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Measuring the impact of financial taxation on capital: evidence from Chilean manufacturing plants

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ABSTRACT

Using panel data from Chilean manufacturing plants, we estimate the impact of a stamp tax, levied on loans by financial institutions, on capital stock. Our results show that the tax has a statistically significant negative effect on the stock of capital. Specifically, we find that a rise of one percentage point in the financial tax rate decreases the stock of capital by about 4%. We also find that the impact on firms is heterogeneous, depending on the intensity of the different types of capital they hold. In particular, the demand for capital from firms with a higher percentage of structural assets, such as land and buildings, is relatively less affected by the tax.

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KEYWORDS

Financial transaction tax; stock of capital; manufacturing industry

1. Introduction

Most of the literature regarding the relationship between taxes and the demand for capital has focused the analysis on the effect of corporate taxes on firms' stock of capital (see Hsieh & Parker, 2007; and Djankov, Ganser, McLiesh, Ramalho, & Shleifer, 2010; among others). However, there is little empirical research studying the effect that taxation of financial transactions could have on the stock of capital. In this paper, we provide evidence on the effect of a stamp tax, levied on loans by financial institutions, on the capital stock of Chilean firms.

Decree Law No. 3,475 introduced a stamp tax into Chile's financial institutions sector in 1980. This tax was levied on two main financial transactions: loans made by financial institutions (with and without a fixed maturity), and checks and other with-drawal operations from banks that are carried out with debit cards. The tax rate on financial loans is levied on the amount of the credit per month of duration of the credit, with a maximum of 12 months. The tax is one-time and collected through financial institutions at the time of the loan origination. For instance, if the maturity of a loan is 6 months and the monthly tax rate is a%, then the tax charged is equal to $6 \times a\%$ of the loan principal. For a loan with a maturity equal to or higher than 12 months, the tax rate equals $12 \times a\%$. Additionally, a fixed tax rate is levied on loans without maturity, whereas checks and other withdrawal operations from banks are taxed in a lump sum.

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This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/ by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The Chilean stamp tax has many features that resemble a bank debit tax (BDT). These taxes are usually levied on withdrawals from financial institutions' accounts, including check clearances, cash withdrawals, and payments of loan installments. There is considerable diversity in the design of these taxes from country to country. Transactions subject to or exempt from the tax also differ significantly, as well as tax rates.¹ The most common scheme for BDTs involves taxes imposed on debits to (withdrawals from) checking, savings, and term accounts in banks and other financial institutions, and on loan withdrawals.² In other countries-for instance, Ecuador-the tax is imposed not only on withdrawals but also on credits to checking, savings, loans, and other accounts at financial institutions. The taxation of both debits and credits is also a feature of the tax introduced in Argentina in 2001.³

A strand of the literature attempts to understand the effectiveness of BDTs for raising fiscal revenues. Coelho, Ebrill, and Summers (2001), Kirilenko and Summers (2003), Baca-Campodónico, de Mello, and Kirilenko (2006), and Restrepo (2013), among others, conclude that, for policy makers, taxes on bank transactions have been a particularly attractive source of revenue, as their collection is relatively efficient and inexpensive. However, the literature has also highlighted that BDTs create a strong incentive for economic agents to shift away from holding bank deposits, and move instead into using cash and other quasi-currencies. Several related articles have shown that the induced change in the behavior of agents as a consequence of BDTs produces three important effects in the economy: (i) a fall in long-term fiscal revenues (Albuquerque 2006; Baca-Campodónico et al., 2006; Coelho et al., 2001; Kirilenko & Summers, 2003, 2004); (ii) a financial disintermediation (Arbeláez, Burman, & Zuluaga, 2004; Coelho et al., 2001; Kirilenko & Summers, 2004; Restrepo, 2013); and, (iii) cascading effects that trigger resource misallocations (Arbeláez et al., 2004). In contrast from this strand of the literature, in this paper we address the question of how this type of tax might affect capital formation. More specifically, we study how a tax on loans made by financial institutions to the private sector affects firms' demand for capital. As explained above, the taxation of loans by financial institutions is one of the forms that BDTs have adopted.

A financial stamp tax may affect the rental cost of capital in economies where firms finance their capital units by relying on the credit market. Therefore, our paper also relates to the general cost of capital literature.⁴ This strand of the literature has successfully identified the user cost elasticity of capital as a key parameter of the impact of tax policy on capital formation. However, less success has been achieved when trying to reach consensus on the actual values of this parameter. Early research by Jorgenson (1963), and Hall and Jorgenson (1967), built on a Cobb-Douglas production function, implies a user cost elasticity of the capital stock equal to minus one. Subsequent studies

¹There is also considerable diversity in what these taxes are called, including bank debit taxes, bank account debit taxes and financial transaction taxes. However, financial transaction taxes are more usually associated in the literature with securities transaction taxes (see Matheson, 2011 for a general description of financial transaction taxes). On the other hand, Coelho et al. (2001) argue that the term "financial transaction tax" means, in general, a tax levied on each instance of specified banking, equity, currency, securities, or other financial dealings between a broad base of market actors. Therefore, following Coelho et al. (2001), BDTs may also be considered a subset of financial transaction taxes.
²In some countries the BDT has been creditable against the income tax or the VAT.

³See, for instance, Coelho et al. (2001), Kirilenko and Summers (2003), and Restrepo (2013) for a more detailed description of BDT schemes operating in Latin American countries.

