PIER
PENN INSTITUTE for ECONOMIC RESEARCH
UNIVERSITY of PENNSYLVANIA

The Ronald O. Perelman Center for Political Science and Economics (PCPSE)
133 South 36th Street
Philadelphia, PA 19104-6297

pier@econ.upenn.edu
http://economics.sas.upenn.edu/pier

PIER Working Paper
23-005

Beware the Side Effects: Capital Controls, Trade, Misallocation and Welfare

EUGENIA ANDREASEN
University of Chile

SOFÍA BAUDUCCO
Central Bank of Chile

EVANGELINA DARDATI
Universidad Diego

ENRIQUE G. MENDOZA
University of Pennsylvania & NBER

February 7, 2023

Beware the Side Effects: Capital Controls, Trade, Misallocation and Welfare*

Eugenia Andreasen† Sofía Bauducco‡ Evangelina Dardati§ Enrique G. Mendoza¶

February 7, 2023

Abstract

We show that capital controls have large adverse effects on misallocation, exports and welfare using a dynamic Melitz-OLG model with heterogeneous firms, monopolistic competition, endogenous trade participation and collateral constraints. Static effects increase misallocation by reducing capital-labor ratios and rising firm prices, dynamic effects reduce it by incentivizing saving and delaying entry into export markets, and general equilibrium effects are ambiguous. Firms at the collateral constraint or at their optimal scale are barely affected but those in between are severely affected. Calibrated to the 1990s Chilean *encaje*, the model yields higher aggregate misallocation with larger effects on exporters and high-productivity firms. Social welfare falls and welfare of exporters falls significantly more. LTV regulation cuts credit by the same amount at sharply lower costs, because it spreads the burden of the cut more evenly. A panel data analysis of Chilean manufacturing firms yields strong evidence supporting the model's predictions.

Keywords: Capital controls, welfare, misallocation, financial frictions, international trade.
JEL codes: F12, F38, F41, O47

---

*We thank Jonathan Rojas for excellent research assistance and the Financial Stability and Development Network of the Inter-American Development Bank for its support. Eugenia Andreasen and Evangelina Dardati also acknowledge financial support from Fondecyt regular projects #1200101 and#1200568, respectively. We are grateful for comments from seminar and conference participants at the 2021 NBER Summer Institute, 2021 LACEA-LAMES Conference, 2021 Econometric Society European Meeting, 2021 Money Macro and Finance Society Conference, 2021 Bank of England-Banque de France– IMF–OECD–Banca d'Italia Conference on International Capital Flows, 2022 BSE Summer Forum, 2022 ITAM-PIER Macroeconomics Conference, 52nd Annual Conference of the Money, Macro & Finance Society, V Annual Santiago Macro Workshop, Bank of Portugal, BIS, Columbia University, CEMFI, Dallas Fed, Minneapolis Fed, New York Fed, International Monetary Fund, Universidad de Chile, Universitat Autonoma de Barcelona, and University of Wisconsin. The views and conclusions presented in this paper are exclusively those of the authors and do not necessarily reflect the position of the Central Bank of Chile or of the Board members.

†Department of Economics, University of Chile. Diagonal Paraguay 257, Santiago, Chile. Email: eandreasen@fen.uchile.cl.
‡Economic Studies Unit, Central Bank of Chile. Agustinas 1180, 8340454. Santiago, Chile. Email: sbauducco@bcentral.cl.
§Department of Economics, Universidad Diego Portales, Av. Santa Clara 797, Santiago, Chile. Email: evangelina.dardati@udp.cl.
¶Department of Economics, University of Pennsylvania, 3718 Locust Walk, Philadelphia, PA 19104, and NBER. Email: egme@sas.upenn.edu.

1 Introduction

Views on capital controls (CCs) shifted widely in the last half century. They were considered bad policy from the time of the collapse of the Bretton Woods System in 1971 to the mid-1990s. Then, they began to gain favor after the emerging markets Sudden Stops as an instrument to prevent credit booms and vulnerabilities arising from surging capital inflows, and finally became a widely-accepted macroprudential policy tool after the 2008 Global Financial Crisis. This turnaround was partly supported by research showing that macroprudential CCs can address pecuniary externalities that cause overborrowing and sudden stops via credit constraints linked to collateral prices (see Bianchi and Mendoza (2020) for a literature review). Most research on capital controls, however, focuses on how they affect financial intermediaries, aggregate balance-of-payments adjustment and macroeconomic dynamics and typically in representative-agent settings.

This paper takes a new direction by examining the "side effects" of capital controls. In particular, we emphasize their heterogeneous impact across firms and the resulting aggregate effects. This approach is motivated by ample empirical evidence showing that CCs affect firms differently depending on size, financial dependence, external trade, and capital intensity (e.g., Alfaro et al. (2017), Forbes (2007), Andreasen et al. (2022)). Thus, the data suggest that there is an important transmission mechanism linking CCs to firm dynamics and firm heterogeneity, but to date little is known about this mechanism and its positive and normative implications.[1]

We study two key questions: What are the side effects of CCs on misallocation of capital across firms and external trade participation? And, what are the aggregate and social welfare implications of these side effects? This paper provides theoretical, quantitative and empirical answers derived from a dynamic Melitz model with overlapping-generations of monopolistically-competitive entrepreneurs that face a collateral constraint. Entrepreneurs produce differentiated varieties of intermediate goods and sell them to domestic final-good producers and to foreign buyers, if they choose to be exporters. They differ in a one-time exogenous productivity draw, the size of their capital stock, their age, their debt, and whether they export or not. CCs enter as a tax-equivalent levy on foreign borrowing (i.e., an asymmetric tax) that increases the interest rate on debt and thus adds to the financial frictions already present because of the collateral constraint.

We show that, without collateral constraints and CCs, there is no misallocation (i.e., disper-

[1]Some of the research and policy debates on macroprudential CCs warn of investment distortions akin to those of capital taxes, but still using representative-agent models. Bianchi and Mendoza (2020) and Darracq-Paries et al. (2019) show that CCs need to be state-contingent in order to avoid "taxing investment" in states in which is inefficient to do so.

sion in marginal revenue products of capital (MRPK) and labor (MRPL)) and factor allocations are efficient. There is also no misallocation in the decentralized equilibrium with monopolistic competition, but the world opportunity cost of capital that pins down MRPK is inefficient, because monopolistic competition distorts prices. Adding the collateral constraint raises MRPKs of some firms and thus causes misallocation of capital, via the mechanism that is standard in the literature: Credit-constrained firms operate below their long-run optimal scale of capital (i.e., they display an "optimal scale gap," OSG) with an effect that is larger for more constrained firms.

