Beware the Side Effects: Capital Controls Cause Misallocation and Reduce Welfare*

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Abstract

This paper studies the effect of capital controls on misallocation and welfare in an economy with financial constraints. We build a general equilibrium model with heterogeneous firms, financial constraints and international trade and calibrate it to the Chilean economy. Since high-productivity and exporting firms need to borrow more to reach their optimal scale, capital controls that tax international borrowing hit them harder. As a result, misallocation increases relatively more for this group of firms, and for young firms that are still trying to reach their optimal scale. In terms of welfare, the model predicts a sizable aggregate loss of 2.39% when capital controls are introduced, with welfare decreasing twice as much for high-productivity firms. We empirically corroborate the main insights in terms of misallocation obtained from the model using Chilean manufacturing firm data from 1990 to 2007.

Keywords: Capital controls, welfare, misallocation, financial frictions, international trade.

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1 Introduction

Capital controls (CCs) were extensively implemented through the 1990s to counteract potential vulnerabilities arising from the large capital inflows that many countries were receiving. Since the 2007-2008 crisis, they regained widespread attention becoming part of the macro prudential toolbox used by policy-makers seeking to reduce systemic financial risk and contagion. In this context, some recent contributions have provided new theoretical justification for the use of CCs based on the idea that they can reduce the pecuniary externalities that lead to sudden stops (Bianchi (2011), Bianchi and Mendoza (2018)). However, from the firm level point of view, capital controls increase the interest rate at which firms borrow, making financing more expensive. Moreover, CCs affect firms differently depending on their intrinsic characteristics such as size, financial dependance or capital intensity (Alfaro et al. (2017), Forbes (2007), Andreasen et al. (2020)).

In this paper, we study the effects of CCs on misallocation and welfare in an economy with financial frictions. To this end, we build a model with three main characteristics: 1) heterogeneity in productivity; 2) international trade; and 3) financial frictions, in the form of a collateral constraint. In this economy, a continuous number of heterogeneous entrepreneurs produce differentiated domestic varieties and sell them to final-good producers domestically and abroad. Entrepreneurs differ in their idiosyncratic productivity. They can save and borrow internationally, but they face a collateral constraint. The CC is modeled as a tax on borrowing, effectively affecting all firms that rely on external borrowing by increasing the effective interest rate on loans.

We show that the unconstrained planner sets allocations such that the marginal revenue products of capital and labor are equalized across firms, irrespective of their idiosyncratic productivity level or the sector where they operate. Absent financial distortions such as the collateral constraint and the CC, the decentralized equilibrium yields the same result, and there is no misallocation. In the presence of financial distortions, however, there is dispersion in the marginal revenue product of capital across firms and misallocation arises. This is due to the fact that financial distortions prevent firms to produce at their optimal level causing inputs to be assigned inefficiently across heterogenous production units. In this context, CCs introduce an additional source of misallocation into an economy that is already inefficient. As inefficient equilibria cannot be ranked in general, there is no guarantee that the equilibrium with CC yields higher or lower welfare than the one without CC.

We show numerically how the introduction of a CC affects misallocation and welfare. We use as our laboratory the well studied Chilean *encaje*, i.e., a 30% unremunerated reserve requirement imposed by the Chilean government between 1991 and 1998. We calibrate the model with pre-policy Chilean data and then introduce a CC in the form of a tax on capital inflows, analogous to the Chilean *encaje*. We find that, when the CC is implemented, misallocation increases for exporters and high productivity firms, while it decreases for low productivity ones. Low productivity firms have smaller optimal scales and, consequently, need to borrow less to reach them. Similarly, exporters operate larger optimal scales and, consequently, rely more on credit to accumulate capital and pay the fixed cost of becoming an exporter. Finally, we find that misallocation increases relatively more for young firms as they are still trying to reach their optimal scales and therefore more exposed to the CC.

In terms of the welfare consequences, we find that the introduction of the CC implies a sizable welfare loss of 2.39%. High productivity firms are relatively more affected showing a welfare loss of 3.52%, while for low productivity firms the loss is 1.65%. As in the case of misallocation, the high productivity firms are more exposed to the CC because they need to borrow more in order to accumulate capital to reach their optimal scales. We also decompose the aggregate welfare loss into changes associated with the aggregate allocation of resources and changes associated with the redistribution of the resources in the economy. We find a small and positive distributional effect, which accounts for the fact that consumption is slightly more equally distributed when the CC is in place. This effect, however, is not enough to compensate the negative effect of the distortion in aggregate prices and quantities.

We compare the results of our baseline model with three additional cases. First, we assume that the quantity paid by each entrepreneur due to the CC is rebated in the same quantity as a lump-sum transfer. Results are quantitatively similar, although, as expected, the decrease in welfare is lower than in the benchmark case. Second, we consider two alternative policies that reduce aggregate credit/value added in the same magnitud as the CC: a symmetric increase in the interest rate and a decrease in the fraction of the capital that can be pledged as collateral, that is, a tighter loan to value requirement (LTV). The first policy lowers the optimal scales of all firms, which in turn generates more misallocation and higher welfare loss than in the case of the CC. The LTV has substantially lower welfare costs than the CC. This is due to the fact that this measure affects only the speed at which firms accumulate capital and, contrary to the CC, the substitution effect between capital and consumption stimulates production and domestic sales.

Finally, we empirically corroborate the main insights on misallocation obtained from the model using Chilean manufacturing firm data from 1990 to 2007 from the *Encuesta Nacional Industrial Anual* (ENIA). Following Bai et al. (2020) we define misallocation at the firm-level as the absolute value of the difference, in each period, between the firm's MRPK to the mean MRPK of the industry. Mostly in line with the results from our model, we find that CCs increase misallocation relatively more for more productive, exporting and younger firms.

The paper is organized as follows: Section 2 presents the related literature; Section 3 develops the theoretical model; Section 4 presents the main numerical results; Section 5 characterizes the empirical analysis; and Section 6 concludes.

2 Related Literature

Our paper relates to three strands of literature. First, it relates to studies that explore the relation between misallocation and financial frictions. In general, this literature uses heterogeneous-firms models to study and quantify how policies or other characteristics can generate input misallocation (Restuccia and Rogerson (2008), Hsieh and Klenow (2009)). In the presence of financial frictions firms cannot produce at their optimal capacity affecting the capital dynamics. This generates misallocation that can potential be exacerbated by other policies. In a model with sectors that differ in their degree of financial dependence, Buera et al. (2011) show that financial frictions can significantly distort the allocation of productive factors. Midrigan and Xu (2014) propose a model with one traditional and one modern productive sector in which debt constraints distort technology adoption decisions and create misallocation. Both papers predict that financial liberalization is associated with lower misallocation. However, more recently, Gopinath et al. (2017) develop a model with size-dependant financial frictions and show that a decline in interest rates can lead to a significant decline in sectoral total factor productivity as capital inflows are misallocated towards firms that have higher net worth but are not necessarily more productive. They document dispersion and productivity looses in Spain, Portugal and Italy during a period of declining real interest rates but not in Germany, France, and Norway.

Other empirical papers also focus on the relation between capital controls and TFP. Bekaert et al. (2011) demonstrate that the easing of CCs positively affects capital stock growth and TFP. Larraín and Stumpner (2017), focusing on Eastern European countries, find that capital account liberalization increases aggregate productivity through a more efficient allocation of capital across firms. Related to this, Varela (2018) studies the financial liberalization episode of Hungary in 2001 and shows that a reduction in CCs can lead firms to invest in technology adoption and, through this channel, aggregate TFP increases. Some papers study closer the Chilean case. Oberfield (2013) studies allocative efficiency and TFP during the 1982 financial crisis. He finds that within-industry either remained constant or improved in 1982, while a decline in between-industry allocation efficiency accounts for about one-third of the reduction in TFP. Chen and Irarrázabal (2015) provide suggestive evidence that financial development might be an important factor explaining growth in output and productivity in Chile between 1983 and 1996. Pavcnik (2002) investigates the effects of liberalized trade on plant productivity in Chile in the early 1980s. Using plant-level manufacturing data, she finds that improvements in within plant productivity and in many cases aggregate productivity improvements because of reallocation from less to more efficient producers. Our paper contributes to this literature by considering how capital controls affect misallocation in an economy with financial constraints. We approach this question both empirically and also providing a theoretical framework in which to study how capital controls affect misallocation and ultimately, welfare.

Second, our paper is related to studies of how misallocation impacts the trade margin. Berthou et al. (2018) study the impact of international trade on aggregate productivity. They show that trade reforms such as bilateral and unilateral export liberalization have ambiguous effects on welfare and productivity in the presence of resource misallocation. Using data on 14 European countries and 20 manufacturing industries during 1998-2011 they document that export expansion and import penetration increases aggregate productivity. However, the productivity gains work through different channels. Export growth induces higher average productivity and a reallocation towards more productive firms. Imports, on the other hand, improve competition and raises average firm productivity. Bai et al. (2020) incorporates firm-level distortions into a Melitz model and characterizes welfare under misallocation. They find that, contrary to the Melitz (2003) model where trade induces a reallocation from low productivity to high productivity firms, the presence of distortions can bring out the opposite and exacerbate misallocation. They use Chinese manufacturing data and contrast the key implications of the model. Our paper is closely related to Andreasen et al. (2020). In that paper, we build a general equilibrium model with heterogeneous firms, financial constraints and international trade and calibrate it to the Chilean economy. We find that capital controls reduce aggregate production and investment while increasing exports, the share of exporters and TFP. The effects of capital controls are exacerbated for firms in more capital-intensive sectors and for exporters. We add to this literature by studying how capital control affects trade and misallocation in an economy with previous distortion.

Finally, our paper relates to the literature that studies the microeconomic implications of capital controls. Alfaro et al. (2017) find a decline in cumulative abnormal returns for Brazilian firms following the imposition of CCs in 2008-2009, they also find that this effect is stronger for smaller, non-exporting and more financially dependent firms. For the specific case of the Chilean encaje, Forbes (2007) finds that smaller firms experienced significant financial constraints, which decreased with firm size. We add to this literature by considering another aspect of the microeconomic effects of capital controls, i.e. its effect on resource allocation.

3 Model

To evaluate the effect of capital controls on misallocation we present a model with heterogeneous entrepreneurs and financial frictions in the spirit of Midrigan and Xu (2014) and Buera and Moll (2015). In the model, entrepreneurs sell differentiated domestic varieties to both domestic and foreign final-good producers in monopolistically competitive markets. They can save and borrow in the international financial market at the international risk-free interest rate, but they face financial frictions in the form of a collateral constraint. They can also access international markets by paying a fixed cost and becoming an exporter.

Financial frictions generate misallocation through two channels. First, because of the collateral constraints firms cannot reach their steady state capital immediately. Second, the fixed cost to become an exporter implies that firms need to accumulate enough assets to be able to access the international market.

In this framework, we introduce a CC on inflows in the form of a tax on foreign borrowing aimed at capturing the main features of the Chilean *encaje*.[1] Unlike the collateral constraint, the friction introduced by the tax on foreign inflows affects all firms that rely on external borrowing, effectively increasing the interest rate on loans.

