t, it is the sum of items cash, term deposits and stock holdings of the balance sheet divided by lagged variable capital, expressed in prices of year t. I eliminated two percent of the outliar observations.

Sales/K: It is year t sales divided by lagged variable capital, expressed in prices of year t. I eliminated two percent of outliar observations.

Appendix 2

If a large firms production function is: $F(K+I)$ the investment decision is given by the condition:

$$F'(K+I) = (1+i)$$

Using a explicit production function as: $F(K+I) = A(K+I)^{\alpha}$, we have that:

$$I = \left(\frac{A\alpha}{1+i}\right)^{\frac{1}{1-\alpha}} - K$$

which is similar to condition (2.6), except for the K. Because the expression for the investment now has a sum, the semielasticity I am interest in, becomes the less esthetic:

$$-\frac{\partial \ln I}{\partial i} = \left(\frac{I+K}{I}\right) \frac{1}{(1-\alpha)(1+i)}$$

The difference with the previous expression is given by the term $\left(\frac{I+K}{I}\right)$, which do not depend on the small firms investment, and thus does not change cualitatively any of the model's results.

Chapter 3

Essay 3: On the use of p-values as evidence when estimating linear regressions models with time series and panel data

3.1 Introduction

Endogeneity is maybe the most delicate and frequent problem to deal with in empirical economics. To identify causal marginal effects of explanatory variables on the variable of interest, in the presence of endogeneity, we need instruments. Besides the issue of whether the instruments are valid or not, another problem arises when the researcher has more instruments available than the minimum needed to identify the parameters of the equation: there are many subsets of valid instruments to estimate with, and each subset yields a different estimation. Consider a researcher estimating a model with one endogenous explanatory variable, but with two valid instruments available. The researcher has three alternative ways to estimate: using either one of the two instruments, or using both. In each case, the estimates will be different and also the p-values. Using Monte Carlo simulations I show that there is a big chance to find a significant p-value when the true value of the parameter is zero in a given sample, using valid subsets of lags as instruments. My point goes beyond the use of over identification tests, since I performs the simulations using valid subsets of instruments.

Situations in which researchers have several valid subsets of lags available and thus the possibility to try different estimations and pick the most attractive for them do not represent a problem itself. The issue is that the use of p-values as conclusive evidence is overstated. Evidence should also rely on theoretical motivations, and several robustness checks. Non-parametric or semi-parametric estimations, whenever possible, may be a good complement to evidence from linear equations estimated with several subsets of lags. Despite they are less efficient, they may alsso be more robust.

Lovell (1983) and Denton (1985) show how data mining can distort the probabilities of the significance tests. Similarly, the use of different subsets of instruments gives a good chance to find apparently reliable results, when they are actually false. Donald and Newey (2001) show how to choose the optimal number of Instruments among a large set of valid instruments, but trying to minimize the mean square error of the estimates, and not considering the data mining problem. The researcher has the incentive to pick the subsets that result attractive when they validate the researcher's hypothesis. The bias in the selection of the subsets of instruments distorts the probability of type I error. In other words, the p-values are not reliable.

Related literature has focused on problems that arise when using large sets of instruments (Roodman, 2007; Donald and Newey; 2001) or when using weak instruments (Stock and Yogo, 2005; Hausman et al., 2007; Andrews and Stock, 2007; and Bun and Windmeijer, 2007). In my simulations I make experiments that do not suffer from any of these two problems. I generate "strong" instruments, in the sense that they are highly correlated with the instrumented variable; and in the simulation I estimate using subsets with a relatively small number of instruments.

3.2 The Problem of Alternative Instruments

To illustrate, consider the case of a researcher who is estimating the following equation:

$$y_i = \beta x_i + u_i$$

where both y_i and x_i are scalars, u_i is an iid random shock, with $E\left(u_i^2\right) = \sigma^2$ and $E\left(x_i u_i\right) \neq 0$. The researcher is interested in the value of parameter β. To overcome the problem of endogeneity, the researcher has two alternative valid instruments: z_{1i}, z_{2i}, with $E\left(z_{1i} u_i\right) = E\left(z_{2i} u_i\right) = 0$. Let us consider the case of Instrumental Variables (IV) estimation. There are two alternative IV estimators of β:

$$\hat{\beta}_k = \frac{\sum_{i=1}^{N} z_{ki} y_i}{\sum_{i=1}^{N} z_{ki} x_i}$$

for $k = 1, 2$.