Our analysis focuses on the effects of introducing CCs into an economy with collateral constraints. Misallocation responds to three effects: First, "static" effects on firms' debt, capital, labor, production and prices taking as given aggregate variables (wages and the price and output of final goods). These effects worsen misallocation by tightening further the firms' access to credit, which reduces their capital and capital-labor ratios and increases their prices, thus increasing their MRPKs. Second, dynamic effects driven by stronger saving incentives, as tighter credit access increases the marginal return on saving and incentivizes entrepreneurs to grow their net worth faster, and by a delay in the timing with which firms enter export markets that reduces exports and the share of exporting firms. Hence, the static effects increase the MRPK of firms with a given net worth but faster net-worth growth may result in more firms at higher levels of net worth with lower MRPKs in the stationary equilibrium. Third, general equilibrium effects that result from changes in aggregate variables, which change as CCs affect aggregate demand for final goods and labor and demand and supply of intermediate goods. The net impact of these effects on misallocation, aggregate outcomes, and social welfare is, therefore, theoretically ambiguous.[2]

The effects of capital controls on misallocation differ from those of collateral constraints that are well-known in the literature. In particular, the static effects of collateral constraints reducing capital and increasing MRPK shrink monotonically with net worth, while those resulting from CCs are non-monotonic: Capital falls more and MPRK rises more for firms operating at the pseudo-steady-state of capital consistent with the world opportunity cost *inclusive* of the tax on foreign borrowing, and for larger firms forced to self-finance their growth. MRPKs are unaffected by CCs both for firms at the collateral constraint and at their long-run optimal scale.

We study the model's quantitative predictions by comparing stationary equilibria before and after the imposition of capital controls for a calibration based on the case of the Chilean *encaje*,

[2]CCs add another source of misallocation into an economy that is already inefficient because of the collateral constraint. Since inefficient equilibria cannot be ranked in general, the social welfare effect of CCs is theoretically ambiguous.

an unremunerated reserve requirement on capital inflows introduced in 1991 and removed in 1998. The calibration uses targets derived from Chilean firm-level data. With this calibration, the model approximates well the Chilean firm-size distributions from before and after the *encaje* was in place, and it does so largely because of the size difference across exporters and non-exporters.

The model predicts that capital controls have sizable aggregate effects. Real wages fall 0.7% and the output and price of final goods fall 0.85% and 0.36%, respectively. As a result, long-run optimal capital scales and net profits of exporters and non-exporters rise 0.38% and 0.27%, respectively. Aggregate consumption, the credit-value added ratio, exports, and the share of exporters also fall. Misallocation, measured as the mean deviation of MRPKs relative to the world opportunity cost of capital, rises 0.5 percentage points (pp) for the economy as a whole and significantly more for exporters than non-exporters and for firms with large v. small OSG. Across low-productivity firms, which are all non-exporters, misallocation worsens more at higher levels of productivity, but the opposite is true across high-productivity firms, which are mainly exporters.

Capital controls reduce social welfare by 0.61%, in terms of a compensating consumption variation common to all entrepreneurs applied to a utilitarian social welfare function (with weights given by the model's firm-age distribution). The welfare costs are much larger for exporters (1.82%) than non-exporters (0.56%), and they are non-monotonic in productivity: They initially fall as productivity rises from its lowest level to the average (i.e., for non-exporters) and then jump and become increasing in productivity at higher productivity levels (i.e., for exporters and switchers). These results are due to heterogeneous effects on labor and capital income: Low-productivity entrepreneurs suffer more from the fall in real wages because they operate smaller firms and collect a larger share of their income from wages. As productivity and firm-size rise, capital income (i.e., profits) becomes relevant. Profits fall if the firm's relative price rises, and the latter falls as the real wage falls but rises as MRPK rises. As a result, profits rise (fall) for firms with low (high) enough misallocation, and misallocation worsens less for firms with lower productivity.

The quantitative analysis also includes three counterfactual experiments. First, since the 1.75% tax on inflows implied by the Chilean *encaje* is much smaller than the long-run average of estimates of optimal macroprudential CCs in the 3-12% range, we examine the effects of a 6% tax. This yields much larger effects on aggregate variables, misallocation and welfare. Aggregate misallocation rises 2.28pp and social welfare falls 1.41%. There are also important changes in the distribution and magnitude of misallocation and welfare costs across firms due to the much stronger general equilibrium effects and the aggregation with the firm-age distribution.

The second counterfactual examines loan-to-value (LTV) regulation as an alternative policy to reduce credit (by lowering the debt that firms can obtain per unit of capital pledged as collateral). Calibrated to attain the same cut in the credit-value added ratio as the CCs, this policy is far superior. Aggregate misallocation rises 0.29pp and welfare falls only 0.2%. LTV regulation is superior because it spreads the burden of the credit cut more evenly by reducing credit to firms at the collateral constraint that were unaffected by CCs and increasing it to firms affected by them.

The last counterfactual rebates the debt taxes paid by each firm back to them. Capital controls are usually in the form of legal or exchange-rate restrictions, or unremenurated reserves, and as such are not rebated. Still, this experiment sheds light on the role of the income effects of CCs. The results show weaker aggregate effects and smaller welfare costs but larger increases in misallocation at the aggregate level, for exporters and nonexporters and most levels of productivity.

We close the paper with an empirical analysis testing whether the model's quantitative predictions that the adverse effect of capital controls on misallocation is larger for firms with higher productivity, for exporters and for firms further away from their optimal scale hold in the data. We conduct panel estimations using Chilean manufacturing firm-level data from the *Encuesta Nacional Industrial Anual* (ENIA). The results provide statistically significant evidence in favor of the model's predictions, and the results are robust to a number of control checks (e.g., using sales or value added to define misallocation, balanced v. unbalanced panels, exclusion of the late-1990s-crisis periods, macro controls, outliers, backward or forward definition of exporters). Moreover, we also find statistically significant evidence supporting the model's prediction that the effect on misallocation as productivity rises is much stronger for non-exporters than exporters.

The rest of the paper is organized as follows: Section 2 compares our work with the related literature. Section 3 presents the model. Section 4 derives its implications for misallocation. Section 5 discusses the quantitative results. Section 6 conducts the empirical analysis. Section 7 concludes.

2 Related Literature

Our paper is related to the large literature on misallocation and financial frictions that uses heterogeneous-firms models to examine how policies and firm characteristics generate misallocation (e.g., Restuccia and Rogerson (2008), Hsieh and Klenow (2009), Guner et al. (2008)). Several studies focus on closed-economy models under perfect competition. Buera et al. (2011) present a model with sectors that differ in their degree of financial dependence and show that financial frictions can significantly distort factor allocations. Midrigan and Xu (2014) propose a two-sector model in which debt constraints distort technology adoption and create misallocation. Both models predict that financial development reduces misallocation. Buera and Moll (2015) examine how shocks to a collateral constraint under three forms of heterogeneity affect wedges used to account for aggregate fluctuations. Our work differs from these studies in that we examine an open-economy model, which links MRPKs to world opportunity costs, assume monopolistic competition and model the firms' life cycle, both of which amplify the effects of financial frictions on MRPKs.

Cavalcanti et al. (2021) propose a model that relaxes the assumption that firms face a collateral constraint at a common financing cost. They obtain dispersion in credit spreads due to lenders' market power and intermediation costs that fall with a firm's assets and productivity, and find larger real effects than with the common financing cost. In our model financing costs also vary, albeit in a simpler way, because CCs cause borrowing and saving rates to differ. We obtain a similar result indicating larger real effects than in a regime with collateral constraints but no CCs.