3.1 Final-good producers

A unit measure of final-good producers purchase differentiated varieties from domestic and foreign entrepreneurs and aggregate them to produce a final good. Final-good producers maximize profits subject to a constant elasticity of substitution production function with $\sigma > 1$. Let the set $[0, 1]$ index the measure of entrepreneurs in the domestic economy. Then, given prices $\{p_{h,t}(i)\}_{i\in[0,1]}$ and p_m charged by domestic and foreign entrepreneurs, respectively, final-good producers choose the optimum bundle of domestic, $\{y_{h,t}(i)\}_{i\in[0,1]}$, and imported, $y_{m,t}$, varieties so as to maximize final-good production, y_t:

$$\max_{y_{h,t}(i), y_{m,t}} \; p_t y_t - \int_0^1 p_{h,t}(i) y_{h,t}(i) di - p_m y_{m,t},$$

subject to

$$y_t = \left[\int_0^1 y_{h,t}(i)^{\frac{\sigma-1}{\sigma}} di + y_{m,t}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where p_t is the aggregate price index of the economy and equation (1) is the production function of final goods.

Similarly, the rest of the world demands the domestic varieties produced by entrepreneurs and sells foreign intermediate goods to domestic final-good producers. Then, the demands faced by a domestic producer $i \in [0, 1]$ are given by:

$$y_{h,t}(i) = \left(\frac{p_{h,t}(i)}{p_t} \right)^{-\sigma} y_t, \text{ and} \tag{2}$$

$$y_{f,t}(i) = \left(\frac{p_{f,t}(i)}{\bar{p_t}^*} \right)^{-\sigma} \bar{y_t}^*, \tag{3}$$

[1]We explain the main features of the Chilean *encaje* in Appendix A.

where $\bar{p}_t^*$ is the exogenous foreign final-good price index; $\bar{y}_t^*$ is the exogenous foreign final-good production; $y_{f,t}(i)$ is the foreign demand faced by the domestic entrepreneur $i \in [0, 1]$; and $p_{f,t}(i)$ the price charged for that variety.

3.2 Entrepreneurs

Risk-averse entrepreneurs produce differentiated intermediate varieties and sell them in monopolistically competitive domestic and international markets. Preferences of an entrepreneur $i \in [0, 1]$ are:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\gamma}}{1-\gamma},$$

where c_t is consumption; γ is the coefficient of relative risk aversion; and β is the subjective discount factor. The expectation, $\mathbb{E}_0$, is taken over the realizations of a death shock, which happens with probability ρ. At the end of the period, deceased entrepreneurs are replaced by a measure ρ of newborn entrepreneurs. In order to insure against the probability of death, entrepreneurs engage in an annuity contract by which, in the case of death, all savings and capital are transferred to existing entrepreneurs. Surviving entrepreneurs obtain $\frac{\rho}{1-\rho}$ additional units of capital and savings from deceased entrepreneurs at the beginning of each period.[2] In every period, entrepreneurs are endowed with a unit of labor that they supply inelastically to other entrepreneurs through the competitive labor market at the equilibrium wage w_t.

Selling goods in the international market is costly. If the entrepreneur wants to export in period $t + 1$, she has to pay a sunk export entry cost F in period t. F is denominated in units of labor. On top of the entry cost, entrepreneurs that export also have to pay an ad-valorem trade cost that requires them to ship τ units of intermediate goods for every unit that is sold in the foreign market, with $\tau > 1$.

At the beginning of their lifespan, entrepreneurs receive a fixed transfer of capital from the government $\underline{k}$, and they draw an idiosyncratic productivity parameter z that remains constant throughout their lifetime. z is distributed log-normally with mean μ_z and standard deviation ω_z. We assume that the technology available to entrepreneurs of type z is also

[2] We introduce this annuity contract in order to make the model more tractable. However, we are aware that this implies the presence of a well-developed financial market that may look contradictory with the assumption of financial constraints that we describe below.

a function of the capital stock k_t, the amount of labor hired n_t, and the capital intensity $\alpha \in (0,1)$:

$$y_{h,t} + \tau y_{f,t} = z k_t^{\alpha} n_t^{1-\alpha}. \tag{4}$$

In every period, capital depreciates at a rate δ. In order to increase their stock of capital in the next period, entrepreneurs can invest in the current period x_t. Then, taking into account the probability of death, the law of motion of capital is given by:[3]

$$k_{t+1} = \frac{1}{1-\rho}[(1-\delta)k_t + x_t]. \tag{5}$$

3.2.1 Financial markets

Entrepreneurs can save or borrow internationally through a one-period risk-free bond, but they face a collateral constraint by which they can borrow up to a fraction $\theta \leq 1$ of the value of the capital stock at the time that the loan is due for repayment; i.e.:

$$d_{t+1} \leq \theta k_{t+1}. \tag{6}$$

The international risk-free interest rate is r. However, the effective interest rate $\hat{r}$ that entrepreneurs face depends both on r and on whether there are capital controls in place. In the model, the introduction of the CC varies the effective interest rate that entrepreneurs face, depending on whether they want to save or borrow. If they want to save, the interest rate remains equal to the risk-free interest rate r. However, if they want to borrow, the effective interest rate that they face is higher and given by $r + \nu$, where ν is the tax-equivalent on a capital inflow with m-month maturity.[4]

It is worth analyzing the implications of assuming that entrepreneurs have access only to international financing. This simplifying assumption prevents lenders from lending domestically, which, if allowed, could push up the domestic lending rate.[5] We do this so that

[3]Notice that k_{t+1} is multiplied by $1-\rho$ because of the extra $\frac{\rho}{1-\rho}$ units of capital k_{t+1} that entrepreneurs receive at the beginning of each period from the annuity contract.

[4]We will consider capital inflows with a 12-month maturity in our benchmark exercise.

[5]Depending on the size of the domestic supply and demand of funds, three possibilities can arise when we allow for a domestic financial market: first, when demand is large with respect to supply, the domestic interest rate is equalized to the borrowing rate from international lenders. Second, if supply is large with respect to demand, the domestic interest rate is equal to r. Third, demand and supply meet at a domestic interest rate lower than $\hat{r}$ but higher than r. The first and third cases are similar and have the undesirable effect of

a CC in the model affects entrepreneurs only in their transition to their optimal scales. To see this, notice that, as entrepreneurs become lenders when reaching their optimal scale[6], the scale remains unchanged (except for general equilibrium effects on aggregate prices). This is a desirable feature of the exercise since restrictions on capital inflows should not affect the long-run allocation of capital (see Gourinchas and Jeanne (2006) for a discussion).

3.2.2 Entrepreneur's problem

The entrepreneur's problem consists of choosing consumption c, capital in the next period k', investment x, production, and debt due next period d' in order to maximize lifetime utility. Then, an entrepreneur with productivity level z solves the following dynamic programming problem:

$$V(k,d,e;z) = \max_{c,x,n,d',k',p_h,p_f,y_h,y_f,e\in\{0,1\}} \frac{c^{1-\gamma}}{1-\gamma} + \beta(1-\rho)V(k',d',e';z)$$

subject to (4), (5), (2), (3), (6), and

$$pc + px + pd + wn + wF\mathbb{I}_{e=0,e'=1} = w + p_h y_h + p_f y_f + pd'\frac{1-\rho}{1+\hat{r}} - T,$$

where $e = 1$ if the firm exports, and $e = 0$ otherwise; T is a lump-sum tax paid to the government, and:

$$\hat{r} = \begin{cases} r+\nu & \text{if } d' > 0 \\ r & \text{if } d' \leq 0 \end{cases}.$$

To reduce the number of state variables, we follow the methodology in Buera and Moll (2013) and assume that capital in the next period is chosen at the beginning of that period. We define a new variable $a = k - \frac{d}{1+r}$, which represents the entrepreneur's net worth. The

distorting the optimal scale of firms. In the second case, capital controls have no effect and, given that capital controls were economically significant, as discussed in Appendix A, this scenario is not plausible.

[6]We assume in the calibration that $\beta(1+r) > 1$ in order to eliminate possible multiplicity of equilibria when introducing the capital control. We discuss this in more detail in the next section.

previous problem can then be written as:[7]

$$G(a,e;z)=\max_{c,n,a',k,p_h,p_f,e'\in\{0,1\}}\frac{c^{1-\gamma}}{1-\gamma}+\beta(1-\rho)G(a',e';z)$$

subject to:

$$pc+pa'(1-\rho)+pk(\hat{r}+\delta)+wn+wF\mathbb{I}_{e=0,e'=1}=w+\frac{p_h^{1-\sigma}}{p^{-\sigma}}y+\frac{p_f^{1-\sigma}}{\bar{p}^{*-\sigma}}\bar{y}^*+pa(1+\hat{r})-T, \quad (7)$$

$$k(1+\hat{r}-\theta)\leq(1+\hat{r})a, \text{ and} \quad (8)$$

$$\left(\frac{p_h}{p}\right)^{-\sigma}y+\tau\left(\frac{p_f}{\bar{p}^*}\right)^{-\sigma}\bar{y}^*=zk^{\alpha}n^{1-\alpha}. \quad (9)$$

To clarify the impact of the capital control on entrepreneurs' decision problem, it is useful to analyze the Euler equation of this problem:

$$c^{-\gamma}=\beta(1+\hat{r})(c'^{-\gamma}+\lambda'), \quad (10)$$

where λ is the Lagrange multiplier associated with the collateral constraint (8). Notice that introducing a CC as a tax on capital inflows does not have a homogeneous effect on all entrepreneurs. Entrepreneurs that hold assets are not affected, as they continue to face the market interest rate r. Entrepreneurs that hold debt, however, face a higher interest rate that induces them to delay consumption. Finally, entrepreneurs facing a binding collateral constraint tomorrow (i.e., $\lambda'>0$) are the most affected, as decreasing consumption today increases by $\beta\lambda'(1+\hat{r})$ the marginal value of assets that can be pledged as collateral tomorrow, reflecting the value of relaxing (8).

3.3 Recursive equilibrium

For a given value of the interest rate $\hat{r}$, a recursive stationary competitive equilibrium of this economy consists of prices $\{w,p\}$, policy functions $\{c,n,k,p_h,p_f,y_h,y_f,a',e'\}$, lump-sum

[7] Notice that this last problem is identical to the first one, but now there is only one continuous endogenous state variable, a, instead of two, k and d. This simplifies the numerical solution of the model. As the entrepreneur is not subject to shocks (except for the survival shock, which is irrelevant to the decision of how to assign net worth to capital and debt), this decision can be made at the end of period t or the beginning of period $t+1$, indistinctively.

taxes T, value functions v and g and a measure $\phi : \mathcal{Q} \to [0,1]$ over entrepreneurs' states such that:

1. Policy and value functions solve the entrepreneurs' problem;
2. Policy functions solve the final-good producers' problem;
3. The government budget constraint is satisfied: $p\rho\underline{k} = T$;
4. Labor market clears: $\int_{\mathcal{S}}[n(q) + F\mathbb{I}_{\{e=0,e'(q)=1\}}]\phi(q)dq = 1$;
5. Markets for domestic varieties clear: $y_h(i) = y_h(q)$ if $q_i = q$;
6. Final-good market clears: $\int_{\mathcal{S}}[c(q) + x(q)]\phi(q)dq + \rho\underline{k} = y$;
7. The measure ϕ is stationary.

3.4 Misallocation and Capital Controls

In this section we explore how the presence of financial distortions, in the shape of collateral constraints and CCs, translate into misallocation of production factors. We assume that $\beta(1+r) > 1$ in order to ensure that initial conditions for a do not determine the optimal scale to which the entrepreneur converges when the CC is introduced, as it would be the case if $\beta(1+r) = 1$.