Let us consider that the asymptotic distribution of the estimators is normal with mean β and variance equal to:

$$var\left(\hat{\beta}_k\right) = \sigma^2 \frac{\sum_{i=1}^{N} z_{ki}^2}{\left(\sum_{i=1}^{N} z_{ki} x_i\right)^2}$$

The t statistic of individual significance is, in each case:

$$t_k = \frac{\hat{\beta}_k}{\sqrt{var\left(\hat{\beta}_k\right)}}$$

Note that the covariance between t_1 and t_2 is:

$$cov\left(t_1, t_2\right) = \frac{\sum_{i=1}^{N} z_{1i} z_{2i}}{\sqrt{\sum_{i=1}^{N} z_{1i}^2 \sum_{i=1}^{N} z_{2i}^2}}$$

which equals zero when the instruments are orthogonal.

When $\beta = 0$, each t statistic has an asymptotic standard normal distribution. Thus if $\beta = 0$, and the researcher is using a significance level $\alpha = 5\%$, there is a 5% chance of rejecting the null when it is actually true. But, it is true for each instruments used in the estimation, thus the probability that at least one of the t tests is significant is higher than α. In fact, if the instruments, and thus the t tests are orthogonal, the probability of rejecting the null when it is actually true is:

$$\begin{aligned} \Pr\left(|t_1| > 1.96 \text{ and/or } |t_2| > 1.96\right) &= 1 - \Pr\left(|t_1| < 1.96 \text{ and } |t_2| < 1.96\right) \\ &= 1 - \Pr\left(|t_1| < 1.96\right) \Pr\left(|t_2| < 1.96\right) \\ &= 1 - 0.95^2 = 9.75\% \end{aligned}$$

which is higher than $\alpha = 5\%$.

If there were h orthogonal instruments, the probability of rejecting $H_0 : \beta = 0$, when it is true, is:

$$\Pr\left(\text{reject } H_0 \text{ when it is true}\right) = 1 - 0.95^h$$

The above probability tends to 1 as h grows. In other words, with many instruments there is a large chance that the researcher find supporting evidence to false hypothesis.

3.3 Monte Carlo Experiment

To illustrate, I perform two Monte Carlo Experiments: One is the case of a time series, with endogenous explanatory variable, but where the lags of both the explanatory and the dependent variable are valid instruments. In this case, because all lags are valid instruments there are many different combinations of instruments yielding different results. The second is the Arellano and Bond (1991) estimation of dynamic models of panel data, where the number of instruments can be very large, and the combinations of instruments subsets much larger.

3.3.1 Time Series Example

Consider the following data generating process:

$$\begin{aligned} y_t &= \beta x_t + \varepsilon_t \qquad (3.1) \\ x_t &= \rho x_{t-1} + \delta \varepsilon_t + v_t \end{aligned}$$

$\varepsilon_t \sim iidN\left(0, \sigma_\varepsilon^2\right), v_t \sim iidN\left(0, \sigma_v^2\right)$, $\varepsilon \perp v$.

I used the parameters $\beta = 0$, $\delta = 0.25$, $\sigma_\varepsilon^2 = 1$, $\sigma_v^2 = 1$. Parameter ρ is a measure of the quality of the lags as instruments for x_t, similar to the concentration parameter[1]. I made simulations for three different values of ρ: 0.1, 0.5 and 0.9. In each simulation, the first value of the explanatory variable x, was drawn from a distribution $N\left(0, \frac{\delta^2\sigma_\varepsilon^2+\sigma_v^2}{1-\rho^2}\right)$.

All the lags of x are valid instruments of x_t (also the lags of y). I perform Two Stages Least Squares (2SLS) estimation of parameter β, with all the subsets of lags of

[1]Indeed, the concentration parameter for x_{t-1} in this case is $\frac{\rho^2 \sum x_t^2}{\delta^2\sigma_\varepsilon^2+\sigma_v^2}$

variable x, up to the 5th lag that include all lags between the first and last of the lags. It gives 15 different subsets of instruments. I generate 500 samples, and in each sample I compute the t test for each subset of instruments. Table 1 shows the proportion of samples where at least one combination of lags gave a significant estimate with a 5% level of significance. The first row of table 1 shows the proportion of samples where at least for one subset of instruments the estimated β was significantly positive, the second row when it was significantly negative, and the third row when it was significantly different from zero.