An important branch of this literature uses open-economy models to examine the effects of financial integration modeled as a fall in the world real interest rate. Gopinath et al. (2017) study a model with infinitely-lived firms and monopolistic competition in partial equilibrium. Productivity shocks and capital adjustment costs, combined with a collateral constraint that is increasing and convex in capital (i.e., size-dependent borrowing capacity), yield the result that capital inflows triggered by the interest-rate drop are misallocated towards high net-worth firms that may be less productive. Firms accumulate precautionary savings and those with more capital can borrow more and speed up convergence to their new optimal scale, but poorer firms may draw higher productivity. They find empirical evidence supporting this result in data for Southern European countries in the 2000s. Our setup also features monopolistic competition, but modeling the firms' life-cycle and using the standard collateral constraint linear in capital.[3] Still, our model would predict that, without CCs, a lower interest rate increases misallocation in partial equilibrium, during the transition. This occurs because the collateral constraint makes firms take longer to reach their new, higher optimal scales.[4] The main focus of our analysis, however, is not a fall in the interest rate but an asymmetric increase that affects firms only when borrowing, representing capital controls. Interestingly, this asymmetry makes borrowing capacity size-dependent: a newborn firm hits first

[3]We also abstract from precautionary savings because of the Blanchard-Yaari OLG setup and at-birth-only productivity shocks, but we introduce endogenous trade participation and study general equilibrium outcomes, both of which are found to be quantitatively relevant.

[4]In general equilibrium, changes in the price level can alter this result.

the collateral constraint, then outgrows it and repays its debt, and then self-finances the rest of its transition to steady-state. Firms of different age cohorts are at different stages, with the result that the CCs *increase* aggregate misallocation in an economy that already had the collateral constraint.

Asriyan et al. (2021) study a general equilibrium model with infinitely-lived heterogeneous entrepreneurs, financial frictions and an imperfectly-elastic supply of capital. They find that the effect of a lower interest rate on aggregate output is ambiguous. It may fall if a pecuniary externality generated by the elasticity of capital props up investment of less productive firms by enough to crowd out that of more productive firms. Their model is different from ours, but the two highlight the importance of general equilibrium effects, in their case via a pecuniary externality on the cost of capital, in our case via changes in aggregate demand, the price of final goods and wages. Theoretically, the effect of the *higher* interest rate implied by CCs on aggregate output is also ambiguous, but in our calibrated solutions we find that output falls.

This paper is also related to the analysis of capital controls in an economy with financial constraints by Andreasen et al. (2022). Using Chilean manufacturing data, they find that exporters in more capital-intensive sectors are more negatively affected by CCs, while the converse is true for non-exporting firms. Moreover, CCs reduce aggregate production but increase TFP. This paper differs in that it studies the effects of CCs on misallocation and examines their welfare implications.

Another strand of the literature relevant to our analysis studies how the interaction of trade and financial frictions affects misallocation and welfare. Brooks and Dovis (2020) show that misallocation across exporters and non-exporters reduces the gains from trade liberalization with the typical collateral constraint linked to existing capital but not with one linked to future profits. They find evidence consistent with the latter using Colombian data. Our model and theirs are similar in that both feature a dynamic Melitz setup with OLG firms and endogenous trade participation, but we examine the effects of CCs instead of a trade reform, and in an economy that already has a (standard) collateral constraint. Appendix E shows that our main results still hold with a constraint linked to profits. Leibovici (2021) examines the industry-level and aggregate effects of financial development on trade shares (ratios of exports to domestic sales). He uses a rich multi-sector model with infinitely-lived entrepreneurs exposed to idiosyncratic productivity shocks who choose to operate in various tradable or nontradable industries. These industries differ in capital intensity and this induces differences in financial dependence. A cut in the fraction of capital pledgeable as collateral for debt reallocates trade shares to less capital-intensive industries. Our analysis has a simpler sectoral setup and abstracts from recurrent productivity shocks, but we model the firms' life cycle and examine CCs as a financial friction additional to the collateral constraint. Still, both studies find that exporters are larger and more credit constrained than non-exporters, tighter financial frictions reduce sharply the share of firms that export but the aggregate trade share hardly changes. Finlay (2021) also proposes a model with infinitely-lived firms in which exporters are more credit constrained than non-exporters. Tightening credit constraints for exporters lowers aggregate productivity because they are more productive. Similarly, in our model, exporters are more credit constrained, because their optimal scales are larger, but tightening credit constraints using CCs has non-monotonic effects across exporters and non-exporters depending on productivity. Also, in our setup the life-cycle dynamics of the firms drives the aggregate effects.

Other studies examine the effects of trade integration in two-country Melitz models with pre-existing firm-level distortions but without financial frictions. Bai et al. (2019) find that welfare may fall due to worsened misallocation. Using Chinese data, they obtain an 18% welfare loss. Berthou et al. (2020) show that effects on welfare and productivity are theoretically ambiguous because of different effects from free trade in exports and imports. Our work shares with these studies the interest in examining the effects of international trade on misallocation and welfare, but we study these effects in the context of a model with collateral constraints and capital controls.

Finally, our paper also relates to the empirical literature on the firm-level effects of CCs. Bekaert et al. (2011) show that easing CCs positively affects capital stock growth and TFP. Larraín and Stumpner (2017), focusing on Eastern European countries, find that financial openness increases aggregate productivity via a more efficient allocation of capital across firms. Varela (2017) studies the 2001 financial liberalization in Hungary and shows that it can lead firms to invest in technology adoption and thereby increase aggregate TFP. Alfaro et al. (2017) find a decline in cumulative abnormal returns for Brazilian firms following the imposition of CCs in 2008-2009, and that this effect is stronger for smaller, non-exporting and more financially dependent firms. Some papers study the Chilean case. Oberfield (2013) examines allocative efficiency and TFP during the 1982 financial crisis. He finds that within-industry TFP either remained constant or improved in 1982, while a decline in between-industry allocative efficiency accounts for about a third of the fall in TFP. Chen and Irarrázabal (2015) provide suggestive evidence that financial development might be an important factor explaining the fall in misallocation driving growth in output and productivity in Chile between 1983 and 1996. Forbes (2007) finds that smaller firms experienced significant financial constraints, which decreased with firm size. Our paper contributes to this literature by examining the effects of the Chilean *encaje* on misallocation using a large panel dataset of manufacturing establishments and showing that misallocation increased relatively more for high-productivity and exporting firms and for firms further away from their optimal scale.