3.4.1 No financial distortions

We first study, as a benchmark, the allocation of productive factors in the absence of financial distortions, i.e. $\theta \to \infty$, to ensure that the collateral constraint is never binding and $\nu = 0$, no CCs are in place. In this case, the marginal revenue products of capital and labor are equalized across firms in the decentralized equilibrium. Moreover, an unconstrained planner that assigns equal Pareto weights to all entrepreneurs sets allocations in this manner as well. These results are contained in the following propositions:

Proposition 1. *When $\theta \to \infty$ and $\nu = 0$ (no collateral constraint and no CCs), all firms equate factor prices to their corresponding marginal revenue products.*

Proof. If $\theta \to \infty$ and $\nu = 0$, the first order conditions of entrepreneur i's problem with respect to labor and capital are, respectively,

$$MRPN_i \equiv \frac{\partial (p_{h,i} y_{h,i} + p_{f,i} y_{f,i})}{\partial n_i} = w, \text{and}$$

$$MRPK_i \equiv \frac{\partial (p_{h,i} y_{h,i} + p_{f,i} y_{f,i})}{\partial k_i} = p(r + \delta).$$

□

Despite the fact that firms differ in their inherent productivity z_i, in equilibrium all firms equate their MRPK and MRPN because they all face the same aggregate prices w, r, p.

Proposition 2. *The efficient allocation with Pareto weights* $\xi_i = \bar{\xi} \quad \forall i$ *implies constant marginal revenue products of capital and labor across firms.*

Proof. See Appendix D. □

The marginal revenue products of capital and labor are equal between firms both in the decentralized and the optimal equilibria, and there is no misallocation, in the sense that no reallocation of production factors between firms would be optimal.[8]

3.4.2 Financial distortions

The presence of financial distortions, either in the form of collateral constraints or CCs, implies that the MRPK is no longer equalized across all firms if some firms start out with a level of capital lower than their optimal scale, $\bar{k}_i$. To see this, consider first the case in which there are no collateral constraints but a CC is introduced.

Proposition 3. *When* $\theta \to \infty$ *and* $\nu > 0$ *(no collateral constraint with CCs),* $MRPK_i > \overline{MRPK} = p(r + \delta)$ *if* $k_i < \bar{k}_i$.

[8] As it is standard in monopolistic competition settings, the first best allocations yield higher production than the decentralized equilibrium ones because imperfect substitutability between varieties implies that firms have market power to set prices in the latter case. For this reason, we can constrain the planner to use the same aggregate levels of capital and labor as in the decentralized equilibrium to obtain the same allocations in both problems.

Proof. If $\theta \to \infty$ and $\nu > 0$, the first order conditions of entrepreneur i's problem with respect to labor and capital are, respectively,

$$MRPN_i \equiv \frac{\partial(p_{h,i}y_{h,i} + p_{f,i}y_{f,i})}{\partial n_i} = w, \text{and}$$

$$MRPK_i \equiv \frac{\partial(p_{h,i}y_{h,i} + p_{f,i}y_{f,i})}{\partial k_i} = \mathbb{I}_{d_i>0}[p(r+\nu+\delta)] + \mathbb{I}_{d_i\leq 0}\left[p(r+\delta) + \frac{p\chi_i}{U_{c,i}}\right],$$

where χ_i is a Lagrange multiplier associated to the constraint that $d_i \leq 0$ that arises as an equilibrium condition once $d_i = 0$ and the firm is no longer subject to the CC. □

Firms that have capital levels lower than their optimal scales borrow in order to invest and are subject to the CC, so the interest rate they face is $r+\nu$ and $MRPK_i = p(r+\nu+\delta) > \overline{MRPK}$. Since $\beta(1+r) > 1$, at some point where k_i is still lower than $\bar{k}_i$, since debt is too expensive, it becomes optimal to start repaying debt and eventually they reach a point in which $d_i = 0$. From then onwards, the interest rate that applies to them becomes r, so they start accumulating capital again. As long as k_i is lower than the optimal scale for the firm, $MRPK_i > \overline{MRPK}$ because $\chi_i > 0$.[9]

The previous proposition shows that the introduction of a CC distorts the allocation of capital across firms. Consider now the case of a collateral constraint:

Proposition 4. *When $\theta < \infty$ and $\nu = 0$ (collateral constraint without CCs), $MRPK_i > \overline{MRPK} = p(r+\delta)$ if $k_i < \bar{k}_i$.*

Proof. If $\theta < \infty$ and sufficiently low so that constraint (6) binds, the first order conditions of entrepreneur $i's$ problem with respect to labor and capital are, respectively,

$$MRPN_i \equiv \frac{\partial(p_{h,i}y_{h,i} + p_{f,i}y_{f,i})}{\partial n_i} = w, \text{and}$$

$$MRPK_i \equiv \frac{\partial(p_{h,i}y_{h,i} + p_{f,i}y_{f,i})}{\partial k_i} = p(r+\delta) + \frac{p\eta_i}{U_{c,i}}(1+r-\theta), \tag{11}$$

where η_i is the Lagrange multiplier associated to constraint (8).

□

[9] Notice that, in this case, the constraint that $d_i \leq 0$ needs to be imposed in equilibrium.

In this case, firms that have levels of initial capital that are lower than their optimal scales borrow from financial markets in order to invest. Absent the collateral constraint, they would borrow so as to immediately jump to their optimal level of capital. Collateral constraints prevent them from doing this, however, so capital accumulation occurs gradually and the constraint is binding as long as $k_i < \bar{k}_i$, so $\eta_i > 0$. Notice that, in this case, the marginal revenue product of capital is equal to the return of holding capital, $p(r + \delta)$, plus the marginal cost of increasing capital and making the collateral constraint more stringent. This last cost is given by the shadow price associated to the constraint η_i in terms of marginal utility of consumption, multiplied by the opportunity cost of holding capital instead of assets net of the fact that, by acquiring an additional unit of capital, the collateral constraint is relaxed by a fraction θ. Notice that, as in the previous case, the presence of a financial distortion generates misallocation through dispersion in the MRPK of firms that have not reached their optimal production scales.

When considering both a collateral constraint and CCs, in light of the previous results it is straightforward to see that there will be misallocation. There are four channels through which misallocation arises in this case: 1) a binding collateral constraint; 2) the CC ν that increases the cost of financing investment through debt; 3) a binding constraint preventing debt to become positive, once $d_i = 0$ when the firm is subject to the CC; 4) general equilibrium effects that affect aggregate prices $\{p, w\}$, thus altering the optimal scales of firms and, consequently, the stringency of the collateral constraint. It is not entirely clear, however, whether the misallocation triggered by the introduction of a CC worsens or lessens the overall misallocation in the economy with respect to the case in which there is only a collateral constraint. For this reason, in the next section, we resort to a numerical exercise to explore the question on how misallocation changes when a CC is introduced. To this end, we calibrate a version of the model and investigate the effects on misallocation and, ultimately, welfare of implementing a CC in an economy with collateral constraints.

4 Calibration and numerical analysis

4.1 Calibration

We calibrate the model to match key features of the Chilean economy during the period 1990-1991, before the introduction of the tax on capital inflows. This serves as our benchmark economy, in which firms are subject to collateral constraints but do not have to pay a tax on international debt. As a second step, we introduce the tax on capital inflows, compute the steady state of this economy, and compute the effects of CCs on misallocation and welfare. To this end, we derive the tax-equivalent ν_g for the unremunerated reserve requirement following the methodology inDe Gregorio et al. (2000), as described in Appendix B. We consider the average tax equivalent for the period 1991-1998 corresponding to a loan maturity of 12 months, which results in $\nu_g = 1.98$ percent.

4.1.1 Predetermined parameters

We follow the standard values used in the literature to set several of the parameters of the model. We consider a CRRA utility function with a coefficient of relative risk aversion $\gamma = 2$, and we set the subjective discount factor $\beta = 0.96$. We set the elasticity of substitution across varieties $\sigma = 4$ and the rate of depreciation $\delta = 0.06$. The exogenous exit rate of firms is $\rho = 0.08$ to match the average exit rate of firms in the sample. We set the interest rate $r = 6\%$ to match the average real interest rate in Chile over the period. Table 1 summarizes the parameter values.

4.1.2 Calibrated parameters

We discipline the model by calibrating the rest of the parameters in the model to match key features in terms of exports, sales and capital of Chilean manufacturing firms prior to the introduction of the capital control. Specifically, the calibrated parameters are the iceberg trade cost τ, the productivity dispersion ω_z, the sunk export entry cost F, the stringency of the collateral constraint θ, and the fraction of steady-state capital allocated to new entrepreneurs as initial net worth $\underline{a}$.[10] We consider one version of the model with only one productive sector,

[10] We assume that all new entrepreneurs receive a transfer from the government that equals a fraction $\underline{a}$ of their capital in steady state so that $a_0 = \underline{a}k_{SS}$.

in which we also calibrate the capital share α in the production function of entrepreneurs. The moments that we aim to match in the data are: (1) the share of firms that export; (2) the average sales of exporters divided by average sales of non-exporters; (3) the ratio of average sales between five-year-old and one-year-old firms, among new firms that survive for at least five years; (4) aggregate exports as a fraction of total sales; (5) aggregate credit as a fraction of value added; and the (6) the aggregate capital stock divided by the wage bill. All targeted moments are computed using the Chilean Encuesta Nacional Industrial Anual (ENIA) for the period 1990-1991, except for aggregate credit that is computed from the total value of outstanding credit in the manufacturing sector from 2000 to 2007, as reported by the Superintendencia de Bancos e Instituciones Financieras de Chile. We choose the 1990-1991 time period for the calibration because capital controls were implemented only in mid-1991 and, arguably, did not affect the data reported for these years.

Table 2 shows the moments in the data and their counterparts generated in the calibrated model economy. As we can observe from Table 2, the calibration delivers moments that are reasonably close to the data. Moreover, in Andreasen et al. (2020) we show that the model does a reasonable job at matching untargetted sectoral moments in the pre-capital controls period, which provides external validation to the framework.

4.2 Results

As discussed in Section 3.4, misallocation in this framework depends crucially on the presence of financial distortions: absent any financial distortions, there is no misallocation. The introduction of the CC creates misallocation by itself, and it can positively or negatively interact with the collateral constraint depending on whether the latter becomes more or less stringent with the policy. More formally, we can describe the difference in MRPK with and without CC among firms subject to them (i.e., firms with $d_i \geq 0$) through the following equation:[11]

$$MRPK_{cc} - MRPK_{ncc} = (p_{cc} - p_{ncc})(r + \delta) + p_{cc}\nu \left(1 + \frac{\eta_{cc}}{U_{cc}}\right) + \left[\frac{p_{cc}\eta_{cc}}{U_{c,cc}} - \frac{p_{ncc}\eta_{ncc}}{U_{c,ncc}}\right](1 + r - \theta) \quad (12)$$

[11]To arrive to this term we consider (11) and take the difference between the case with capital controls and without capital controls.

Note that the first term of the previous difference corresponds to the difference in the efficient levels of MRPK in the case with CC with respect to the the case without CC. In general, the economy with the CC displays a lower price level, therefore this first term can be assumed to be negative (see Table 3). The second term is unequivocally positive and corresponds to the direct distortion in MRPK introduced by the CC in an economy with a collateral constraint. The third term represents the change in how constrained the firm is when the CC is introduced, and its sign depends on a number of factors: first, consumption falls (and marginal utility increases) after the introduction of the CC, at least in the periods when the firm is taking debt and therefore subject to the CC. Moreover, the aggregate price level is lower too. The last ingredient, the Lagrange multiplier η of the collateral constraint is also typically lower for firms acquiring debt when the CC is in place with respect to the case in which there are no CCs.[12] All in all, this third term is usually negative. Therefore, an increase or decrease in misallocation will be determined by the sizes of the second (positive) term and the third (usually negative) one. This in turn depends on the level of productivity and how far the firm is from the steady state: for low productivity firms that are start out far from their optimal scales and have low levels of consumption, η/U_c is relatively large and the third term dominates, leading to a decrease in misallocation. Conversely, for high productivity firms which have high levels of consumption, η/U_c is relatively small and the second term dominates. Thus, misallocation increases for this group of firms.