We can see in Table 1 that the chance of finding a significant marginal effect of x on y in a given sample, when the real marginal effect is zero is high, and it does not fall when the size of the sample grows or the quality of the instruments increases.

3.3.2 Panel Data Example

Other common use of lagged variables as instruments is the estimation of dynamic panels. In panel data estimation, the number of instruments available can be very large which already represent a problem. Roodman (2007) offers a review of the problems that arise in the estimation of dynamic panel models due to the use of large number of instruments, and solutions as to reduce the number of lags or the use of the collapsed instrument matrix[2]. When including too many instruments in a finite sample, induces bias to the estimates and distorts the Hansen specification test. In my simulations I avoid the problems related to the use of large sets of intruments by following both suggestions: (i) I do not buid all the possible instruments, but only the instruments related to the first three lags; and (ii)

[2]The collapsed instrument matrix explotes the moment conditions $E\left(y_{i,t-l}\Delta v_{it}\right) = 0$ for each $l > 1$, instead of the traditional instrument matrix that explotes $E\left(y_{i,t-l}\Delta v_{it}\right) = 0$ for each $t > 2$, $l > 1$.

I repeat the experiment using the collapsed instrument matrix. A large number of instruments imply an even larger number of instruments' subsets, and thus a higher probability of wrongly rejecting the null hypothesis.

Consider the following data generating model:

$$\begin{aligned} y_{it} &= \rho y_{i,t-1} + \beta x_{it} + \eta_i + v_{it} \\ x_{it} &= \phi x_{i,t-1} + \theta v_{it} + \varepsilon_{it} \end{aligned}$$

with $\rho = 0.5$, $\beta = 0$, $\phi = 0.5$, $\theta = 0.5$, $\eta_i \sim N(0,1)$, $v_{it} \sim N(0,1)$, and all error terms are uncorrelated with each other. I use five different panel sizes: $N = \{50; 100; 500\}$ and $T = \{5; 7; 15\}$. The explanatory variable is endogenous, but the lagged values of y_{it} and x_{it} are valid instruments of the error term of the model in differences. To build the subsets of instruments I considered lags of y and x up to the third lag, discarding the subsets with no consecutive lags. I use Arellano-Bond style instrument matrix, and also the collapsed instruments matrix. I generate 100 samples, and in each sample I estimate with each of the subsets of instruments. The initial values of y and x are drawn from:

$$\begin{aligned} x_{i,1} &\sim iid\left(0, \frac{\theta^2\sigma_v^2 + \sigma_\varepsilon^2}{1-\theta^2}\right) \\ y_{i,0} &\sim iid\left(0, var\left(y\right)\right) \end{aligned}$$ [3]

For each sample, I performed the first step GMM estimation and computed the t

[3] The inconditional variance of y is: $var\left(y\right) = \frac{1}{\left(1-3\rho^2\right)}\left(\frac{\beta^2\left(\theta^2\sigma_v^2+\sigma_\varepsilon^2\right)}{\left(1-\phi^2\right)} + \frac{\sigma_\mu^2\left(1+\rho\right)}{\left(1-\rho\right)} + \sigma_v^2\left(1+2\beta\theta\right)\right)$

statistic for the hypothesis $H_0 : \beta = 0$. Table 2 shows the proportion of samples where at least one of the subsets of instruments found a significant marginal effect of x on y. The first column shows the proportion of times that at least one subset resulted in a significantly negative estimate, the second row for positive estimate and the third row the proportion of at least one significant result. Again, the probability of finding some significant evidence in a given sample, when it does not really exist, is high.

According to table 2, the probability of wrongly rejecting the null hypothesis is increasing in T and decreasing in N. As N growths, each sample moment condition is computed with more observations and the variance and bias of the estimates decreases together with the probability of a wrong rejection. In contrast, larger values of T implies the use of more moment condition in each estimation, but it does not imply the use of more data to compute each of the sample moment conditions. Using too many instruments may bias the estimates causing the larger probability of wrong rejection as T grows. Indeed, it is the probability of a wrong significant sing that clearly increases as T grows, but not the probability of a wrong significant negative estimate, that decreases with T in most cases.