3 Model

We propose a model in which overlapping generations of entrepreneurs sell differentiated varieties of intermediate goods to domestic and foreign final-goods producers in monopolistically-competitive markets. Entrepreneurs can make an irreversible choice to become exporters by paying an entry cost. Their access to foreign financing is limited by a collateral constraint and, if present, CCs. The collateral constraint induces dispersion in MRPKs via the standard mechanism from the literature (i.e., constrained firms grow their net worth gradually with MRPKs that are monotonically larger the further away firms are from their optimal scale). CCs operate also as a financial friction, but with a mechanism that changes MRPKs non-linearly as firms grow, as we explain later in this Section. These financial frictions also interact with the entry cost to become an exporter, because firms must accumulate enough assets for them to find it optimal to become exporters.

3.1 Final-goods sector

A representative producer of final goods purchases differentiated varieties of intermediate goods from domestic and foreign firms and uses them to operate a constant-elasticity-of-substitution (CES) technology. The elasticity of substitution across inputs is denoted by $\sigma > 1$. Let the set $[0, 1]$ index the measure of domestic entrepreneurs and define $\{p_{h,t}(i)\}_{i\in[0,1]}$ and p_m as the prices charged by domestic and foreign entrepreneurs, respectively. The producer of final goods chooses the optimum bundle of domestic, $\{y_{h,t}(i)\}_{i\in[0,1]}$, and imported, $y_{m,t}$, inputs so as to maximize profits from final-goods production, y_t, taking all input prices as given and subject to the CES technology:

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

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

where eq. (1) is the CES production function and p_t is the CES price index of final goods, $p_t = [\int_0^1 p_{h,t}(i)^{1-\sigma} di + p_m^{1-\sigma}]^{1/(1-\sigma)}$.

This problem yields standard demand functions for domestic inputs:

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

Because of monopolistic competition among intermediate goods producers, these are the demand functions that they internalize in their optimization problems. By analogy, we assume that they face the following demand functions from abroad:

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

where $p_{f,t}(i)$ is the price entrepreneur i charges abroad, and p^* and y^* are the exogenous price and production of foreign final goods, respectively. Hence, the real exchange rate is given by p/p^*.

3.2 Intermediate-goods sector

Entrepreneurs supply one unit of labor inelastically and have iso-elastic preferences:

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

where c_t is consumption, $1/\gamma$ is the elasticity of intertemporal substitution, and β is the subjective discount factor. The expectation $\mathbb{E}_0$ is taken over the probability of death ρ. At the end of each period, deceased entrepreneurs are replaced by a measure ρ of newborn entrepreneurs. In order to remove the effects of the risk of death from the entrepreneur's optimization problem (i.e., make this risk insurable), we adopt a standard Blanchard-Yaari formulation: Entrepreneurs use insurance contracts so that, upon their death, all savings and capital are transferred to existing entrepreneurs. Surviving entrepreneurs are paid an amount that expands their net worth by a proportion $\frac{\rho}{1-\rho}$.[5]

Entrepreneurs make a choice to remain non-exporters ($e = 0$) or become exporters ($e = 1$) at the beginning of each period. The latter choice is irreversible while a non-exporter retains the option to become an exporter in the future.[6] If the entrepreneur chooses $e = 1$, it pays a one-time entry cost F in units of labor at t and starts exporting at $t + 1$. Exporting goods also incurs an "iceberg" trade cost that requires shipping ζ units for every unit sold abroad, with $\zeta > 1$.

[5] We acknowledge that assuming well-developed insurance markets is a bit at odds with assuming credit constraints.

[6] This assumption is validated by the Chilean data that show that 71% of firms that export in a given period continue exporting in the next one. For firms that have exported for three periods, this proportion increases to 93%.

Newborn entrepreneurs arrive with zero debt, draw idiosyncratic productivity z that remains constant until they die, and receive a transfer of capital from the government $\underline{k}(z)$ so that they can start operations.[7] z is log-normal with p.d.f $f(z)$, mean μ_z and standard deviation ω_z. Entrepreneurs produce intermediate goods using capital, k_t, and labor, n_t, to operate a Cobb-Douglas technology with capital intensity $\alpha \in (0,1)$. The technological constraint requires:

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

Capital depreciates at rate δ and investment is denoted x_t. Taking into account the insurance payments, the law of motion of capital is given by:[8]

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

Entrepreneurs participate in a global market of one-period, risk-free discount bonds. d_{t+1} denotes debt issued (bonds sold) at price q at date t to be repaid at t+1.[9] They also face the collateral constraint typical of the literature, by which entrepreneurs cannot borrow more resources than a fraction $0 \leq \theta \leq 1$ of the value of their capital stock:

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

Without CCs, the gross interest rate on debt is the world real interest rate $R^* \equiv 1 + r^*$ and the price is $q^* = 1/R^*$. We model CCs on inflows as an asymmetric tax on external borrowing: for $d_{t+1} > 0$, the interest rate is $\hat{r} = r^* + \nu$ and the bond price is $\hat{q} \equiv 1/(1+\hat{r})$, where ν is the tax-equivalent capital control, and for $d_{t+1} \leq 0$ the interest rate is $r = r^*$ with bond price q^*.[10] Hence, bond prices are given by $q = \mathbb{1}_{d' \leq 0} q^* + \mathbb{1}_{d'>0} \hat{q}$. Moreover, since CCs prevent borrowing at the rate R^*, entrepreneurs face the additional constraint $q^* d_{t+1} \leq 0$.

[7] $\underline{k}(z)$ varies with z and is such that even firms with the lowest z start with capital below their optimal scale.

[8] The entrepreneur accumulates capital by the amount $(1-\delta)k_t + x_t$ and receives an extra $\frac{\rho}{1-\rho}[(1-\delta)k_t + x_t]$ from the annuity, which yields $k_{t+1} = \frac{1}{1-\rho}[(1-\delta)k_t + x_t]$.

[9] The debt is assumed to be denominated in units of domestic final goods for simplicity. We could assume that risk-neutral banks intermediate foreign debt that pays a real rate of r^* in units of p^* and that $p^* = 1$. Since our analysis focuses on the stationary equilibrium where p_t is constant, the no arbitrage condition of banks would imply $r = r^*$.

[10] Appendix A.1 describes the mapping from capital controls regulation to values of ν and applies it to Chilean data.

3.3 Recursive formulation of the entrepreneur's problem

We follow Buera and Moll (2015) in formulating the entrepreneurs' recursive optimization problem so that cash-on-hand is the only relevant endogenous state variable.[11] The entrepreneur's cash on hand is: $m \equiv [w + \frac{p_h^{1-\sigma}}{p^{-\sigma}} y + e \frac{p_f^{1-\sigma}}{p^{*-\sigma}} y^* - wn + p(1-\delta)k - pd - T]/p$, where T are lump-sum taxes. Defining net worth a' as $a' \equiv k' - qd'$, the budget constraint of the entrepreneur can be expressed as $c = m - (1-\rho)a'$.[12] The entrepreneur's optimal plans can then be formulated as a solution to a two-stage budgeting problem: An optimal choice of a' to maximize lifetime utility and a "static" choice to maximize m' by allocating a' into a portfolio of k' and d' and by setting p_h', p_f' and n'.