Table 4 shows these effects at work in the calibrated economy: the table presents results on how misallocation, measured as the sum of squared residuals from MRPK with respect to its efficient level $p(r + \delta)$, changes when CCs are introduced. When all firms are considered, the introduction of the CC increases misallocation by 0.11%. We divide firms according to their level of productivity and whether they are exporting or not. More specifically, we group all firms pertaining to the lowest 50% in the distribution of productivity z and label them *Low z*. Similarly, all firms that belong to the 50% with higher z are classified as *High z*. Misallocation increases for high-productivity firms (0.38%), while it decreases for low-productivity ones (−0.79%). Low-productivity firms have smaller optimal scales after the

[12]The Lagrange multiplier η is the shadow price of the collateral constraint, that is, the change in the objective function when the constraint is relaxed slightly. When the CC is imposed, an extra unit of debt finances less capital because the interest rate the firm has to pay is higher. Then, consumption increases by less and the multiplier is lower.

introduction of the CC and, consequently, need to borrow less to reach them. Conversely, high-productivity firms are exporters or will become exporters once they reach an appropriate scale. Therefore, these firms become more financially constrained when the CC is in place, which explains the increase in misallocation in this group. When considering the exporting status of firms, exporters are more affected by the CCs, in the sense that misallocation increases for this group while it decreases for the group of non-exporters.[13] Finally, misallocation increases for young firms, which we define as those that are transitioning towards their optimal scales.[14]

Table 5 shows results classifying firms in terms of their productivity level. As before, the group of exporters sees an increase in misallocation, while the converse is true for non-exporters, even when analyzing these categories within high-productivity firms only. Notice now that misallocation decreases for young firms pertaining to the low-productivity group, while the converse is true for young firms in the high-productivity group. The former result is the consequence of these firms having lower optimal scales, and thus being less constrained, in the economy with the CC, so the third term in equation (12) is not only negative but also quantitatively large. On the contrary, the latter result arises because the direct distortion in MRPKs for high productivity firms is sufficiently large to counteract a quantitatively small third term due to larger optimal scales (as these firms become exporters).

4.3 Welfare

In this section we compute the welfare losses associated with the introduction of CCs. To do this, we follow the standard practice in the literature and compute the welfare effects as the permanent change in consumption that an agent (in this case, an entrepreneur) would have to receive in the economy without the CC to be indifferent between remaining in this economy, and switching to one in which there is a CC in place. More specifically, for each entrepreneur i identified by initial state (z^i), the welfare loss from the CC policy is given by

$$\sum_{t=0}^{\infty}(\beta(1-\rho))^t u\left(c_t^{i,ncc}(1+g^i)\right) = \sum_{t=0}^{\infty}(\beta(1-\rho))^t u\left(c_t^{i,cc}\right),$$

[13] Note that only high productivity firms export.

[14] Old firms have mostly reached their optimal scales so MRPK is very close to its efficient level. Thus, there is no misallocation in this group of firms.

where $c_t^{i,ncc}$ and $c_t^{i,cc}$ are consumption of entrepreneur i at time t in the economy with no CC and with CC, respectively, and g^i is the consumption equivalent that entrepreneur i would need to give up in order to be indifferent between living in the economy without CC and the one with CC. Given homotheticity of the utility function, g^i can be computed as

$$g^i = \left[\frac{\sum_{t=0}^{\infty} (\beta(1-\rho))^t u\left(c_t^{i,cc}\right)}{\sum_{t=0}^{\infty} (\beta(1-\rho))^t u\left(c_t^{i,ncc}\right)} \right]^{\frac{1}{1-\gamma}} - 1 = \left[\frac{V_0^{i,cc}}{V_0^{i,ncc}} \right]^{\frac{1}{1-\gamma}} - 1, \tag{13}$$

where $V_0^{i,ncc}$ and $V_0^{i,cc}$ are the value functions at $t = 0$ for entrepreneur i in the economy without and with the CC, respectively.

Figure 1 shows $g^i(z)$ for different levels of productivity z. Some general patterns are evident from this figure: in all cases, $g^i < 0$, which is to be expected because the CC is a tax on borrowers that is not being rebated to agents. In addition, the welfare losses associated to the introduction of the CC are always higher for those firms with the highest productivity levels, and lower for entrepreneurs with the lowest productivity levels. This, again, goes in line with our finding about changes in misallocation: the CC affects entrepreneurs that are transitioning to their optimal scales and borrow in order to acquire capital. Entrepreneurs with low productivity have lower optimal scales and, consequently, need to borrow less, so they are naturally less affected by the policy.

Figure 1 shows, moreover, that the welfare losses are not always monotonically increasing in productivity z. This has to do with the fact that firms that become exporters benefit from the fall in domestic prices (which is equivalent to a real exchange rate depreciation) and wages associated with the CC to increase exports, which allows them to partially overturn the negative direct effect of the CC.

In order to obtain aggregate measures of welfare losses associated to CCs, we assume a utilitarian social welfare function that assigns equal weight to all entrepreneurs operating in the economy. Then, the aggregate welfare loss of the CC is the permanent loss in consumption of all agents in the economy with no CCs that would make them *ex-ante* indifferent to being in the economy with the CC in place. More formally,

$$\int_{\mathcal{S}} \sum_{t=0}^{\infty} (\beta(1-\rho))^t u\left(c_t^{i,ncc}(1+G)\right) \phi(q) dq = \int_{\mathcal{S}} \sum_{t=0}^{\infty} (\beta(1-\rho))^t u\left(c_t^{i,cc}\right) \phi(q) dq, \tag{14}$$

where G is the aggregate welfare loss. This simplifies to

$$G = \left[\frac{W_0^{cc}}{W_0^{ncc}}\right]^{\frac{1}{1-\gamma}} - 1, \tag{15}$$

where $W_0^{ncc} = \int_{\mathcal{S}} V_0^{i,ncc}\phi(q)dq$ and $W_0^{cc} = \int_{\mathcal{S}} V_0^{i,cc}\phi(q)dq$.

The last column of Table 4 shows the aggregate welfare losses in total, and dividing by productivity.[15] The aggregate welfare loss is 2.39%, which is a non-negligible figure. Low productivity entrepreneurs, which are all non-exporters, are less affected and suffer a welfare loss of 1.65%. Conversely, high productivity firms that are all considered to be exporters have losses of 3.52%. As discussed before, the latter firms need to borrow more to reach their optimal scales, so the CC heavily distorts their consumption patterns in the transition towards their optimal scales.

4.3.1 Distributional effects

In this section we asses whether the changes in welfare due to the introduction of the CC occur because of the changes associated with the aggregate allocation of resources or because the policy involves a redistribution of resources in the economy. We follow Domeij and Heathcote (2004) and decompose the welfare change into two components: the aggregate component and the distributional component. To separate these effects we first denote the fraction of the aggregate consumption that an entrepreneur i was consuming with no CC, that is:

$$\hat{c}_t^{i,cc} = \frac{c_t^{i,ncc}}{C_t^{ncc}} C_t^{cc}$$

where C^{cc} and C^{ncc} denote the aggregate consumption with and without CCs, respectively.

We define the aggregate component of the welfare change G^a analogous to equation (14) but assuming that, in the state with CC, the entrepreneur consumes the same fraction of aggregate consumption as in the state with no CC. Thus,

[15] We cannot report results for exporting status or age because welfare is computed as an ex-ante measure and these two classifications vary with t.

$$\int_{\mathcal{S}} \sum_{t=0}^{\infty} (\beta(1-\rho))^t u\left(c_t^{i,ncc}(1+G^a)\right) \phi(q)dq = \int_{\mathcal{S}} \sum_{t=0}^{\infty} (\beta(1-\rho))^t u\left(\hat{c}_t^{i,cc}\right) \phi(q)dq, \qquad (16)$$

Finally, we define the distributional component G^d as the difference between the aggregate welfare change as defined in the previous section and the aggregate component. Thus:

$$(1+G) = (1+G^a)(1+G^d)$$

Table 6 shows the results. When considering all firms the aggregate component of the welfare change is negative and equal to -2.70% and the distributional component shows a welfare gain of 0.33%. The large negative aggregate component points to the fact that the CC taxes capital accumulation and, through this, significantly distorts aggregate prices and quantities. The small positive distributional component, on the other hand, reflects the fact that firms that are converging to their optimal scales are the ones directly affected by the CC tax on debt, and therefore see a sharper reduction in consumption with respect to the case of no CC. This effect is especially strong for high productivity, exporting firms that have larger optimal scales. Then, consumption is slightly more equally distributed when the CC is in place.

When we look at firms by their productivity level, the pattern that emerges is similar to the previous analysis in that the aggregate component of the welfare loss is negative and large. Nevertheless, the distributional component, both for high productivity and low productivity firms, now is negative (and still small). This is telling us that within these classes of firms, consumption under CCs is more unequally distributed than without the policy. In the case of low-productivity firms this is driven by the fall in the wage rate that impacts entrepreneurs with low z the most, as wages are a very important source of revenues for these agents. In the case of high-productivity firms, on the other hand, the transition towards the optimal scale takes longer for firms with lower z in this group, so these again are the most affected. Thus, $G^d < 0$ for both groups of firms. Interestingly though, the overall positive G^d implies that there is redistribution between these two groups of firms that makes consumption more equally distributed in the economy with CC, driven by the fact that high productivity firms are also exporters that need to finance the sunk costs of becoming exporters and that need to reach larger optimal scales, and this implies that the CC tax burden is significant for them.

4.4 Sensitivity analysis: lump-sum transfers

We compute the equilibrium considering now that the quantity paid by each entrepreneur due to the CC, $p\nu(k-a)$ is rebated in the same quantity as a lump-sum transfer. We consider this type of rebate scheme to rule out redistribution among entrepreneurs.

Tables 3 and 7 show the results under this scenario. Results are qualitatively and quantitatively very similar to the case without lump-sum transfers. The decrease in welfare, both when considering all firms, as well as when discriminating by type of firm, is always lower than in the benchmark case. This is to be expected because under this scenario firms are receiving what is collected from their payments of the CC tax. The change in magnitude, however, is small. This points to the fact that the main mechanism by which the CC is affecting welfare comes through the change in the stringency of the financial friction.

4.5 Counterfactual analysis

In this section we consider two alternative policy measures that reduce aggregate credit/value added in the same magnitude as the CC. The aim of the exercise is to study how these other macroprudential policies might differ in their implications from the CC. The policies we analyze are a symmetric increase in the interest rate, which could be due to restrictions on capital inflows as well as outflows, and a decrease in the fraction θ of capital that can be pledged as collateral. This measure is akin to a more stringent loan-to-value (LTV) ratio requirement.

4.5.1 Interest rate increase

While the CC increases the interest rate for debtors, it is informative to analyze the effects of an increase in r both for debtors and borrowers. Table 8 show the results. The main difference of this case is that the optimal scales of all firms, irrespective of their productivity levels, are lower, even abstracting from general equilibrium effects on aggregate prices and quantities. This implies that firms get faster to their optimal level of capital and therefore to their efficient level. This generates lower MRPK with respect to the case with CC. However, this economy presents with higher aggregate prices p than the economy without the policy because the higher opportunity cost of capital limits investment and, ultimately, production. Overall, this latter effect on prices dominates and misallocation increases 7.53% for all firms. As before, misallocation increases more for high productivity firms (the increase in misallocation is (7.80%) than for low productivity firms (6.61%), as high productivity firms are the ones more affected since they invest more. When we consider exporters vs non-exporters, misallocation increases by 19.95% and 5.55%, respectively, because the real exchange rate appreciation impacts exporters substantially.