⁴We would like to thank an anonymous referee for pointing this issue out.

were based on aggregate investment data (Eisner & Ishaq Nadiri, 1968) or micro-panel data (Chirinko, Fazzari, & Meyer, 1999) and they find that this parameter, when freely estimated, is well below unity in absolute terms.⁵ A second strand of research focuses on evidence that comes from periods with major tax reforms (Cummins & Hassett, 1992; Cummins, Hassett, & Glenn Hubbard, 1994, 1996). Using large panel datasets, these studies report substantially larger estimates that are not statistically different from unity (in absolute value). Rather than using an investment equation, Caballero, Engel, and Haltiwanger (1995) use plant-level data to estimate a cointegrational regression of the natural log of the capital-to-output ratio on the cost of capital. These authors obtain a wide range of user cost elasticity estimates for equipment (-0.01 to -2.0, with an average value of -1.0). These disagreements about the empirical estimates of the user cost elasticity of capital⁶ leave the question of whether or not taxes matter for business investment spending unanswered.⁷

We show in this paper that financial taxation on capital can indeed impact the firms' demand for capital. A financial stamp tax such as the one described above⁸ may impact firms' decisions regarding the desired stock of capital by affecting the rental cost of capital in economies where firms rely on the credit market to finance their capital units. In this way, a financial tax with the characteristics of the Chilean stamp tax might distort the optimal allocation of capital stock and, hence, decrease the potential growth of an economy. As argued by Shome (2011), in general, financial transaction taxes "may impose significant efficiency costs by increasing the cost of capital to firms". This type of distortion is important to quantify.

Additionally, a financial tax could have a heterogeneous impact across firms with different intensities of use of different types of capital. For instance, the incidence of the tax on the quantity of capital demanded can crucially depend on the possibilities that firms have to substitute the capital that needs to be financed in the credit market, where transactions are being taxed, with other production factors. Therefore, firms whose production is intensive in types of capital that can easily be substituted with other factors should experience a more pronounced decline in their demand for capital.

We use an extensive panel database of 10,946 Chilean manufacturing plants to (i) estimate the effect of a stamp tax levied on financial loans on firms' stock of capital, and (ii) test the hypothesis that this impact is heterogeneous across firms with different intensities of use of different types of capital. We find that the tax has a statistically significant negative impact on the capital stock. Specifically, a rise in the financial transaction tax of one percentage point decreases the stock of capital by about 4%. We also find that this effect is heterogeneous across firms with different intensities of use of different types of capital in their production process. In our sample, firms with a higher percentage of structural assets, such as land and buildings, decrease their stock of capital relatively less when the tax is increased.

⁵A summary by Chirinko (1993) found the elasticity estimates varied widely but were generally small.

⁶See Bond and Van Reenen (2007), Chirinko (2002), and Hassett and Hubbard (Hassett & Glenn Hubbard, 2002), for an overview of this discussion.

⁷See also King and Fullerton (1984) for a comparative analysis of the effective tax rates levied on capital income in the nonfinancial corporate sector in four major economies: the United States, the United Kingdom, Sweden, and West Germany.

⁸In Section 2 we further describe the main characteristics of the Chilean tax.

One of the empirical challenges of attempting to estimate the effect of a financial tax on the stock of capital is identifying the effective tax rate. As explained above, the tax is levied on the loan principal per month of duration of the loan, with a maximum of 12 months. Since the tax rate varies depending on the maturity of the credit, firms face different tax rates depending on the type of loans they take out. Our data permit us to identify the amount of financial tax paid by every manufacturing firm, and then we can construct the effective tax rate faced by every firm. However, since firms choose the amount of debt they assume, we face an endogeneity problem when estimating the impact of the tax using the effective financial transaction tax rate. In order to address this issue, we use instrumental variables two stage least squares estimation. We implement this methodology using a rich set of panel data from Chilean manufacturing firms. We find a statistically significant negative effect of the tax on the stock of capital. As a robustness check, we also estimate our empirical model using the statutory tax rate.

Our results contribute new evidence to the scarce empirical literature on the effects of financial taxes on the stock of capital in developing countries. Moreover, our findings show that the effects of these type of taxes can be heterogeneous across firms, depending on firms' intensity of use of different types of capital. One potential explanation for this result is that the different substitution capacity that firms have to replace capital with other production factors determines the magnitude of the elasticity of demand for capital and, thus, the effect of taxation.

The rest of the paper is organized as follows. Section 2 gives more detail about the Chilean financial stamp tax. Section 3 proposes a simple model to show how a financial tax may differently impact heterogeneous types of capital. Section 4 describes the database used and the construction of the variables employed in our estimations. Section 5 presents our empirical strategy, including a description of the methodology used to address the endogeneity problem. Section 6 reports and discusses the results of our estimations. Section 7 concludes.