3.4 Conclusion

With a large number of valid instruments available, it is likely that at least one subset of the instruments reveals the researcher the evidence she was looking for. Similar to the data mining problem, it is not always possible to know whether the instruments used were the best available or those that turned out to be convenient for the researcher. It does not mean that all estimations based on the use of lags as instruments are invalid, but it is a warning for not considering p values as the most reliable piece of evidence. Empirical work should also rely on solid theoretical motivations of the hypothesis being tested, not just on p values. A good complement to the evidence from linear equations estimated with several subsets of lags available is the use of less structured models as may be non parametric or semi parametric estimations that despite they are less efficient, they are also more robust.

Bibliography

[1] Andrews, Donald and Stock, James "Testing with Many Weak Instruments," *Journal of Econometrics*, Vol. 138 (2007), pp. 24-46.

[2] Arellano, Manuel and Bond, Stephen "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations," *The Review of Economic Studies*, Vol. 58 (1991), pp. 277-97.

[3] Bun, Maurice and Windmeijer, Frank "The Weak Instrument Problem of the System GMM Estimator in Dynamic Panel Data Models," CeMMAP Working Paper CWP08/07 (2007).

[4] Denton, Frank T. "Data Mining as an Industry," *The Review of Economics and Statistics*, Vol. 67 (1985), pp. 124-27.

[5] Donald, Stephen G. and Newey, Whitney K. "Choosing the Number of Instruments," *Econometrica*, Vol. 69 (2001), 1161-91.

[6] Hausman, Jerry; Newey, Whitney; Woutersen, Tiemen; Chao, John; and Swanson, Norman "Instrumental Variable Estimation with Heteroskedasticity and Many Instruments," CeMMAP Working Paper CWP22/07 (2007).

[7] Lovell, Michael C. "Data Mining," *The Review of Economics and Statistics*, Vol. 65 (1983), pp. 1-12.

[8] Roodman, David "A Short Note on the Theme of Too Many Instruments," Center for Global Developement, Working Paper No. 125 (2007).

[9] Stock, James and Yogo, Motohiro "Asymptotic Distributions of Instrumental Variables Statistics with Many Weak Instruments," in *Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothemberg*, ed. Donald Andrews and James Stock (2005).

Table 1: Probability of finding at least one subset of instruments that reject the null hypothesis of $\beta = 0$, when it is true.

		$\Pr(t > 1.96)$	$\Pr(t < -1.96)$	$\Pr(\lvert t \rvert > 1.96)$
$\rho = 0.1$	$T = 50$	61.8%	1.2%	62.8%
	$T = 100$	61.8%	2.2%	64.0%
	$T = 500$	57.2%	7.0%	63.8%
$\rho = 0.5$	$T = 50$	58.8%	30.6%	85.8%
	$T = 100$	54.2%	40.0%	90.6%
	$T = 500$	51.0%	47.2%	96.8%
$\rho = 0.9$	$T = 50$	51.4%	53.2%	98.6%
	$T = 100$	50.2%	50.8%	99.0%
	$T = 500$	51.6%	48.6%	98.8%

Table 2: Probability of finding at least one subset of instruments that reject the null hypothesis of $\beta = 0$, when it is true.

	Sample Size	$\Pr(t > 1.96)$	$\Pr(t < -1.96)$	$\Pr(\lvert t \rvert > 1.96)$
AB instruments	$N = 50; T = 5$	37%	5%	39%
	$N = 50; T = 7$	74%	3%	75%
	$N = 50; T = 15$	100%	0%	100%
	$N = 100; T = 5$	35%	5%	38%
	$N = 100; T = 7$	70%	2%	71%
	$N = 100; T = 15$	100%	0%	100%
	$N = 500; T = 5$	31%	7%	37%
	$N = 500; T = 7$	65.5%	8.6%	70.7%
Collapsed	$N = 50; T = 5$	34%	3%	37%
	$N = 50; T = 7$	79%	1%	79%
	$N = 50; T = 15$	100%	0%	100%
	$N = 100; T = 5$	27%	5%	30%
	$N = 100; T = 7$	46%	10%	53%
	$N = 100; T = 15$	88.9%	16.7%	93.3%
	$N = 500; T = 5$	20%	12%	28%
	$N = 500; T = 7$	45.1%	11%	50%