Finally, aggregate welfare loss is 2.74%, a number higher than in the CC case. Interestingly, welfare decreases for low and high productivity firms in almost identical magnitudes. Notice that this is different from the case of CCs in which the burden of the policy is borne disproportionally by high productivity firms, which are the ones more taxed by the policy measure.

4.5.2 Decrease in θ

We consider now the case of a tighter LTV requirement, which can be modeled as a decrease in the fraction θ of capital that can be pledged as collateral. Table 9 shows the main results. The lower θ implies that capital is less valuable as collateral. [16] This deters investment and fosters consumption, which, along with lower levels of production (because of lower levels of capital) it translates into a higher aggregate price level. As in the previous case, the higher price level causes misallocation to increase for all types of firms.

In terms of welfare, this policy measure has substantially lower welfare costs than CCs. This is due to the fact that the measure affects only the speed at which firms that are borrowing accumulate capital and that the substitution effect between capital and consumption stimulates production and domestic sales (contrary to CCs).

[16] In the limit, if $\theta = 0$ then capital cannot be used as collateral, and there is no borrowing from firms.

5 Empirical Analysis

5.1 Data

The empirical analysis requires three key ingredients: measures of misallocation; a proxy for the CC; and control variables at the firm and country levels.

For the measures of misallocation and industry control variables, we use the plant-level panel data from the *Chilean Encuesta Nacional Industrial Anual* (ENIA) for the period 1990 to 2007. The ENIA has data on all manufacturer establishments with more than ten employees.[17] It includes approximately 4,500 observations per year and provides detailed information on establishments' characteristics, such as type of industry, employment, domestic sales, exports, investment, inputs, assets, etc.

We complement the database with some auxiliary calculations. We construct capital stock by adding cars, machinery, land and buildings. Since we do not have data on the depreciation rate before 1995, we use a standard annual depreciation rate of 6% for the 1990-1994 period. Before 1992 we do not have data on the variables to construct fixed capital so we impute the capital stock using investment and the depreciation rate of 6%. To measure productivity at the establishment level, we follow Wooldridge (2009).[18] To deflate the variables used to calculate the productivity measure, we use the 4-digit NAICS code deflator and the price of capital provided by the ENIA. Additionally, we use the wholesale price index and fuel price index reported by the *Instituto Nacional de Estadística* (INE) to deflate the electricity and fuel use, respectively.

Our main independent variable of interest is the Chilean encaje. As a proxy for the Chilean encaje we derive the implied interest rate-equivalent cost that agents face when taking into account the existence of reserve requirements on capital inflows following the methodology in De Gregorio et al. (2000), (see Appendix B for a detailed derivation).[19] To calculate the effective value of the tax equivalent, we use the information in Table 15 on the evolution of the required fractional reserve requirement and the length of the fixed term. Finally, we use the Libor interest rate from the FRED Economic Data as a proxy for the risk-free interest

[17]This restriction does not apply to firms that belong to companies that operate in more than one sector or that have more than one plant.

[18]The results are robust to computing TFP as in Levinsohn and Petrin (2003).

[19]See, also, Cárdenas and Barrera (1997) and Soto (1997).

rate. Figure 2 in the Appendix presents the evolution of the tax equivalent of the *Chilean Encaje* during the 1990s. The variable presents a high degree of variability throughout the period, which is crucial to identify the effect of the CC. The variation comes from changes in the interest rate and the unremunerated reserve requirement u.

5.2 Misallocation

To construct a measure of misallocation we first need to compute the marginal revenue product of capital (MRPK). We derive it from our model following the framework in Gopinath et al. (2017) and Hsieh and Klenow (2009). In our setting we can show that:

$$MRPK = \frac{(\sigma - 1)}{\sigma}(p_h y_h + p_f y_f)\frac{\alpha}{k}. \tag{17}$$

(See Appendix for derivation).

To take it to the data we replace $(p_h y_h + p_f y_f)$ with total sales. We replace $k_{h,t}(i)$ with real fixed capital (tangible assets deflated by the price of capital). The parameters σ and α are taken from our model.

Finally, we construct a measure of misallocation at the firm level following Bai et al. (2020) and define misallocation as the absolute value of the difference between the firm's MRPK to the mean of the industry such that:

$$MIS_{ijt} = \mid MRPK_{itj} - \overline{MRPK_{jt}} \mid,$$

where $\overline{MRPK_{jt}}$ is the yearly industry mean of the MRPK. We define industries as a 4-digit ISIC code.

5.3 Empirical Strategy

The following strategy allows us to explore how the effect of the CC on firm-level misallocation is shaped by the firms' relative TFP, whether the firm is young or old and its export status:

$$MIS_{ijt} = \omega_0 + \omega_1 CC_{t-1} * Rank\_TFP_{ijt} + \omega_2 CC_{t-1} * Young_{ijt} + \omega_2 CC_{t-1} * Exp_{ijt} + \omega_4 X_{ijt} + A_i + B_t + \epsilon_{ijt}, \tag{18}$$

where the subscript i refers to firms, j to industry, and t to time. All of our firm-level variables are expressed in logs. CC_{t-1} is our main variable of interest, lagged one period. Our measure for $Rank\_TFP_{ijt}$ considers the relative ranking of firm's TFP i at each period t, where industry is defined at the two-digit level. The variable $Young_{ijt}$ is a dummy variable that takes the value of 1 when firms have ten or less years of existence.

We consider two alternative definitions for exporters, Exp_{ijt}, a backward-looking definition and a forward-looking classification. With the backward-looking classification, we consider as exporters firms that exported at least once during the previous two years. From this perspective, exporters can be differently affected as they typically have a higher level of capital in the steady state and are more productive. With the forward-looking classification, we define exporters as firms that export at least once in the next two years. This classification aims at capturing that firms that want to export in the future might have to undertake more extensive investments today, thus being more exposed to the CC.

X_{ijt} is a set of time-varying firm characteristics–i.e., fixed capital, total workers, productivity, and expenditures on interest, $Int.Exp_{j,t}$. (which we include as a proxy for the level of indebtness). Table 10 presents the summary statistics of the firm-level variables.

Finally, A_i is a vector of firm dummy variables that account for firm fixed effects that control for time-invariant firm characteristics and B_t is a vector of time dummy variables that account for unobservables at the aggregate level that could be correlated with CC_{t-1}, which could potentially induce a bias in our estimation. We cluster the errors at the firm level.

Table 12 presents our baseline results. Columns (1) and (2) show the results for the backward and forward-looking definitions of exporters, respectively, when considering the full sample of firms while columns (3) and (4) present the results when only considering firms that existed in 1990 and fixing the $Rank\_TFP_{ijt}$ to the ranking that firms had in 1990, i.e., before the introduction of the CC. We include the results while fixing the sample of firms in 1990 to make sure that our results with the full sample are not driven by a potentially endogenous firms' entry decisions. Having confirmed that entry is not driving the results, for the rest of the section we will focus on the full sample since otherwise we miss almost half of the sample and important dynamics.

In line with our theoretical results, i.e., see Table 4, the main insight from Table 12 is that the effect of capital controls on misallocation is higher the higher the firms' relative productivity, when firms are young and when firms decide to become exporters (for both classifications considered). The fact that the relative effect of being young is non-significant when considering the 1990-sample is expected as the young-firms group is ever shrinking, as there is no entry, making it very difficult to identify the effect.

To get closer to the analysis of the quantitative exercise, Table 13 divides the sample in terms of the firms' relative productivity. Columns (1) to (4) compare the top and bottom 50% of the sample while columns (5) to (8) compare the upper and lower 30% tails. This analysis provides further interesting insights which are in line with the results of Table 5. While the overall patterns remain, i.e., more productive, younger and exporting firms are relatively more affected than their counterparts, some new findings emerge. As in the quantitative exercise, we find that misallocation increases relatively more for exporting-high-productivity firms, while it does not seem to have a significant effect on exporting-low productivity firms. To better understand this result it is important to highlight that while around 30% of high-productivity firms export (depending on the exports and TFP classification), exporting firms shrink to 10% when considering the low-productivity group. In terms of the young vs. old group, when disaggregating by productivity, we find that being young increases misallocation relatively more for high than for low-productivity firms, with the effect becoming non significant when low-productivity is defined using the 30% threshold.

5.3.1 Robustness

Interaction of capital intensity with macroeconomic controls: Another potential concern is that our interaction terms could be capturing the effect of an interaction between $Rank\_TFP_{ijt}$, $Young_{ijt}$, Lag_Exp_{ijt} or Fwd_Exp_{ijt} and other macroeconomic variables. To make sure this is not the case, Table 14 presents the results of replicating our baseline regression introducing, one at a time, the interactions of a macroeconomic variable and our variables of interest, $Rank\_TFP_{ijt}$, $Young_{ijt}$, Lag_Exp_{ijt} or Fwd_Exp_{ijt}. The macroeconomic variables under consideration are: the Libor rate, inflation, growth, RER, private credit_GDP and world growth. All macroeconomic variables are lagged one period (Table 11 presents the summary statistics of the macroeconomic indicators during our period of analysis). The results show that all of their coefficients of interest maintain their sign and significance.

P-Hacking tests: We also run p-hacking tests of our baseline regressions to rule out the possibility that our results are only significant for a particular set of controls. Following Brodeur et al. (2020a) and Brodeur et al. (2020b), we report t-curves and effect curves, which are "the t-statistics and estimated effect sizes derived from regressions using every possible combination of control variables." Specifically, we run 4 different simulations, one for each of our dependent variables of interest. In each simulation we perform 296 permutations which account for all the possible combinations of the remaining control variables, with the exception of the time fixed effects and the direct effect of the interacted variable which are always included in all permutations.

Figure 3 presents the t-statistics by number of controls for our main independent variables of interest, $CC * Rank\_TFP$, $CC * Young$, $CC * Lag\_Exp$, $CC * Fwd\_Exp$, based on the XX coefficient estimates for each regression. All values of t-statistics are above conventional thresholds, suggesting that the coefficient estimates are statistically significant. Overall, p-hack tests show that our main results are robust to different combinations of control variables, showing that we do not intentionally select the model specification that delivers significant coefficients.

Additional robustness: In unreported regressions we perform additional exercises to test the robustness of our results to alternative assumptions and specifications. For instance, one relevant concern is the potential that firms in specific industries could be driving our results. To rule out this possibility, in two separate exercises, we check the robustness of the results to winsorizing the distribution of TFP and our measure of misallocation at the top and bottom 1%. Our coefficients of interest are robust to these modifications.

6 Conclusion

In this paper we use a dynamic general equilibrium model with trade and financial frictions to study the effects of CCs on misallocation and welfare. We use as our laboratory the *Chilean encaje*—i.e., a 30% unremunerated reserve requirement (URR) imposed by Chile between 1991 and 1998. We calibrate the model with pre-policy data and them impose the CC to study the effects. We find that, when the CC is implemented, misallocation increases for exporters and high productivity firms, while it decreases for low productivity ones. Low productivity firms have smaller optimal scales and, consequently, need to borrow less to reach them. On the other hand, exporters operate larger optimal scales and, consequently, rely more on credit to accumulate capital and pay the fixed cost of becoming an exporter. In terms of welfare, we find that the welfare cost of the policy is sizable. Overall welfare decreases by 2.39%. Finally, we test the main implications of the model using *Chilean* manufacturing data.