An entrepreneur with a given z starts each period being a non-exporter $(e = 0)$ or an exporter $(e = 1)$ from the period before. Since exporting is an absorbent state, if $e = 1$, it remains an exporter and hence $e' = 1$. But if $e = 0$, it decides optimally whether to become a switcher who starts exporting the following period $(e' = 1)$ or not $(e' = 0)$. The payoff of the entrepreneur is:

$$v(m, z, e) = ev^E(m, z) + (1-e)\left[\max_{e' \in \{0,1\}} \left\{(1-e')v^{NE}(m, z) + e'v^S(m, z)\right\}\right], \tag{7}$$

where $v^{NE}(m, z)$ is the value of continuing as a non-exporter and $v^S(m, z)$ is the value of switching to be an exporter. Keep in mind that z does not vary over time.

$v^{NE}(m, z)$ solves the following two-stage optimization problem:

$$v^{NE}(m, z) = \max_{a'} \left[u\left(m - (1-\rho)a'\right) + \tilde{\beta} v\left(\tilde{m}'(a', z), z, e'\right)\right], \tag{8}$$

$$\tilde{m}'(a', z) = \max_{k', d', p'_h, n'} \left[\frac{w' + \frac{{p'}_h^{1-\sigma}}{p'^{-\sigma}} y' - w'n' + p'(1-\delta)k' - p'd' - T(z)}{p'}\right] \tag{9}$$

$$\text{s.t.} \quad \left(\frac{p_h'}{p'}\right)^{-\sigma} y' = z{k'}^{\alpha}{n'}^{1-\alpha}, \qquad a' = k' - qd', \qquad \hat{q}d' \leq \theta k', \qquad q^* d' \leq 0.$$

where $\tilde{\beta} \equiv \beta(1-\rho)$. The function $v(\cdot)$ appears in the right-hand-side of (8) because the non-exporter retains the option to become an exporter in the future. Lump-sum taxes vary with z because the government sets them to pay for the capital endowments of newborn firms of each

[11]Because of the monopolistic competition, however, in our setting the firms' profits and their debt and capital choices are non-linear in net worth, and hence the net worth decision rule is non-linear in cash on hand.

[12]The entrepreneur's budget constraint is $pc + p[(1-\rho)k' - (1-\delta)k] + pd + wn = w + p_h y_h + e(p_f y_f) + p(1-\rho)qd' - T$. Using the definition of a' and rearranging terms yields $pc + p(1-\rho)a' - p(1-\delta)k + pd + wn = w + p_h y_h + e(p_f y_f) - T$. Then using the demand functions (2)-(3) and rearranging terms yields $pc = w + \frac{p_h^{1-\sigma}}{p^{-\sigma}} y + e \frac{p_f^{1-\sigma}}{p^{*-\sigma}} y^* - wn + p(1-\delta)k + pd - T - p(1-\rho)a'$. Finally, applying the definition of m and dividing through by p yields $c = m - (1-\rho)a'$. Notice that a' is multiplied by $1-\rho$ because the annuity contract transfers all savings and capital to existing entrepreneurs.

productivity type: $T(z) = p'\rho\underline{k}(z)$. This avoids the redistribution of income from low- to high-z entrepreneurs that would occur with a uniform tax.

The two-stage-budgeting structure of the solution is evident in that the maximization problem (8) yields the decision rule $a'(m, z)$ that drives the evolution of net worth as a function of cash on hand, while the solution to the maximization problem defined by (9) determines $\tilde{m}'$, the optimal portfolio allocation of a' into k' and d' and the optimal p'_h and n', all as recursive functions of (a', z). Hence, evaluating a' at the optimal value given by $a'(m, z)$, we can express the optimal decision rules as $\tilde{m}'(m, z)$, $k'(m, z)$, $d'(m, z)$, $p'_h(m, z)$ and $n'(m, z)$. These decision rules depend also on the aggregate variables (y', p', w'), but we do not carry them as state variables to keep the notation simple, since we will solve for stationary equilibria in which they are time-invariant.

The value of a firm that is already exporting is:

$$v^E(m, z) = \max_{a'} \left[u\left(m - (1-\rho)a'\right) + \tilde{\beta} v^E\left(\tilde{m}'(a', z), z\right) \right], \tag{10}$$

$$\tilde{m}'(a', z) = \max_{k', d', p'_h, p'_f, n'} \left[\frac{w' + \frac{p'^{1-\sigma}_h}{p'^{-\sigma}} y' + \frac{p'^{1-\sigma}_f}{p^{*-\sigma}} y^* - w'n' + p'(1-\delta)k' - p'd' - T(z)}{p'} \right] \tag{11}$$

$$\text{s.t.} \qquad \left(\frac{p'_h}{p'}\right)^{-\sigma} y' + \zeta \left(\frac{p'_f}{p^*}\right)^{-\sigma} y^* = z k'^{\alpha} n'^{1-\alpha}, \qquad a' = k' - qd', \qquad \hat{q}d' \leq \theta k', \qquad q^* d' \leq 0.$$

This problem includes sales abroad as part of cash on hand, adds foreign demand inclusive of the iceberg cost of exporting in the technological constraint, and takes into account that an exporter chooses p'_f in addition to k', d', p'_h and n'. Since the decision to become an exporter is irreversible, $v^E(\cdot)$ is the same function in both sides of (10).

The value of switching to become an exporter, $v^S(m, z)$, solves the following problem:

$$v^S(m, z) = \max_{a'} \left[u\left(m - (1-\rho)a' - wF\right) + \tilde{\beta} v^E\left(\tilde{m}'(a', z), z\right) \right], \tag{12}$$

$$\tilde{m}'(a', z) = \max_{k', d', p'_h, p'_f, n'} \left[\frac{w' + \frac{p'^{1-\sigma}_h}{p'^{-\sigma}} y' + \frac{p'^{1-\sigma}_f}{p^{*-\sigma}} y^* - w'n' + p'(1-\delta)k' - p'd' - T(z)}{p'} \right] \tag{13}$$

$$\text{s.t.} \qquad \left(\frac{p'_h}{p'}\right)^{-\sigma} y' + \zeta \left(\frac{p'_f}{p^*}\right)^{-\sigma} y^* = z k'^{\alpha} n'^{1-\alpha}, \qquad a' = k' - qd', \qquad \hat{q}d' \leq \theta k', \qquad q^* d' \leq 0.$$

The value function in the right-hand-side of (12) is the one for an entrepreneur who is already an exporter, $v^E(\cdot)$, which differs from $v^S(\cdot)$ because of the entry cost of becoming an exporter that is incurred only when the choice to switch is made. Notice that m includes prices, factor demands, and production of date t chosen while still not being able to export, while $\tilde{m}'(\cdot)$ includes optimal choices to start exporting as of $t+1$. This captures the assumption that it takes one period after making the decision to switch for a firm to start exporting.