2. The financial stamp tax in Chile

The financial stamp tax in Chile is regulated by Decree Law No. 3,475 of 1980. It is primarily levied on documents or acts that account for credit and debit transactions of money. Until 2008, the stamp tax had two main components: a tax on loans (with and without a fixed maturity) and a tax on checks and other withdrawal operations from financial institutions that are carried out with debit cards. In October 2008, the second component of the stamp tax was reduced, so that the tax mainly affects loans by financial institutions.⁹

Since January 2016, the stamp tax has been levied on loans and is 0.066% of the loan principal per month of duration of the loan, with a maximum of 12 months, equivalent to a maximum unique rate of 0.8%. Loans over a period of a year or longer are taxed at 0.8%. The tax is one-time and it is collected through financial institutions at the time of

⁹Until 2008, the stamp tax levied a lump sum (adjusted semi-annually according to the Consumer Price Index) on each issued check, withdrawals from ATMs, payments made using a debit card, and electronic money transfers. Law No. 20,291 of 2008 permanently eliminated the lump sum tax on check transactions and withdrawal operations from financial institutions using debit cards. Under the current law, only checks protested due to lack of funds in the checking account are taxed at a rate of 1% of the amount of the check, with a minimum tax of USD 5 (since July of 2016) and a maximum of USD 65.

Maturity	Tax rate (%)
1 month	0.066
2 months	0.132
3 months	0.198
4 months	0.264
5 months	0.33
6 months	0.396
7 months	0.462
8 months	0.528
9 months	0.594
10 months	0.66
11 months	0.726
12 months or longer	0.8

Table 1. The Chilean financial stamp tax in practice.

the loan origination. Table 1 gives some examples of tax rates levied on loans with different maturities.

Additionally, loans without a maturity are taxed at 0.332% of their loan principal. The stamp tax scheme is completed by a 1% tax on the amount of protested checks.

The statutory tax rate has undergone several modifications since the enactment of Decree Law No. 3,475 in 1980. The changes to the tax on loan operations have mainly affected its rate. As explained above, the tax on loans with maturities is a monthly percentage rate that is capped at 12 months. Until December 2006 the monthly rate was 0.134% with a ceiling of 1.608%. At that time, Law No. 20,130 introduced a reduction in the tax rate in three stages. First, in 2007 the monthly rate was set at 0.125% per month with a cap of 1.5%. Second, in 2008 the monthly rate was set at 0.1125% with a 1.35% cap. Third, in 2009 the monthly rate was set at 0.1% with a cap of 1.2%.

In March 2008, Law No. 20,259 set the tax rate on loans at 0.1% for each month or fraction of a month, with a maximum of 1.2%.¹⁰ Then, in January 2009, Law No. 20,326 temporarily reduced to zero the tax rate during that year and reduced the rate by half from January 1 to 30 June 2010. Law No. 20,455, published on 31 July 2010, set the rate at 0.05% per month, with a cap of 0.6%. Law No. 20,630, published in September 2012, set the rate at 0.033% per month, with a cap of 0.4%. Since January 2016, Law No. 20,780 has set the monthly rate at 0.066% of the amount of the loan for every month or fraction of duration of the loan, with a ceiling of 0.8%.

For loans without maturity, the tax rate was set at 0.67% in 2006. This rate fell to 0.625% in 2007, to 0.5625% in 2008, and to 0.5% in 2009. The 0.5% rate remained in effect only until 31 January 2009. Then, Law 20,326, enacted at the beginning of 2009, set at zero the tax rate for 2009, and reduced the rate by half from 1 January to 30 June 2010. Law No. 20,455 set this rate at 0.25%, effective from the end of the term of Law No. 20,326 (30 June 2010). Then, Law No. 20,630 set the rate at 0.166% beginning in January 2013. The last modification was introduced by Law 20,780, setting the rate at 0.332%.

As explained above, in addition to the tax on loans, the original legislation enacted in 1980 included a lump sum tax (the amount of which was semi-annually readjusted by the Consumer Price Index) on each issued check, withdrawals from ATMs, payments made using a debit card, and electronic money transfers. In 2008, the lump sum tax on checks

¹⁰That law also introduced an additional tax credit for VAT taxpayers. In order to be eligible for this tax credit, taxpayers must comply with a ceiling of annual sales. Therefore, the credit is mainly aimed to benefit small and medium businesses.

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Period	Tax rate (%)	Maximum
Operations with maturity		
From 1/1980	0.2	2.4
From 1/1988	0.1	1.2
From 1/2002	0.134	1.608
From 1/2007	0.125	1.5
From 1/2008	0.1125	1.35
From 3/2008	0.1	1.2
From 1/2009	0	0
From 1/2010	0.05	0.6
From 7/2010	0.05	0.6
From 1/2013	0.033	0.4
From 1/2016	0.066	0.8
Operations without maturity		Fixed Tax Rate (%)
Until 12/2006		0.67
From 1/2007		0.625
From 1/2008		0.5625
From 1/2009		0.5
From 2/2009		0
From 7/2010		0.25
From 1/2013		0.166
From 1/2016		0.332

Table 2. Chilean	financial	transaction	tax	rate
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reached USD 0.2 (in 2016 dollars). This tax was eliminated in October 2008 by Law 20,291. Table 2 summarizes the main modifications to the statutory stamp tax over time.

Currently, the financial stamp tax in Chile is primarily a tax on money lending operations. According to the definition of the Internal Revenue Service, "the Stamp Tax is a tax levied mainly on documents or acts that account for a loan transaction of money. The tax base is the amount of capital specified in each document".