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Appendix

Appendix A: The Chilean encaje

The resumption of capital flows to emerging market economies after the Latin American debt crisis of the 1980s led to a new wave of inflows to Chile starting in 1988. This surge in capital inflows exerted upward pressure on the real exchange rate, created symptoms of overheating, and made the trade-off between different macroeconomic objectives increasingly difficult and costly. As a response, in 1991, the Chilean authorities established a capital account restriction in the form of an unremunerated reserve requirement. Specifically, the capital control was an obligation to hold an unremunerated fixed-term reserve equivalent to a fraction of the capital inflow at the central bank. Hence, it was analogous to a tax per unit of time that declined with the permanence or maturity of the affected capital inflow (see Section 5.1 for a detailed derivation of the tax equivalence).[20]

We focus our analysis on the *Chilean encaje* because, for several reasons, it is a good laboratory in which to explore the firm-and industry-level consequences of capital controls. First, the *Chilean encaje* was one of the most well-known examples of market-based controls, –i.e. taxes and reserve requirements, as opposed to administrative controls with which the authority limits some specific assets, and the market is not allowed to operate. Moreover, during the 2000s, many countries, such as Colombia, Thailand, Peru and Uruguay, imposed CCs similar to the ones imposed in Chile. Second, the *Chilean encaje* was economically relevant: the total equivalent reserve deposit represented 1.9 percent of GDP during the period 1991-1998, reaching 2.9 percent of GDP in 1997 and 30 percent of that year's net capital inflows (Gallego et al. (2002)).[21] Finally, the CC period in Chile was long enough to generate sufficient variation in the data for the empirical analysis and to allow us to perform a numerical steady-state analysis. As Table 15 shows, various features of the *Chilean encaje*

[20] The tax equivalence was made more explicit by its alternative form: foreign investors were allowed to pay the central bank an up-front fee instead of depositing the unremunerated reserve fraction with the central bank.

[21] In terms of the macroeconomic effects of the introduction of the Chilean capital control on inflows, the empirical evidence suggests that the more persistent and significant effect was on the time-structure of the capital inflows, which was tilted towards a longer maturity (see De Gregorio et al. (2000), Soto (1997), Gallego and Hernández (2003)). The policy also increased the interest rate differential (although without a significant long-run effect) and had a small effect on the real exchange rate, while there is no evidence on a significant effect on the total amount of capital inflows to the country.

were altered during its existence. These modifications, together with changes in the foreign interest rate, generated significant variability on the effective cost of the CC over time (see Figure 2).[22]

Appendix B: Tax equivalent of Chilean encaje

The introduction of the CC varies the effective interest rate faced by domestic private agents, depending on whether they want to save or borrow. If they want to save, the interest rate remains equal to the risk- free interest rate r. However, if they want to borrow, the effective interest rate they face is higher and given by $r+\nu_g$, where ν_g is the tax equivalent of the CC. In order to compute ν_g, we first need to define r_g, the interest rate ignoring risk premia for a g-months investment in Chile at which an investor makes zero profits:

$$r_g = r + \nu_g.$$

Let u be the fraction of the loan that the investor has to leave as an unremunerated reserve and h the period of time that the reserve must be kept at the Central Bank. Then, if the investment period is shorter than the reserve fixed-time–, i.e., $g < h$–, borrowing US$1 abroad at an annual rate of r to invest at r_g in Chile for g months generates the following cash flows:

- At $t = 0$, the entrepreneur can invest $(1-u)$ at r_g.
- At $t = g$, repaying the loan implies the following cash flow: $-(1+r)^{g/12}$.
- At $t = h$, the reserve requirement is returned generating a cash flow u.

Therefore, the annual rate r_g at which the investor is indifferent between investing at home and abroad (computing all values as of time h, when u is returned) is:

$$(1-u)(1+r_g)^{g/12}(1+r)^{(h-g)/12} + u = (1+r)^{h/12}.$$

Solving for r_g, we find the tax-equivalent of the CC:

[22] Although the initial coverage of the restriction was actually partial in practice, over time, authorities made a great effort to close the loopholes that allowed for evasion of controls. For instance, in 1995, the control was extended to include ADRs, and, in 1996, the rules on FDI were tightened to exclude speculative capital.

$$(1 + r_g)^{g/12} = \frac{(1 + r)^{g/12} - u(1 + r)^{(g-h)/12}}{1 - u} \equiv (1 + r + \nu_g)^{g/12}.$$

If the investment horizon exceeds the term of the reserve requirement–, i.e., $h > g$–, the investor has to decide, at the end of the h-month period, whether to maintain the reserve requirement in Chile or to deposit the amount outside the country. In order to obtain closed-form solutions, we assume that the investor deposits outside the country at the risk-free interest rate. Under this assumption, the previous arbitrage condition remains the same for longer investment horizons.

Using the approximation that $(1 + j)^x \approx 1 + xj$, the approximate tax-equivalent is found by solving the following equation:

$$1 + gr - u(1 + (g - h)r) = (1 - u)(1 + g(r + \nu_g)),$$

which yields:

$$\nu_g = r \frac{u}{1 - u} \frac{h}{g}. \tag{19}$$

Appendix C: Solution Method

The solution method exploits the fact that there is no uncertainty except for the exogenous probability of death that each entrepreneur faces at the beginning of every period. This uncertainty, however, is absent from investment decisions because the annuity market perfectly insures against this event. Then, provided that we know the policy function for assets for a given region of the state space, we can perfectly recover the policies outside of this region by using the first order conditions and the constraints of the problem. To see this, we re-write these here:

- F.O.C. n:

$$-\lambda w + \gamma \left((1-\alpha) z k^{\alpha} n^{-\alpha}\right) = 0 \tag{20}$$

- F.O.C. k:

$$-\lambda p(\hat{r}+\delta) - \mu(1+\hat{r}-\theta) + \gamma z \alpha k^{\alpha-1} n^{1-\alpha} = 0 \tag{21}$$

- F.O.C. p_h:

$$p_h = \frac{\gamma\sigma}{\lambda(\sigma-1)} \tag{22}$$

- F.O.C. p_f:

$$p_f = \frac{\tau\gamma\sigma}{\lambda(\sigma-1)} \tag{23}$$

- F.O.C. c:

$$p\lambda = c^{-\gamma} \tag{24}$$

- Budget constraint:

$$pc + pa'(1-\rho) + pk(\hat{r}+\delta) + wn + wF\mathbb{I}_{e=0,e'=1} = w + \frac{p_h^{1-\sigma}}{p^{-\sigma}} y + \frac{p_f^{1-\sigma}}{\bar{p}^{*-\sigma}} \bar{y}^* + pa(1+\hat{r}) - T, \tag{25}$$

- Production function:

$$\left(\frac{p_h}{p}\right)^{-\sigma} y + \tau \left(\frac{p_f}{p^*}\right)^{-\sigma} \bar{y}^* = z k^{\alpha} n^{1-\alpha} \tag{26}$$

- Collateral constraint:
$$k(1+\hat{r}-\theta) \leq (1+\hat{r})a \tag{27}$$

- Euler equation:
$$c' = c(\beta(1+\hat{r}))^{\frac{1}{\gamma}} - \mu'^{-\frac{1}{\gamma}} \tag{28}$$

where λ is the Lagrange multiplier associated to the budget constraint (7), η is the Lagrange multiplier associated to the borrowing constraint (8), γ is the Lagrange multiplier associated to the resource constraint (9), and primed variables indicate they are next period's.

The algorithm consists of the following steps:

1. Given prices and aggregate quantities p, w, y, solve for the optimal long-run levels of capital k_{ss} and labor n_{ss} for a firm with productivity z by solving the system of equations given by (20), (21), (22), (23) and (26) and noticing that the collateral constraint does not bind once the firm reaches its optimal scale.

2. For a state space interval $[a_{min}; a_{upper}]$ where $a_{min} = k_{ss}$ and a_{upper} is a desired level of assets such that $a_{upper} > a_{min}$, compute the policy functions of the problem of exporters and non-exporters by a global solution method. For the exercise at hand, we use the endogenous grid method.

3. Obtain the trajectories of variables for $a^f > a_{upper}$, using the fact that $k^f = k_{ss}$, $n^f = n_{ss}$, $\mu^f = 0$, from equations (25) and (28).

4. Obtain the trajectories of variables for $a^b < a_{min}$. Two possible situations arise here:

   (a) There is no capital control: in this case, the collateral constraint (27) binds for all $a^b < a_{min}$. Then, setting $c' = c_{min}$, $\mu' = 0$, from (28) we can recover c. From (20), (22), (23), (25), (26) and (27) we can obtain a, k and n. Using (21) we obtain μ. In this fashion, the policy function $a' = f(a; z)$ for $a < a_{min}$ is computed.

   (b) There is a capital control: in this case, the firm accumulates capital through debt paying an interest rate of $\hat{r} = r + \mu > r$ until reaching k_{ss}^{cc}, which would be the optimal scale for the firm if this was the symmetric interest rate it faced.[23] From

[23] k_{ss}^{cc} can be obtained in a similar fashion as k_{ss}.

then onwards, $\hat{r}$ is too high for the firm to continue financing investment through debt, so it starts repaying debt until $d = 0$. Given that from then onwards the relevant interest rate for the firm is r, the firm starts accumulating capital through self-financing until $k = k_{ss}$.[24] Taking into account the behavior of investment and debt just described, the policy function $a' = f(a; z)$ for $a < a_{min}$ is computed in a similar fashion as before.

5. At every point of the state variable space, check whether $G(a', e' = 1; z, e = 0) > G(a', e' = 0; z, e = 0)$. If so, the firm becomes an exporter at that point and remains an exporter for all a larger than that.

6. Iterate on $1 - 5$ until p, w, y are such that the labor market, the markets for domestic varieties and the final-good market clear.

Appendix D: MRPK Derivation

From equation (21) and the production function (26) we obtain:

$$\frac{\gamma}{\lambda}(y_h + \tau y_f)\frac{\alpha}{k} = p(\hat{r} + \delta) + \frac{\mu}{\lambda}(1 + \hat{r} - \theta)$$

Multiplying and diving both sides by p_h and using equation (22) we have:

$$\frac{(\sigma - 1)}{\sigma}p_h(y_h + \tau y_f)\frac{\alpha}{k} = p(\hat{r} + \delta) + \frac{\mu}{\lambda}(1 + \hat{r} - \theta)$$

Using equation (11) derived previously in the model and after some algebra we get:

$$MRPK = \frac{(\sigma - 1)}{\sigma}p_h(y_h + \tau y_f)\frac{\alpha}{k}$$

Finally, from equation (22) and (23) noting that $p_f = \tau p_h$, we obtain:

$$MRPK = \frac{(\sigma - 1)}{\sigma}(p_h y_h + p_f y_f)\frac{\alpha}{k} \tag{29}$$

[24] In this region of the state space, an extra equilibrium condition is that $d \leq 0$.