The entrepreneur's payoff function can be expressed as:

$$v(m,z,e) = \begin{cases} v^{NE}(m,z) & \text{if } e=0 \text{ and } e'(m,z,0)=0, \\ v^{S}(m,z) & \text{if } e=0 \text{ and } e'(m,z,0)=1, \\ v^{E}(m,z) & \text{if } e=1. \end{cases} \tag{14}$$

The first condition holds when the firm starts the period and continues to the next as non-exporter, the second when it also starts as non-exporter but becomes a switcher, and the third when it starts as an exporter ($e'(m,z,1)=1$ for all (m,z) because exporting is an absorbent state). The decision rules for non-exporters, switchers and exporters apply to each of these three cases, respectively.

We verify quantitatively that these value functions are increasing and concave in m for all z, and cross once with $v^S(\cdot)$ crossing $v^{NE}(\cdot)$ from below. Hence, for a given z, there is a threshold value of cash on hand $\hat{m}(z)$ at which the firm switches to become an exporter defined by $v^{NE}(\hat{m},z) = v^S(\hat{m},z)$. For a firm born at date $\tau=0$, there is an associated switching date $\hat{\tau}(\hat{m}(z))$ when it reaches the age at which it decides to become a switcher.[13]

We denote by $\underline{m}(z)$ the cash on hand of a newborn firm, which is given by $\underline{m}(z) = [w + \underline{p}_h(z)z\underline{k}^{\alpha}n(z)^{1-\alpha} - w\underline{n}(z) + p(1-\delta)\underline{k}(z) - T(z)]/p$, where $\underline{p}_h(z), \underline{n}(z)$ are the solutions that maximize m taking as given $k = \underline{k}(z)$ and $d=0$ and subject to the technological constraint for production of y_h.[14] The distribution of $\underline{m}(z)$ is induced by $f(z)$. Moreover, applying the envelope theorem to this maximization problem yields $d\underline{m}(z)/dz = \underline{p}_h(z)\underline{k}^{\alpha}\underline{n}(z)^{1-\alpha} > 0$. Hence, $\underline{m}(z)$ rises with z only via its first-order effect on production. Note also that newborn firms that draw high enough z such that $v^S(\underline{m}(z),z) \geq v^{NE}(\underline{m}(z),z)$ become switchers from the start (i.e., $e'=1$), otherwise $e'=0$.

[13]This is helpful for characterizing the equilibrium in terms of the firm-age distribution $\phi(\tau,z)$, as we explain later.

[14]At equilibrium, total revenue $p_h y_h + p_f y_f$ can be expressed as $p_h z k^{\alpha} n^{1-\alpha}$. To derive this result, substitute the demand functions for y_h, y_f, apply the equilibrium condition $p_f = \zeta p_h$ and simplify.

3.4 Stationary equilibrium

Our analysis focuses on comparing stationary equilibria in the regimes with and without capital controls (NCC and CC, respectively). We do this using the stationary firm-age distribution, because the model's Blanchard-Yaari OLG structure implies that $\phi(\tau, z) = \rho(1-\rho)^{\tau} f(z)$. Hence, the firm-age distribution is exogenous, and thus invariant to whether capital controls are in place or not.[15] Firms of the same age have different (m, z) in the two regimes, but the fraction of firms of a given age and productivity is the same. We also use the firm-age distribution because the Chilean firm-level dataset we use for the calibration has information on the firms' assets, sales, employment and age, but not on their net worth and debt. Since the model has no risk, we assume $\beta R^* = 1$.

For given q, p^* and y^*, the recursive stationary equilibrium consists of aggregate prices $\{w, p\}$, final goods output $\{y\}$, entrepreneurs' decision rules $\{c'(\tau, z), a'(\tau, z), n'(\tau, z), \tilde{m}'(\tau, z),$ $p'_h(\tau, z), p'_f(\tau, z), y'_h(\tau, z), y'_f(\tau, z), d'(\tau, z), k'(\tau, z)\}$, lump-sum taxes $T(z)$, and value functions $v(\tau, z)$, $v^{NE}(\tau, z), v^S(\tau, z), v^E(\tau, z)$ such that:

1. Entrepreneurs' value functions and decision rules solve their optimization problems.

2. Decision rules for demand of intermediate goods and output of final goods solve the final-goods producer's problem.

3. The government budget constraint holds: $\sum_z p\rho\underline{k}(z)f(z) = \sum_z T(z)f(z)$ with $p\rho\underline{k}(z) = T(z)$.

4. The labor market clears: $\sum_\tau \sum_z n(\tau, z)\phi(\tau, z) + F\sum_z \hat{\tau}(\hat{m}(z))f(z) = 1$.

5. The market of final goods clears: $\sum_\tau \sum_z [c(\tau, z) + \rho\underline{k}(z) + x(\tau, z)]\phi(\tau, z) = y$, where $c(\tau, z) = m(\tau, z) - (1-\rho)a'(\tau, z) - \mathbb{1}_{\tau=\hat{\tau}(\hat{m}(z))}wF$ and $x(\tau, z) = (1-\rho)k'(\tau, z) - (1-\delta)k(\tau, z)$.

4 Capital Controls and Misallocation

This Section derives the model's predictions regarding the effects of CCs on misallocation, defined as the as the deviation of a firm's MRPK from its steady-state level $\overline{MRPK} \equiv p(r^* + \delta)$. We start by examining the exporters' second-stage problem of maximizing $\tilde{m}'$ by choosing d', k', p'_h, p'_f, n'

[15] Given the decision rules $a'(m, z)$ and $m'(a', z)$, the solutions obtained for the state space (m, z, e) map into (τ, z) by recursive substitution as follows: When a firm is born ($\tau = 0$), its choices are given by $a'(0, z) = a'(\underline{m}(z), z)$ and $m'(0, z) = m'(a'(0, z), z)$, respectively. Its choices at age 1 are therefore $a'(1, z) = a'(m'(0, z), z)$ and $m'(1, z) = m'(a'(1, z), z)$. Hence, for any age τ the firm's choices are $a'(\tau, z) = a'(m'(\tau-1, z), z)$ and $m(\tau, z) = m'(a'(\tau, z), z)$. For $0 \leq \tau < \hat{\tau}(\hat{m}(z))$ we use the non-exporter's decision rules, for $\tau = \hat{\tau}(\hat{m}(z))$ we use the switcher's, and for $\tau > \hat{\tau}(\hat{m}(z))$ we use the exporter's. Appendix B explains in detail the algorithm used to solve the model.

for a given a' (i.e., problem (11)).[16] Since dynamic effects (changes in a') and general equilibrium effects (changes in p', w', y') are not considered, we refer to the results as the "static effects" of CCs.