Assuming a competitive credit market where some firms own limited capital and therefore need borrowed capital to finance their investments, and that neither the credit supply nor the credit demand is perfectly inelastic, a financial transaction tax levied on the value of the credit transaction will decrease the number of credit transactions. This will also limit firms' investment possibilities, affecting the stock of capital. Since in the end the effect on firms' capital stock depends on the level of the tax rate and the credit supply and demand elasticities, the nature of this paper is mainly empirical. However, in the next section, we present a very simple model of heterogeneous capital to understand how this type of tax may affect different types of capital differently.

3. Financial stamp tax with heterogeneous capital

We assume that both production factors and product markets are competitive and that firms choose the level of some production factor Z, which is financed by the firm's own resources, and n - 1 different types of capital, which are financed by borrowing in the formal credit market, to minimize total cost. We also assume that firms face a generalized Leontief cost function¹¹ of the form

$$C = q \sum_{j=1}^{n} \sum_{h=1}^{n} \gamma_{jh} (c_j c_h)^{0.5},$$

where q represents the output, γ_{jh} the input interaction parameters, and c_j the unitary cost of input j.

Employing Shephard's Lemma and assuming symmetry, that is, $\gamma_{jh} = \gamma_{jh}$, we can obtain the optimal choice of capital stock type *j* as $K_j^* = \frac{\partial C}{\partial c_{K_j}}$. Therefore, we can express the optimal choice of capital stock type *j* as

$$K_j^* = q \sum_{h=1}^n \gamma_{jh} \left(\frac{c_h}{c_j}\right)^{0.5}.$$
 (1)

Given that the financial transaction tax that we are analyzing is levied on the value of the credit transaction, we can define the unitary rental cost of capital type j as $c_{K_j} = (r + \delta + \hat{\tau})P_{K_j}$, with r as the real interest rate, δ as the depreciation rate of capital, $\hat{\tau}$ as the effective financial stamp tax rate, and P_{K_j} as the unitary purchase price of new capital of type j.¹² Notice that $\hat{\tau}$ is not the statutory tax rate but is the effective tax rate, which is paid once when the loan is originated. Consider the case of a firm that must take out a loan to buy a machine which, net of depreciation, can be sold at the end of the period. The effective tax rate paid on the bank loan is equal to $\hat{\tau} = min\{\tau_m \times m, \tau_{max}\}$ in the case of a loan with maturity equal to m, where τ_m is the statutory tax rate for m < 12 and τ_{max} is the statutory tax rate in the case of a loan without maturity. Then, the rental cost of capital must be equal to the financial cost $r \times P_{K_j}$, the cost derived from depreciation $\delta \times P_{K_j}$, and the effective tax stamp rate levied on the amount of the loan $\hat{\tau} \times P_{K_j}$.

Hence, we can reformulate (1) as

$$K_j^* = q\left(\gamma_{jj} + \gamma_{jZ}\left(\frac{c_Z}{(r+\delta+\hat{\tau})P_{K_j}}\right)^{0.5} + \sum_{h=1}^{n-2}\gamma_{jh}\left(\frac{P_{K_h}}{P_{K_j}}\right)^{0.5}\right),$$

with γ_{jZ} denoting the interaction parameter between capital type *j* and input *Z*, and c_Z denoting the unitary cost of input *Z*. We can now see the effect of the financial tax on the stock of capital as

$$\frac{\partial K_j^*}{\partial \hat{\tau}} = -\frac{0.5qc_Z^{0.5}\gamma_{jZ}}{(r+\delta+\hat{\tau})^{1.5}P_{K_i}^{0.5}}.$$

Therefore, we can see that the financial transaction tax has an unambiguous negative effect on capital stock, as long as $\gamma_{jZ} > 0$. We can also observe that the effect varies depending on the type of capital. The differences in the impact of the financial

¹¹The conditions of a generalized Leontief function can be found in Diewert (1971).

¹²We assume that there are no capital gains, no changes in relative prices, and a homogeneous depreciation rate across different types of capital. The main conclusions derived in this section do not depend on these assumptions. However, they greatly simplify the exposition.

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transaction tax depend on the capital-input Z interaction parameter, the depreciation rate of capital, and the unitary purchase price of new capital.

Since $\frac{\partial^2 K_j}{\partial \hat{\tau} \partial \gamma_{jZ}} < 0$, as γ_{jZ} increases in value, the negative effect of the financial transaction tax on capital stock grows. As in a generalized Leontief cost function, a higher γ_{jZ} , *ceteris paribus*, implies a higher degree of substitution between input *Z* and capital type *j*, and so the financial transaction tax affects more negatively the type of capital that is more substitutable with an input financed by the firm's own resources.

In the case of the depreciation rate of capital and the unitary purchase price of new capital, since both $\frac{\partial^2 K_j}{\partial \hat{\tau} \partial B} > 0$ and $\frac{\partial^2 K_j}{\partial \hat{\tau} \partial P_{K_j}} > 0$, higher levels of the depreciation rate of capital and the unitary purchase price of new capital of type *j* decrease the negative effect of the financial transaction tax on capital when $\gamma_{iZ} > 0$.

4. Data and variables

We use a panel of data from Chilean manufacturing plants, covering the period from 1995 to 2007.¹³ Though there are more recent data available, we use data only through 2007 because the instruments used in the estimations are only available through 2007. As will be explained further, we use value-added tax expense and other tax expense to construct our instruments. The database is retrieved from the Annual Chilean Survey of Manufacturers (ENIA), which is a census of manufacturing plants with 10 or more employees, conducted by the Chilean Institute of Statistics at the end of each year. Relevant articles such as Tybout, de Melo, and Corbo (1991), Liu (1993), Levinsohn (1999), Pavcnik (2002), and Levinsohn and Petrin (2003) have used these data in other types of studies.