Appendix F: Proofs

Proof of Proposition 2

Proof. The planner's problem can be written as:

$$\max_{\{c_q,n_q,x_q,k'_q,y_{h,q},y_{f,q}\}_{i\in\mathcal{S}}} \int_{\mathcal{S}} \xi_q \sum_{t=0}^{\infty} [\beta(1-\rho)]^t U(c_{q,t})\phi(q)dq$$

s.t.

$$\int_{\mathcal{S}} [c_{q,t} + x_{q,t}]\phi(q)dq = y_t \quad \forall t, \tag{30}$$

$$\left[\int_0^1 y_{h,t}(i)^{\frac{\sigma-1}{\sigma}} di + y_{m,t}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} = y_t \quad \forall t, \tag{31}$$

$$y_{h,t}(i) + \tau y_{f,t}(i) = z_i k_{i,t}^{\alpha} n_{i,t}^{1-\alpha} \quad \forall i, \forall t, \tag{32}$$

$$k_{i,t+1} = \frac{1}{1-\rho}((1-\delta)k_{i,t} + x_{i,t}) \quad \forall i, \forall t, \tag{33}$$

$$\int_{\mathcal{S}} n_{q,t}\phi(q)dq = 1 \quad \forall t, \tag{34}$$

$$\int_0^1 p_{f,t}(i)y_{f,t}(i)di - p_{m,t}y_{m,t} = \overline{TBD} \quad \forall t, \tag{35}$$

$$y_{f,i}(i) = \left(\frac{p_{f,t}(i)}{p^*}\right)^{-\sigma} y^* \quad \forall i, \forall t. \tag{36}$$

Equation (35) represents the trade balance of this economy, where $\overline{TBD}$ is a given level of trade balance deficit, and equation (36) is the foreign demand for domestic varieties. After some algebra, the planner's problem becomes

$$\max_{\{c_q,n_q,x_q,k'_q,y_{h,q},y_{f,q}\}_{i\in\mathcal{S}}} \int_{\mathcal{S}} \xi_q \sum_{t=0}^{\infty} [\beta(1-\rho)]^t U(c_{q,t})\phi(q)dq$$

s.t.

$$\int_{\mathcal{S}} [c_{q,t} + (1-\rho)k_{q,t+1} - (1-\delta)k_{q,t}]\phi(q)dq = \left[\int_0^1 (z_i k_{i,t}^{\alpha} n_{i,t}^{1-\alpha} - \tau y_{f,t}(i))^{\frac{\sigma-1}{\sigma}} di + y_{m,t}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \quad \forall t, \tag{37}$$

$$\int_{\mathcal{S}} n_{q,t}\phi(q)dq = 1 \quad \forall t, \tag{38}$$

$$y^{*1/\sigma}p^* \int_0^1 y_{f,t}(i)^{\frac{\sigma-1}{\sigma}} di - p_{m,t}y_{m,t} = \overline{TBD} \quad \forall t, \tag{39}$$

Assuming $\xi_i = \xi_j$ for all $i, j \in \mathcal{S}$, the FOC of the planner with respect to capital reads:

$$\lambda_t = \beta\lambda_{t+1}\left[(1-\delta) + \left[\int_0^1 (z_i k_{i,t}^{\alpha} n_{i,t}^{1-\alpha} - \tau y_{f,t}(i))^{\frac{\sigma-1}{\sigma}} di + y_{m,t}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}} \left(z_i k_{i,t}^{\alpha} n_{i,t}^{1-\alpha} - \tau y_{f,t}(i)\right)^{\frac{-1}{\sigma}} z_i \alpha \left(\frac{n_{i,t}}{k_{i,t}}\right)^{1-\sigma}\right]$$

$\forall t$, $\forall i$. After some algebra, this expression becomes

$$\lambda_t = \beta\lambda_{t+1}\left[(1-\delta) + \left(\frac{y_t}{y_{h,t}(i)}\right)^{1/\sigma} \frac{\alpha}{k_{i,t}}\left(y_{h,t}(i) + \tau y_{f,t}(i)\right)\right] \quad \forall i, \forall t.$$

Notice that, from equation (29) and using (2), we can write

$$\lambda_t = \beta\lambda_{t+1}\left[(1-\delta) + \frac{MRPK_{i,t}}{p}\frac{\sigma}{\sigma-1}\right] \quad \forall i, \forall t.$$

This condition needs to hold for every $i \in \mathcal{S}$. Then,

$$MRPK_i = MRPK_j \quad \forall i, j \in \mathcal{S}$$

□

Appendix E: Figures and Tables

Figure 1: Welfare in 1-Sector Model

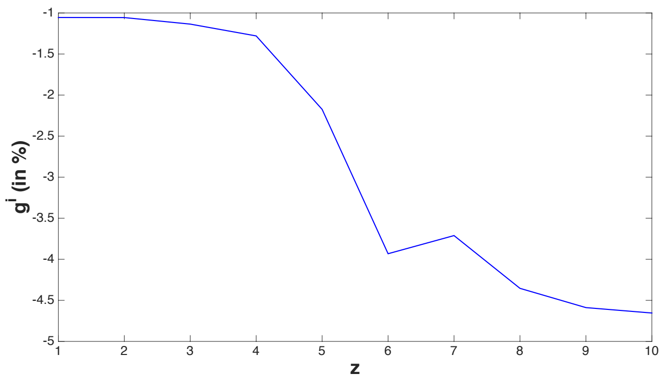
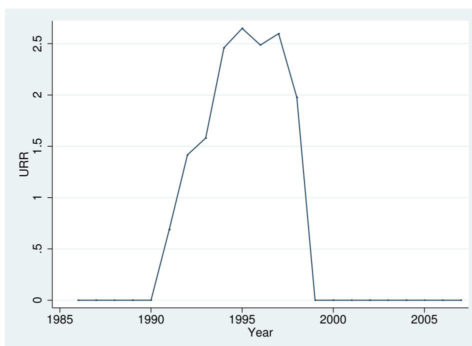
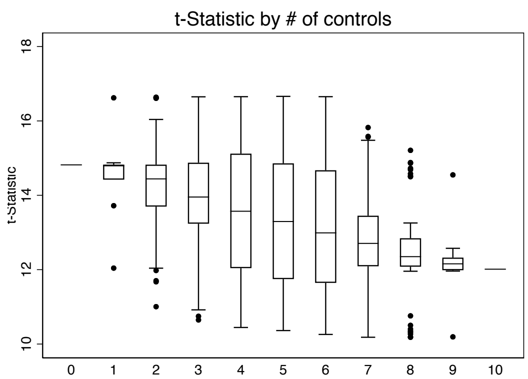


Figure 2: The tax equivalent of the *Chilean encaje*

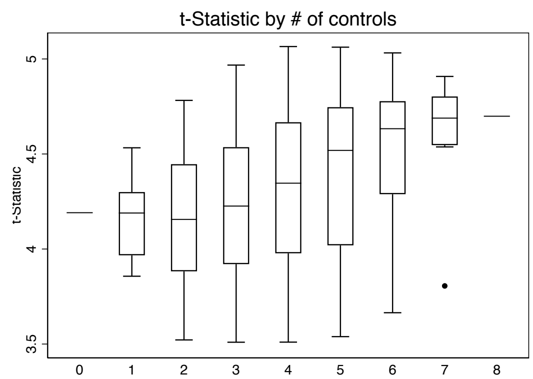


Note: We calculate the tax equivalent following the methodology in De Gregorio et al. (2000) .

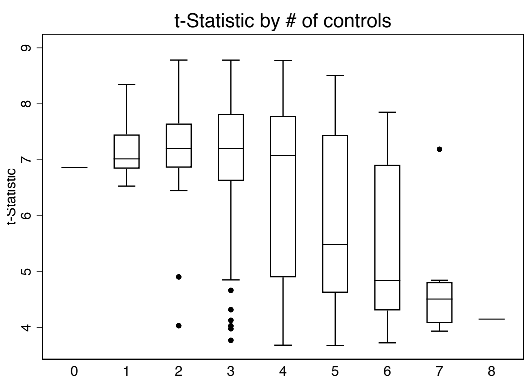
Figure 3: P-Hacking tests



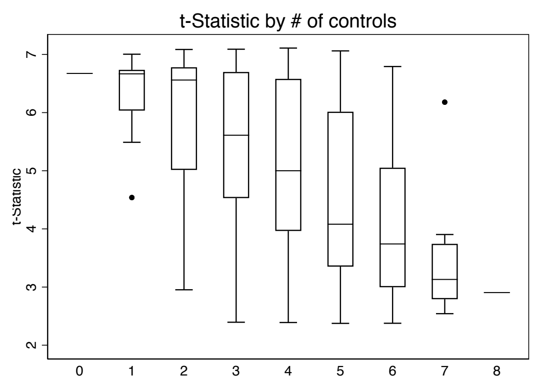
(a) $CC * Rank\_TFP$



(b) $CC * Young$



(c) $CC * Lag\_Exp$



(d) $CC * Fwd\_Exp$

Notes: This figure presents the t-statistics by number of controls for our main independent variables of interest, in Graph A through D are $CC * Rank\_TFP$, $CC * Young$, $CC * Lag\_Exp$, $CC * Fwd\_Exp$, based on 296 combinations of control variables for each regression where the dependent variable in all cases is misallocation, defined as the absolute value of the difference between the firm's MRPK to the mean of the industry.

Table 1: Parameter Values

	Predetermined parameters			Calibrated parameters	
β	Discount factor	0.96	τ	Iceberg trade cost	5.127
γ	Risk aversion	2	σ_z	Productivity dispersion	0.435
σ	Substitution elasticity	4	F	Sunk export entry cost	1.350
δ	Depreciation rate	0.06	θ	Collateral constraint	0.136
r	Interest rate	0.06	$\underline{a}$	Fraction of SS capital as initial net worth	0.252
ν	Death probability	0.08			
			α	Capital intensity	0.354

Table 2: Moments

Target Moment	Data (1990-1991) (1)	Model (No C.controls) (2)
Share of exporters	0.18	0.18
Average sales (exporters/non-exporters)	8.55	8.44
Average sales (age 5 / age 1)	1.26	1.39
Aggregate exports / sales	0.21	0.20
Aggregate credit / Value added	0.20	0.20
Aggregate capital stock / wage bill	6.60	6.70

Table 3: Aggregate effects of the CC

	Model w/o Lump sum (Δ%) (1)	Model with Lump-sum (Δ%) (2)
Exports	2.0%	1.8%
Share of exporters	−8.0%	−6.9%
Domestic Sales	−3.6%	−3.2%
Investment	−4.4%	−4.1%
Real GDP	−1.7%	−1.5%
Wage	−2.6%	−2.4%
Price	−1.4%	−1.2%

Table 4: Dev MRPK from efficient level

	% change	G (%)
All firms	0.11%	−2.39%
Low z	−0.79%	−1.65%
High z	0.38%	−3.52%
Exporters	5.34%	—
Non-exporters	−1.53%	—
Young	0.04%	—
Old	$\simeq 0\%$	—

Table 5: Dev MRPK from efficient level, by level of z

	% change
Exporters, low z	—
Exporters, high z	5.34%
Non-exporters, low z	−0.79%
Non-exporters, high z	−2.73%
Young, low z	−0.83%
Young, high z	0.38%
Old, low z	$\simeq 0\%$
Old, high z	$\simeq 0\%$

Table 6: Welfare: Distributional Effects

	$G(\%)$	$G^a(\%)$	$G^d(\%)$
All firms	−2.39%	−2.70%	0.33%
Low z	−1.65%	−1.35%	−0.30%
High z	−3.52%	−3.36%	−0.17%

Table 7: Dev MRPK from efficient level, with lump sum transfers

	% change	G (%)
All firms	0.19%	−2.14%
Low z	−0.63%	−1.51%
High z	0.44%	−3.12%
Exporters	4.72%	—
Non-exporters	−1.25%	—
Young	0.13%	—
Old	$\simeq 0\%$	—