The first-order conditions of the second-stage problem simplify to:

$$MRPN \equiv \frac{p_h'}{\varsigma}(1-\alpha)z(k')^{\alpha}(n')^{-\alpha} = w', \tag{15}$$

$$MRPK \equiv \frac{p_h'}{\varsigma}\alpha z(k')^{\alpha-1}(n')^{1-\alpha} = \mathbb{1}_{d'\leq 0}\left[p'(r^*+\delta)+\mu\right] + \mathbb{1}_{d'>0}\left[p'(\hat{r}+\delta)+\eta(1-\theta)\right], \tag{16}$$

$$\left(\frac{p_h'}{p'}\right)^{-\sigma} y + \zeta\left(\frac{p_f'}{p^*}\right)^{-\sigma} y^* = z{k'}^{\alpha}{n'}^{1-\alpha}, \tag{17}$$

$$p_f' = \zeta p_h', \tag{18}$$

$$qd' = k' - a'. \tag{19}$$

where $\varsigma = \sigma/(\sigma-1)$ is the markup of price over marginal cost, η is the multiplier on the collateral constraint, and μ is the multiplier on the constraint that prevents borrowing at R^* because of the CCs.[17] As shown in Appendix C, the left-hand-sides of (15) and (16) are the marginal revenue products of labor ($\frac{\partial(p_h y_h + p_f y_f)}{\partial n}$) and capital ($\frac{\partial(p_h y_h + p_f y_f)}{\partial k}$), respectively. In addition, the complementary slackness conditions $\eta(a' - (1-\theta)k') = 0$ and $\mu(a' - k') = 0$ must also hold. When $\eta > 0$, k' is set by the collateral constraint at $k'(a') = a'/(1-\theta)$, and when $\mu > 0$, $k'(a') = a'$.

Note three properties of the above conditions: First, μ and η cannot be positive at the same time. A firm with the collateral constraint binding borrows at $\hat{R}$, hence $\eta > 0$ and $\mu = 0$. A firm that is not borrowing because it would like to borrow at R^* but not at $\hat{R}$, has $\eta = 0$ and $\mu > 0$. Second, the optimal choice of k' only depends on a' if either $\eta > 0$ or $\mu > 0$. Otherwise, Fisherian separation holds (the optimal k' is independent of a' and d'). Third, the MRPN of all firms is the same and equals the wage rate. However, the wage is different in the NCC and CC regimes and in the efficient equilibrium without credit frictions, and thus MRPNs differ. In this sense, there is labor misallocation across regimes (i.e., MRPN differs in the two and both differ from the efficient MRPN) but there is no labor misallocation within each regime since all firms have the same MRPN. In contrast, MRPKs differ both across regimes and across firms within each regime.

Condition (16) drives the static effects of CCs on misallocation. To understand the trans-

[16] The second-stage problems of non-exporters and switchers are very similar, except there are no foreign sales and no price associated with them.

[17] The budget constraint with CCs is akin to the textbook problem with a kinked budget constraint, which is represented by the constraint $q^*d' \leq 0$ for $R = R^*$. The multipliers η and μ for maximizing $\tilde{m}'$ are related to those for maximizing lifetime utility in the standard optimization problem, $\tilde{\eta}$ and $\tilde{\mu}$, by the conditions $\eta = \tilde{\eta}\frac{p'}{\tilde{\beta}u'(c')}$ and $\mu = \tilde{\mu}\frac{p'}{\tilde{\beta}u'(c')}$.

mission mechanism and contrast it with the one typically at work in the literature, we study its implications first without financial frictions, then introduce the collateral constraint and CCs separately, and finally, add CCs to the economy with the collateral constraint.

4.1 No financial frictions

To remove all financial frictions, assume $\theta \to \infty$ so that the collateral constraint never binds for any firm, and $\nu = 0$.[18] In this case, MRPK and MRPN are equalized across firms in the decentralized equilibrium. Moreover, a utilitarian social planner without financial frictions sets allocations in a similar manner. These results are contained in the following propositions:

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

Proof. If $\theta \to \infty$ and $\nu = 0$, the first-order conditions (15) and (16) reduce to:

$$MRPN_i = w \quad \text{and} \quad MRPK_i = p(r^* + \delta) \quad \forall i.$$

□

Proposition 2. *If $\beta R^* = 1$, the MRPK and MRPN of the decentralized equilibrium without financial frictions (as $\sigma \to \infty$ and intermediate goods become perfect substitutes) match the efficient real returns on capital and labor attained by a utilitarian social planner free of financial frictions. These MRPs are time-invariant, constant across firms regardless of their age and productivity, and $MRPK_i = \overline{MRPK}$.*

Proof. The proof is provided in Appendix D. There, we also show that the planner equalizes consumption and the real returns on capital and labor across all firms each period. □

Without financial frictions, there is zero dispersion in MRPN and MRPK across firms and this is socially optimal. There is no misallocation (i.e., no factor reallocation across firms is desirable).[19] If $\underline{k}_i < \bar{k}_i$, where $\bar{k}_i$ is the steady state of capital for firm i, a newborn firm jumps to its optimal scale immediately by borrowing as much as needed.

[18] $\theta \to \infty$ is sufficient but not necessary for the collateral constraint to be irrelevant. The necessary condition for a firm of productivity z at birth is $\theta(z) > 1 - (\underline{k}(z)/\bar{k}(z))$, where $\bar{k}(z)$ is the firm's steady-state capital. Intuitively, with this θ even newborn firms can borrow enough to attain $\bar{k}(z)$ in the first period.

[19] Due to monopolistic competition, the first-best allocations yield higher production than the decentralized equilibrium, because imperfect substitutability of input varieties implies that firms have market power to set prices. Hence, we could constrain the planner to use the same aggregate capital and labor as in the decentralized equilibrium to obtain the same allocations in both problems. Alternatively, we can compare the *competitive* decentralized equilibrium (as $\sigma \to \infty$) with a standard utilitarian planner's equilibrium that chooses production efficiently, as we do in Proposition 2.

4.2 Collateral constraints & capital controls separately

Consider next the NCC regime, which has collateral constraints ($\theta > 0$) but no CCs ($\nu = 0$).

Proposition 3. *For θ sufficiently low so that constraint (6) binds for entrepreneur i and $\nu = 0$ (collateral constraint without CCs), $MRPK_i > \overline{MRPK}$ and $k_i < \bar{k}_i$.*

Proof. The first-order conditions of the second-stage problem imply:

$$MRPK_i = p(r^* + \delta) + \eta_i(1 - \theta).$$

Firms with $k_i < \bar{k}_i$ need to borrow to invest. If the required debt exceeds $\theta\bar{k}_i$, jumping to the optimal scale at birth is unfeasible and, instead, they set investment as high as the constraint allows: $k_i'(a_i') = a_i'/(1-\theta)$. The firm accumulates capital gradually as it grows its net worth and the constraint binds as long as $k_i < \bar{k}_i$, so $\eta_i > 0$ and $MRPK_i > \overline{MRPK}$.[20] □

These firms behave as those in open-economy models of misallocation caused by credit constraints: MRPK equals $p(r^* + \delta)$ plus the marginal cost of capital associated with the tightness of the constraint. This cost is given by the shadow value of the constraint η_i, which is in terms of marginal utility, multiplied by $(1 - \theta)$ (i.e., the opportunity cost of capital net of the benefit that an additional unit of capital provides as pledgeable collateral). Misallocation thus results from dispersion in the MRPKs of credit-constrained firms that operate below their optimal scale, with higher MRPKs for those that are more constrained. Importantly, for a firm of productivity z, the excess of MRPK over its steady-state level decreases monotonically as a' rises.