The information is reported at the plant level and consolidated at the firm level. The panel includes 10,946 plants across 20 industries at the ISIC 2-digit level. We note that most of the sample is concentrated in the ISIC 15 category (manufacture of food products and beverages). However, most industries have a large number of firms. We use information about sales, fixed assets, investment, debt, and tax expense. All amounts are given in thousands of current Chilean pesos.

The ENIA 1995–2007 panel provides the previous year's value and the current year's investment for five types of fixed assets: (i) land, (ii) buildings, (iii) machinery and equipment, (iv) furniture and fixtures, and (v) vehicles. We first adjust the nominal value of each type of asset using the capital deflator provided by the Central Bank of Chile. After obtaining the real value for each type of asset, we use the perpetual inventory method to compute the capital stock for each type of asset as

$$k_{it} = (1 - \delta_k)k_{it-1} + I_{it},$$

where k_{it} is the type of fixed asset for plant *i* at time *t*, δ_k denotes the depreciation rate of fixed asset k,¹⁴ and *I* is the investment in fixed asset k.¹⁵ We denote the aggregate stock of capital of firm *i* in period *t* as K_{it} .

¹³Data from the Enterprise Surveys elaborated by the World Bank Group show that 80% of Chilean firms have a bank loan, 50% use banks to finance investment, and 40% of investments is financed by banks.

As we explain in Section 2, the statutory stamp tax rate varies with different maturities and types of financial instruments. A firm that takes out a loan for 12 or more months faces a tax rate of $12 \times a\%$ of the loan principal, where a% represents the monthly statutory tax rate. However, if the same loan had a maturity of only 3 months, the tax rate would be $3 \times a\%$. Since our data contain the amount of tax paid by the firm, but not the maturity of the loan on which the stamp tax is levied, the statutory tax rate may not accurately represent the effective stamp tax rate.¹⁶ In order to address this issue, we construct an effective financial transaction tax rate.

As in the model of Section 3, assuming that all types of capital subject to the stamp tax are financed by borrowing in the formal credit market, one possibility is to construct the effective tax rate as the tax level paid by the firm divided by capital. Another alternative is to construct the effective tax rate as the tax level paid by the firm divided by credit, since some capital transactions may not be financed by loans from financial institutions, and thus would not be subject to the stamp tax. A third alternative is simply to use the statutory tax rate. In order to analyze the robustness of our results, our empirical approach considers all three alternatives: (i) the statutory stamp tax rate, T_1 , measured as the maximum stamp tax rate for loan operations with maturity; (ii) the effective tax rate T_2 , constructed as the tax level paid by the firm divided by capital; and (iii) the effective tax rate T_3 , constructed as the tax level paid by the firm divided by credit.

Although the statutory tax may not reflect the effective tax rate, it has the advantage of being exogenous, which is not the case for both T_2 and T_3 .¹⁷ To address the endogeneity problems arising from the use of the effective tax rate, we present estimates using instrumental variables. The first instrument is the effective value-added tax VA, constructed as

$$VA_{it} = \frac{VAE_{it}}{M_{it}}$$

where VAE_{it} is the value-added tax expense of firm *i* during period *t* and M_{it} corresponds to the expenditure on materials and raw materials of firm *i* during period *t*. The second instrument is the natural logarithm of other tax expense, denoted as OT_{it} , which mainly includes the sum of the values of the expenses on nonrecoverable value-added taxes and readjustments of income taxes.

5. Empirical strategy

In our empirical model we (i) estimate the effect of the financial tax on the stock of capital, and (ii) test the hypothesis that this impact is heterogeneous across firms with different intensities of use of different types of capital. To do so, we use the following empirical models:

¹⁴We use depreciation rates of 2.5%, 13%, 13%, and 25% for buildings, machinery and equipment, furniture and fixtures, and vehicles, respectively, as documented by Oulton and Srinivasan (2003).

¹⁵Investment is defined as the purchase of new and used assets plus asset improvements minus the sales of used assets.

¹⁶Additionally, as discussed by Cerda and Saravia (2009), firms may use different mechanisms to evade the legal tax rate and pay a lower effective tax rate.

¹⁷Further explanations of endogeneity problems arising from the effective tax rates are provided in the next section.

$$\ln K_{it} = \alpha_0 + \alpha_1 T_s + u_{it}, \tag{2}$$

$$\ln K_{it} = \beta_0 + \beta_1 T_s + \beta_2 (T_s \times \theta'_{it}) + e_{it}, \qquad (3)$$

where $\ln K_{it}$ denotes the log of the capital stock of firm *i* during period *t*, T_s is the stamp tax rate for $s \in \{1, 2, 3\}$, as defined in the previous section, $T_s \times \theta_{it}^j$ is an interaction term between the financial transaction tax rate and the percentage of capital type *j* in the total capital stock of firm *i* during period *t*, which attempts to capture the heterogeneous impact of the tax on firms with different intensities of use of different types of capital, and u_{it} and e_{it} represent idiosyncratic error terms.