Table 8: Dev MRPK from efficient level, with symmetric R

	% change	G (%)
All firms	7.53%	−2.74%
Low z	6.61%	−2.69%
High z	7.80%	−2.81%
Exporters	19.95%	—
Non-exporters	5.55%	—
Young	7.47%	—
Old	$\simeq 0\%$	—

Table 9: Dev MRPK from efficient level, decrease in θ

	% change	G (%)
All firms	4.94%	−0.16%
Low z	6.06%	−0.28%
High z	4.61%	0.04%
Exporters	5.15%	—
Non-exporters	5.75%	—
Young	5.01%	—
Old	$\simeq 0\%$	—

Table 10: Summary statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Fixed Capital	92,690	11.39	2.771	0	22.47
Total Workers	92,690	3.578	1.112	0	8.656
Interest Expenditures	92,690	4.895	4.675	0	18.24
TFP	92,690	2.151	0.149	-3.536	2.858
L_Exp	92,690	0.334	0.472	0	1
F_Exp	92,690	0.195	0.396	0	1
Misallocation	92,690	4.715	3.127	0	17.72
Rank_TFP	92,690	2,584	1,502	1	5,765
Young	92,690	0.486	0.500	0	1
Number of id	12,155	12,155	12,155	12,155	12,155

Table 11: Summary Statistics: Macroeconomic Indicators 1990-2007

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
CC	18	0.881	1.109	0	2.649
Inflation	18	0.017	0.536	-0.626	1.887
RER_dev	18	-0.009	0.055	-0.082	0.113
Growth	18	0.055	0.028	-0.021	0.120
World Growth	18	3.054	1.000	1.369	4.476
Private Credit/GDP	18	0.613	0.107	0.442	0.743
Libor 12m	18	4.918	1.799	1.364	8.415

Note: Capital Controls are calculated following the methodology of De Gregorio et al. (2000). Inflation, RER_dev, Growth and World Growth are from the Central Bank of Chile. RER_dev is calculated as the yearly variation of the real exchange rate, which is defined as the inverse of the nominal exchange rate multiplied by an international price index relevant for Chile and deflated by the chilean price index. The Private Credit to GDP ratio is from the Financial Structure Database (see Beck et al. (2000)). The 12-month Libor interest rate is obtained from the FRED Economic Data.

Table 12: Heterogeneous effects of CC on Misallocation: TFP, Age and Export status

VARIABLES	(1) All Firms	(2) All Firms	(3) Firms in 1990	(4) Firms in 1990
CC*Rank_TFP	0.009***	0.009***	0.000***	0.000***
	(0.001)	(0.001)	(0.000)	(0.000)
CC*Young	0.080***	0.094***	0.017	0.042
	(0.020)	(0.020)	(0.041)	(0.040)
CC*L_Exp	0.087***		0.137***	
	(0.021)		(0.033)	
CC*F_Exp		0.078***		0.060*
		(0.027)		(0.035)
Rank_TFP	-0.024***	-0.024***	-0.001***	-0.001***
	(0.005)	(0.005)	(0.000)	(0.000)
Young	-0.123**	-0.134**	-0.042	-0.074
	(0.055)	(0.054)	(0.091)	(0.091)
L_Exp	-0.125***		-0.289***	
	(0.037)		(0.063)	
F_Exp		-0.082		-0.076
		(0.051)		(0.067)
TFP	-4.521***	-4.515***	-5.108***	-5.114***
	(0.596)	(0.596)	(0.524)	(0.525)
Total Workers	-0.502***	-0.503***	-0.548***	-0.557***
	(0.033)	(0.033)	(0.046)	(0.046)
Fixed Capital	0.482***	0.481***	0.534***	0.532***
	(0.015)	(0.015)	(0.023)	(0.023)
Interest Expenditures	0.007**	0.007**	0.008**	0.008**
	(0.003)	(0.003)	(0.004)	(0.004)
Constant	13.332***	13.336***	15.348***	15.338***
	(1.162)	(1.160)	(1.110)	(1.114)
Observations	92,690	92,690	50,403	50,403
R-squared	0.123	0.123	0.105	0.105
Number of id	12,155	12,155	4,521	4,521
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES

Note: This table examines the effect of the interaction of CC with Rank_TFP, Young, L_Exp and F_Exp on misallocation, defined as the absolute value of the difference between the firm's MRPK to the mean of the industry. Columns (1) and (2) consider the full sample of firms while columns (3) and (4) present the results when only considering firms that existed in 1990 in order to fix the $Rank_TFP_{ijt}$ to the ranking that firms had in 1990, i.e., before the introduction of the CC. All regressions include a constant term, firm and time fixed effects, and robust standard errors. T-statistics in parenthesis. ***, **, and * indicate significance at the 1%,5%, and 10% level.

Table 13: Heterogeneous effects of CC on Misallocation: Age and Export status by productivity.

VARIABLES	(1) High prod. Top 50%	(2) Low prod. Bottom 50%	(3) High prod. Top 50%	(4) Low prod. Bottom 50%	(5) High prod. Top 30%	(6) Low prod. Bottom 30%	(7) High prod. Top 30%	(8) Low prod. Bottom 30%
CC*Young	0.118***	0.051**	0.143***	0.052**	0.118***	0.022	0.135***	0.028
	(0.033)	(0.024)	(0.033)	(0.023)	(0.044)	(0.030)	(0.044)	(0.029)
CC*L_Exp	0.166***	0.032			0.154***	0.028		
	(0.030)	(0.027)			(0.038)	(0.034)		
CC*F_Exp			0.140***	-0.010			0.105**	-0.023
			(0.035)	(0.041)			(0.043)	(0.057)
Observations	46,340	46,350	46,340	46,350	30,892	30,901	30,892	30,901
R-squared	0.0843	0.160	0.0841	0.159	0.0769	0.175	0.0767	0.175
Number of id	8,002	8,703	8,002	8,703	5,702	7,166	5,702	7,166
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	NO	YES	YES	YES	YES	YES

Note: This table examines the effect of the interaction of CC with Young, L_Exp and F_Exp on misallocation,defined as the absolute value of the difference between the firm's MRPK to the mean of the industry, while dividing the sample according to the firms' TFP ranking. Columns (1) to (4) divide the sample at its median while columns (5) to (8) consider the upper and lower 30% tails. All regressions include a constant term, firm and time fixed effects, and robust standard errors. T-statistics in parenthesis. ***, **, and * indicate significance at the 1%,5%, and 10% level.

Table 14: Interaction with macroeconomic controls

VARIABLES	(1) Libor	(2) Libor	(3) Inflation	(4) Inflation	(5) Growth	(6) Growth	(7) RER	(8) RER	(9) PrivCreditGDP	(10) PrivCreditGDP	(11) WorldGrowth	(12) WorldGrowth
CC*Rank_TFP	0.009***	0.009***	0.009***	0.009***	0.010***	0.010***	0.005***	0.005***	0.011***	0.011***	0.009***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CC*Young	0.083***	0.095***	0.085***	0.095***	0.096***	0.097***	0.081***	0.094***	0.074***	0.094***	0.066***	0.085***
	(0.021)	(0.020)	(0.021)	(0.020)	(0.021)	(0.021)	(0.021)	(0.020)	(0.022)	(0.021)	(0.021)	(0.020)
CC*L_Exp	0.081***		0.087***		0.042*		0.084***		0.103***		0.103***	
	(0.022)		(0.021)		(0.023)		(0.024)		(0.023)		(0.021)	
CC*F_Exp		0.071***		0.078***		0.023		0.077**		0.081***		0.105***
		(0.027)		(0.027)		(0.029)		(0.032)		(0.029)		(0.027)
Young*Libor	0.002	0.002										
	(0.006)	(0.006)										
L_Exp*Libor	0.016											
	(0.011)											
Rank_TFP*libor	-0.001***	-0.001***										
	(0.000)	(0.000)										
F_Exp*Libor		0.036***										
		(0.013)										
Young*Inflation			-0.003	-0.003								
			(0.003)	(0.003)								
L_Exp*Inflation			0.004									
			(0.004)									
Rank_TFP*Inflation			-0.001***	-0.001***								
			(0.000)	(0.000)								
F_Exp*Inflation				0.008								
				(0.005)								
Young*Growth					-0.008	-0.002						
					(0.005)	(0.005)						
L_Exp*Growth					0.042***							
					(0.009)							
Rank_TFP*Growth					-0.001***	-0.001***						
					(0.000)	(0.000)						
F_Exp*Growth						0.057***						
						(0.010)						
Young*RER							-0.000	-0.000				
							(0.000)	(0.000)				
L_Exp*RER							-0.000					
							(0.003)					
Rank_TFP*RER							-0.001***	-0.001***				
							(0.000)	(0.000)				
F_Exp*TCR								0.000				
								(0.004)				
Young*PrivCreditGDP									0.021	-0.006		
									(0.063)	(0.064)		
L_Exp*PrivCreditGDP									0.417			
									(0.300)			
Rank_TFP*PrivCreditGDP									0.083***	0.081***		
									(0.011)	(0.011)		
F_Exp*PrivCreditGDP										0.296		
										(0.383)		
Young*WorldGrowth											0.005	0.014
											(0.011)	(0.011)
L_Exp*WorldGrowth											0.205***	
											(0.023)	
Rank_TFP*WorldGrowth											0.006***	0.005***
											(0.001)	(0.001)
F_Exp*WorldGrowth												0.322***
												(0.026)
Observations	92,690	92,690	92,690	92,690	92,690	92,690	92,690	92,690	92,690	92,690	92,690	92,690
R-squared	0.123	0.123	0.124	0.124	0.123	0.124	0.124	0.124	0.124	0.124	0.125	0.125
Number of id	12,155	12,155	12,155	12,155	12,155	12,155	12,155	12,155	12,155	12,155	12,155	12,155
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: This table examines the robustness of the interaction of CC with Rank_TFP, Young, L_Exp and F_Exp on misallocation when introducing, one at a time, the interactions of macroeconomic variables and our variables of interest, $rank_TFP_{ijt}$, $Young_{ijt}$, L_Exp_{ijt} or F_Exp_{ijt}. The macroeconomic variables under consideration are: the Libor rate, inflation, growth, RER, private credit_GDP and world growth. All macroeconomic variables are lagged one period. All regressions include a constant term, firm and time fixed effects, and robust standard errors. T-statistics in parenthesis. ***, **, and * indicate significance at the 1%,5%, and 10% level.

Table 15: Main changes in the administration of the *Chilean encaje*

Jun-1991	20% URR introduced for all new credit Holding period (months)=min(max(credit maturity, 3),12) Holding currency=same as creditor Investors can waive the URR by paying a fix fee (Through a repo agreement at discount in favor of the central bank) Repo discount= US$ libor
Jan-1992	20% URR extended to foreign currency deposits with proportional HP
May-1992	Holding period (months)=12 URR increased to 30% for bank credit lines
Aug-1992	URR increased to 30% Repo discount= US$ libor +2.5
Oct-1992	Repo discount= US$ libor +4.0
Jan-1995	Holding currency=US$ only
Sep-1995	Period to liquidate US$ from Secondary ADR tightened
Dec-1995	Foreign borrowing to be used externally is exempt of URR
Oct-1996	FDI committee considers for approval productive projects only
Dec-1996	Foreign borrowing <US$ 200,000 (500,000 in a year) exempt of URR
Mar-1997	Foreign borrowing <US$ 100,000 (100,000 in a year) exempt of URR
Jun-1998	URR set to 10%
Sep-1998	URR set to zero

Note: URR=Unremunerated Reserve Requirement
Source: De Gregorio et al. (2000).