The empirical model described by Equation (2) measures the impact of the stamp tax on the aggregate capital stock of firms, omitting the issue of the use of heterogeneous types of capital. In Equation (3), we extend (2) by including an interaction term between the effective tax rate and the percentage of land and buildings in the total capital stock during period t.¹⁸ Therefore, the empirical model described by Equation (3) allows us to test the hypothesis that the impact of the tax is heterogeneous across firms with different intensities of use of different types of capital.

As we can see from the previous section, the effective tax rates, T_2 and T_3 , are constructed using capital and credit, respectively. Hence, firms with high levels of capital may also show relatively low levels of T_2 , with the result that the effect of Ton the stock of capital is understated. Another potential endogeneity problem is reverse causality. The amount of capital purchase or debt incurred might be a consequence of firms choosing the optimal level of capital stock, and this optimization behavior would affect the effective tax rates. Therefore, since we have the possibility that $E[u|T] \neq 0$ and $E[e|T, T \times \theta^i] \neq 0$, estimating regressions (2) and (3) by OLS, when using both T_2 and T_3 , may deliver biased and inconsistent estimators of α and β .

In order to address this problem, we propose the use of instrumental variables. Since VA and OT, as defined in Section 4, are not directly correlated with the stock of capital – instead, both the value-added tax rate and readjustments of income taxes, as well as the statutory financial tax rate, are, of course, determined by authorities – we use them as instrumental variables for regressions (2) and (3). As an example, Chilean authorities modified both the financial and value-added taxes in the years 2001, 2002, 2006 and 2007.¹⁹

Therefore, using the instrumental variables approach, we regress

$$T_{s} = \gamma_{0} + \psi_{1} V A_{it} + \psi_{2} O T_{it} + \nu_{it}, \qquad (4)$$

for both T_2 and T_3 . We then recover \hat{T}_s to be used as a regressor in the second stage.

Considering that there may be some particular firm characteristics that remain constant over time and which may affect the capability of negotiating loan's terms, we use firm-fixed effects to control the potential endogeneity coming from that source. There might also be particular yearly shocks that may affect the overall manufacturing

¹⁸The characteristics of land and buildings are different than those of other types of capital, such as machinery and equipment, as documented by Krusell, Ohanian, Ríos-Rull, and Violante (2000).

¹⁹Laws 19,716 and 19,768 of 2001 modified the value-added tax and the stamp tax, respectively; Law No. 19,840 of 2002 modified the value-added tax and the stamp tax; Laws 20,102 and 20,130 of 2006 modified the value-added tax and the stamp tax, respectively; and Law No. 20,190 of 2007 modified the value-added tax and the stamp tax.

sector and which may affect the loan's conditions, thus we use year-fixed effects to control for these shocks. In addition to using firm and year effects, to avoid identification problems that might be caused by omitted potential sources of own financing which do not remain constant over time, we control by firm profitability – which is measured as a firm's profit divided by its sales –, effective interest rate – which is measured as a firm's interest expense divided by its debt stock –, and stock market access –, which is measured as a firm's dividends divided by its retained earnings.²⁰

As explained in Section 2, to check for robustness, we also estimate our empirical model by directly including the statutory tax rate. Whenever we use the statutory tax rate T_1 , we replace the year effects, due to collinearity with the statutory tax, with variables controlling for external macroeconomic conditions, which may affect capital formation in the manufacturing sector. To do so, we include the World Bank's world output index and The Economist's commodity price index as additional covariates. Therefore, our final regressions are as follows:

$$\ln K_{it} = \alpha_0 + \alpha_1 \hat{T}_s + \zeta' \Pi_{it} + \rho' X_t + \varphi_i + \mu_{it}, \qquad (5)$$

$$\ln K_{it} = \beta_0 + \beta_1 \hat{T}_s + \beta_2 \hat{T}_s \times \theta'_{it} + \varsigma' \Pi_{it} + \xi' X_t + \sigma_i + \epsilon_{it}, \tag{6}$$

where Π_{it} denotes the vector of own financing control variables, including profitability, effective interest rate and stock market access; X_t the vector containing the external macroeconomic indicators when using T_1 as the tax rate, or the year effects when using T_2 and T_3 as the tax rates; φ_i and σ_i represent the firm fixed effects; and μ_{it} and ε_{it} represent idiosyncratic error terms. We also check the exogeneity of our instruments using the Hansen J test and their relevance using the Staiger and Stock (1997) condition.

Another issue regarding our estimations is the presence of outliers. The firms in the manufacturing industry are very heterogeneous; a small group may have very high levels of capital stock, while another small group may have very low levels of capital stock. Using the logarithm of the stock of capital may reduce the problems caused by the presence of outliers. However, it may not be sufficient. Therefore, we define outliers as the 2.5% of firms with the lowest levels of capital stock and the 2.5% of firms with the lowest levels of capital stock and the 2.5% of firms with the regressions both including and excluding outliers.

6. Results

Tables 3 to 5 present the results of our empirical estimates. Table 3 presents the effect of the statutory stamp tax on capital stock. Specification 1 regressions, which do not disaggregate by the intensity of use of different types of capital, show a negative effect of the financial tax on the stock of capital. Specifically, we observe that an increase of one percentage point in the financial tax leads to a reduction in the desired level of capital of about 1.7%. This effect is statistically significant at any conventional level.²¹

²⁰A discussion regarding the effect of debt structure on loan's conditions can be found in Blackwell and Kidwell (1988), Barclay and Smith (1996), and Fernández, Pernice, and Streb (2008).

²¹As noted by Blackwell and Kidwell (1988), and Fernández et al. (2008), small or medium size firms' funding mainly come from bank loans while large firms have access to capital markets. Therefore, we may expect that small and medium firms, which have limited access to capital markets, would be more affected by the tax. In line with Blackwell

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	Speci	fication 1	Specification 2			
	Whole Sample	Vhole Sample Excluding Outliers		Excluding Outliers		
T ₁	-1.7230***	-1.7670***	-2.8641***	-2.9333***		
	(0.1642)	(0.1645)	(0.1684)	(0.1686)		
Interaction	- /	_	3.2888***	3.3610***		
			(0.1254)	(0.1252)		
Instrumental Variables	No	No	No	No		
Control Variables	Yes	Yes	Yes	Yes		
Firm Effects	Yes	Yes	Yes	Yes		
Year Effects	No	No	No	No		
Observations	57,257	55,765	57,257	55,765		

Standard errors in parentheses. *** significant at 1% level.

The next columns display the results of Specification 2, which includes an interaction term between the statutory tax rate and the percentage of land and buildings in the total capital stock. Because the interaction coefficients are positive, we conclude that the tax has a less negative impact on firms where the stock of capital contains a higher proportion of structural assets, such as land and buildings. This supports the hypothesis that the financial transaction tax has a heterogeneous impact on firms using different types of capital.

As discussed in the previous section, the statutory tax rate has the disadvantage that it may not accurately reflect the effective stamp tax rate. Therefore, Table 4 shows the OLS regression when using either effective tax rate T_2 or effective tax rate T_3 . The stamp tax has a less negative effect on capital stock when using these effective tax rates than when using the statutory tax. In Specification 2, we can see that the tax has a larger negative impact in firms where the stock of capital contains a higher proportion of structural assets when using T_2 as the effective tax rate. However, the tax has a lower negative impact in firms where the stock of capital contains a higher proportion of structural assets when using T_3 as the effective tax

	Speci	fication 1	Speci	fication 2	
	Whole Sample	Excluding Outliers	Whole Sample	Excluding Outliers	
T ₂	-0.1940***	-0.1926***	-0.1854***	-0.1841***	
	(0.0190)	(0.0189)	(0.0190)	(0.0189)	
Interaction T ₂		_	-2.5828***	-2.5680***	
			(0.4038)	(0.4020)	
T ₃	-0.0499***	-0.0522***	-0.1050***	-0.1085***	
	(0.0101)	(0.0101)	(0.0137)	(0.0137)	
Interaction T ₃	_	-	0.1903***	0.1948***	
			(0.0320)	(0.0320)	
Instrumental Variables	No	No	No	No	
Control Variables	Yes	Yes	Yes	Yes	
Firm Effects	Yes	Yes	Yes	Yes	
Year Effects	Yes	Yes	Yes	Yes	
Observations	57,257	55,765	57,257	55,765	

Table 4. Effect of the effective tax rate on capital stock (OLS).

Standard errors in parentheses. *** significant at 1% level.

and Kidwell (1988), and Fernández et al. (2008), excluding firms with 100 or more workers, we find that an increase of one percentage point in the financial tax leads to a reduction in the desired level of capital of about 1.9%.

	Specification 1		Specification 2		
	Whole Sample	Excluding Outliers	Whole Sample	Excluding Outliers	
\hat{T}_2	-4.0877***	-4.0761***	-5.7636***	-5.8294***	
-	(0.3802)	(0.3781)	(0.6098)	(0.6060)	
Interaction \hat{T}_2			2.6925***	2.8157***	
-			(0.7661)	(0.7607)	
Ĵ ₃	-4.3986***	-5.4925***	-4.9908***	-6.4718***	
5	(0.1684)	(0.2242)	(0.1704)	(0.2252)	
Interaction \hat{T}_3	_ /		1.8122***	2.9204***	
5			(0.0959)	(0.1154)	
Control Variables	Yes	Yes	Yes	Yes	
Firm Effects	Yes	Yes	Yes	Yes	
Year Effects	Yes	Yes	Yes	Yes	
Observations	57,257	55,765	57,257	55,765	
Instrumental Variables	;				
F-statistic \hat{T}_2	59.05***				
-	[0.0000]				
J-statistic \hat{T}_2	[`] 0.0540 [′]				
-	0.8163				
F-statistic \hat{T}_3	63.99***				
5	[0.0000]				
J-statistic \hat{T}_3	0.0016				
-	0.9681				
Firm Effects	Yes				
Year Effects	Yes				
Observations	57,257				

Table 5. Effect of the Effective Tax Rate on Capital Stock (TSLS).

Standard errors in parentheses. P-values in brackets. *** significant at 1% level.

rate. As also shown in this table, our results do not qualitatively change when controlling for outliers.

However, as explained in the previous section, the OLS regressions might deliver biased and inconsistent estimators. In order to address this empirical issue we use instrumental variables two stage least squares estimation (TSLS). We use the effective value-added tax and the natural logarithm of other tax expense as instruments. In order to test the instruments' relevance we use the Staiger and Stock (1997) condition of relevance. Additionally, we test the instruments' exogeneity using the J-statistic of the Hansen test. Table 5 presents the results of these tests and the TSLS coefficients resulting from Equations (5) and (6).

Regarding the relevance of our instruments, we observe from Table 5 that the F-statistic of the first stage regression (4) is 59.05 when using T_2 as the dependent variable and 63.99 when using T_3 as the dependent variable, which satisfies the Staiger and Stock (1997) condition of relevance.²² Additionally, the J-statistic of the Hansen test is 0.0540 when using T_2 as the dependent variable and 0.0016 when using T_3 as the dependent variable, failing to reject the null hypothesis that the instruments are exogenous at any conventional level of significance. Therefore, our instruments meet both relevance and exogeneity conditions when we use either T_2 or T_3 as the effective tax rate.

As for our main results, we observe from Specification 1 in Table 5 that there is a negative and statistically significant effect of the financial tax on the stock of capital. A

²²The correlation values of T_2 with the effective value-added tax and the natural logarithm of other tax expense are 0.36 and 0.49, respectively; while the correlation values of T_3 with the effective value-added tax and the natural logarithm of other tax expense are 0.45 and 0.46, respectively.

	Statutory Rate		Effective Rate			
	Whole Sample	Whole Sample Excluding Outliers		Excluding Outliers		
T ₁	-13.2544***	-13.2341***	-	-		
	(0.3346)	(0.3402)				
\hat{T}_3	_	-	-15.0318***	-17.8272***		
			(0.5047)	(0.6388)		
Instrumental Variables	No	No	Yes	Yes		
Control Variables	Yes	Yes	Yes	Yes		
Firm Effects	Yes	Yes	Yes	Yes		
Year Effects	No	No	Yes	Yes		
Observations	59,273	49,707	59,273	49,707		

Table 6. I	Effect	of	the	tax	on	total	debt
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Standard errors in parentheses. *** significant at 1% level.

rise of one percentage point in the stamp tax rate reduces the stock of capital by 4.1% if we use T_2 as the effective tax rate. When using T_3 as the effective tax rate, we can see from Table 5 that an increment of one percentage point in the tax reduces the stock of capital by 4.4% when using the whole sample and by 5.5% when excluding outliers.

Additionally, we can observe from Specification 2 in Table 5 that as the percentage of structural assets increases, the stamp tax has a relatively less negative impact on the stock of capital, when using either T_2 or T_3 as the effective tax rate. Notice that we draw the opposite conclusion from the OLS results when using T_2 as the effective tax rate. Therefore, the endogeneity problem is more serious when performing the OLS regression (3), since it not only understates the negative effect of the tax on capital stock but also changes the conclusion about how the interaction coefficient affects capital stock. This underlines the necessity of using instrumental variables.

Finally, since the stamp tax increases the cost of loans, we might expect that the channel by which the stamp tax affects the desired level of capital is indeed a decrease in the demand for loans, which decreases firms' debt stock. To test this hypothesis, we regress Equation (5), but instead of using $\ln K_{it}$ as the dependent variable we use the natural logarithm of the firm's debt stock. The first two columns of Table 6 show the results of this regression when using the statutory tax rate as the regressor. As we can see from the table, an increase of one percentage point in the tax rate has a negative impact of about 13% on the debt stock. This table also shows the TSLS regression of the natural logarithm of the debt stock on the effective tax rate \hat{T}_3 . As we can see, an increase of one percentage point in the stamp tax has a negative impact on the debt stock of about 15% when using the whole sample and slightly less than 18% when excluding outliers.

Overall, our results suggest a negative impact of financial taxation on the capital stock of firms. Moreover, our empirical findings show a differentiated impact across firms with different intensities of use of different types of capital.

7. Conclusion

This paper provides empirical evidence of the effect of a financial tax levied on bank loans on firms' capital stock in Chile. Our findings show a statistically significant negative effect of the tax on the stock of capital. Additionally, we assess the degree of heterogeneity of the effect across firms. Specifically, we study the interaction of the effective stamp tax rate with the capital composition of firms. We find that the effect of the tax is not homogeneous across firms that have different types of capital. Our results show that the demand for capital of firms with a higher percentage of structural assets, such as land and buildings, is relatively less affected by a stamp tax on financial transactions.

One potential explanation for this result is that different types of capital have different elasticities of substitution with other inputs; therefore, we expect a different impact of the financial tax on firms with different capital compositions. Economic theory predicts that the incidence of a tax on the quantity demanded of a factor is greater when the possibilities for firms to substitute the taxed factor with other production factors are higher. For example, suppose a production technology that uses labor and different types of capital as the only production factors. Then, we can conjecture that machinery and equipment are easier for firms to substitute by labor compared with structural assets such as land and buildings. A high substitution between machines and low-skill labor has indeed been documented, and is especially relevant for the manufacturing sector where the intensity of low-skill labor is greater than in other sectors (see Acemoglu & Autor, 2011, for a review of the literature in this area). Consequently, our results are consistent with this conjecture. We show that firms with a higher percentage of machinery and equipment decrease their stock of capital relatively more when the tax is increased. In contrast, the demand for capital of firms with a higher percentage of structural assets, such as land and buildings, is relatively less affected by a stamp tax on financial transactions.

These results might be useful to consider before implementing a stamp tax levied on financial institutions' loans, since, as we show, capital stock accumulation is not neutral to such a tax. Moreover, the capital accumulation of firms that depend relatively more on machines or equipment would be affected relatively more by the implementation of this type of tax.

Disclosure statement

No potential conflict of interest was reported by the authors.

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