Consider next a case in which CCs are present but there are no collateral constraints.

Proposition 4. *When $\theta \to \infty$ and $\nu > 0$ (no collateral constraint with CCs), if firm i would need to borrow at R^* to reach its optimal scale, $MRPK_i > \overline{MRPK}$ and $k_i < \bar{k}_i$.*

Proof. If $\theta \to \infty$, $\nu > 0$, and firm i would need to borrow at R^* to reach $\bar{k}_i$, the CCs bind and the first-order conditions of the second-stage problem imply:

$$MRPK_i = \mathbb{1}_{d_i > 0}[p(\hat{r} + \delta)] + \mathbb{1}_{d_i \leq 0}\left[p(r^* + \delta) + \mu_i\right].$$

Firms with $k_i < \bar{k}_i$ face the CCs and hence can only borrow at $\hat{r}$. When they are born, they borrow so that $MRPK_i = p(\hat{r} + \delta) > \overline{MRPK}$. This is akin to the optimality condition without financial

[20] At equilibrium, $u'(c_i)/\beta u'(c_i') = [1/(1-\theta)][(MRPK_i/p') + 1 - \delta - \theta]$ for these firms.

frictions but at a higher interest rate. Hence, these firms jump to a *pseudo-steady-state* with a capital stock $\bar{k}_i^{CC}$ (which differs across them only because of their z_i). Fisherian separation holds and they share a common MRPK equal to $p(\hat{r}+\delta)$. Since $\beta(1+\hat{r}) > 1$, however, the dynamic effects studied later induce these firms to gradually pay down their debt and increase their net worth until $d_i = 0$. At this point, they are free from the CCs and can save at r^*. But at r^* they would like to borrow to jump to $\bar{k}_i$. Hence, the constraint that there is no borrowing at r^* binds ($\mu_i > 0$) and they start accumulating capital gradually, effectively as if they were under financial autarky.[21] As long as $k_i < \bar{k}_i$, $MRPK_i = p(r^* + \delta) + \mu_i > \overline{MRPK}$. Moreover, in this case, the MRPK's differ also across firms in this category, with those more distant from $\bar{k}_i$ having higher MRPK. □

CCs distort the allocation of capital in two ways. First, all firms pay the same tax ν when borrowing, which increases the opportunity cost of funds by the same amount to all firms in a way akin to the efficiency wedge of debt taxes in representative-agent models. Second, there is also heterogeneity in the financial conditions of firms that those models miss: μ_i is larger for more debt-constrained firms (i.e., firms with lower a' that would have liked to borrow at r^* but not at $\hat{r}$).

4.3 Static effects of capital controls

Our main goal is to compare the NCC regime with the one in which both credit constraints and CCs are present, the CC regime. We study first the static effects focusing on how MRPKs differ across regimes (since p is unchanged, changes in misallocation are the same as changes in MRPKs). Figure 1 plots a firm's choice of k' in the interval $a' \in [\underline{k}, \bar{k}]$ (for a given z and keeping (y, p, w) constant). The two horizontal lines correspond to $\bar{k}$ and $\bar{k}^{cc}$. The $45°$ ray corresponds to $k' = a'$, which is the capital choice when the CCs prevent borrowing at R^*. The ray with slope of $1/(1-\theta) > 1$ is the choice of k' implied by the collateral constraint in both the NCC and CC regimes. The red and yellow piece-wise linear functions show the optimal second-stage choices of k' as a function of a' in the CC and NCC regimes, respectively.

Conditions (15)-(19) imply that the choice of k' in the CC regime can be broken down into the four regions labeled in the Figure:[22]

1. *Binding collateral constraints at higher borrowing costs:* For $a' \in [\underline{k}, (1-\theta)\bar{k}^{CC}]$, the outcome is like Proposition 3 but substituting R^* for $\hat{R}$ and $\bar{k}^{CC}$ for $\bar{k}$. The firm would like to borrow at $\hat{R}$ to

[21] At equilibrium, $u'(c_i)/\beta u'(c_i') = (MRPK_i/p') + 1 - \delta$ for these firms.

[22] For the numerical solution, it is important that in each region the system (15)-(19) has closed-form solutions for (k', d', p_h', p_f', n') given $(a', z; y', p', w')$ that do not depend on consumption. Hence, $\tilde{m}'(\cdot)$ is well defined.

jump to $\bar{k}^{CC}$ but is credit constrained, so it can only attain $k'(a') = a'/(1-\theta)$. Firms in this category have higher MRPK the further away they are from $\bar{k}^{CC}$. MRPKs differ across them and they all differ from $\overline{MRPK}$. As we show later, these firms have stronger incentives to save because of they face a higher effective interest rate. Thus, they rise a' and k' gradually until they reach $\bar{k}^{CC}$.

2. *Higher borrowing costs for firms unaffected by the collateral constraint:* For $a' \in ((1-\theta)\bar{k}^{CC}, \bar{k}^{CC}]$, the outcome is related to Proposition 4. These firms attain the pseudo-steady state consistent with $\hat{R}$, and since $\beta\hat{R} > 1$, they also have incentives to save and gradually pay down their debt. MRPK is the same for all firms in this category, but since $\hat{R} > R^*$, it exceeds $\overline{MRPK}$.

3. *CCs preventing firms to borrow at the rate R^*:* For $a' \in [\bar{k}^{CC}, \bar{k})$, the outcome is also related to Proposition 4. The firm has no debt, so it faces the interest rate R^*. It would like to borrow to jump to $\bar{k}$ but it cannot at this rate because of CCs. Hence it chooses $k' = a'$. MRPKs differ across firms in this category, they are higher for the more debt-constrained, and they all exceed $\overline{MRPK}$. These firms also have stronger incentives to save because of a higher effective interest rate given by $R^*[1 + (\mu/p')]$. Thus, a' and k' rise gradually until reaching $\bar{k}$.

4. *Firms at their optimal scale:* For $a' \geq \bar{k}$, the firm is at its optimal scale and $MRPK = \overline{MRPK}$. It does not need to borrow, and neither the collateral constraint nor the CCs affect it.

Figure 1 shows that the static effects of CCs imply that k' is (weakly) smaller for all firms when CCs are introduced. Defining a firm's optimal scale gap as the percent difference between its current capital k and its $\bar{k}$ ($OSG \equiv (\bar{k} - k)/\bar{k}$), the OSGs are larger.[23] k' is the same for firms within either region 1 or 4. In region 2, firms in the CC regime are at the pseudo-steady state $\bar{k}^{cc}$, and $\hat{R} > R^*$ implies that $\bar{k}^{cc} < \bar{k}$. In region 3, firms in the CC regime hit the no-borrowing constraint and set $k' = a'$, which is less than $\bar{k}$, while firms in the NCC regime have more capital because they are either already at $\bar{k}$ or they are credit-constrained but at the same a' can sustain higher k'.

Lower k' under CCs increases $MRPKs$. This follows from three conditions derived from eqs. (15)-(19):

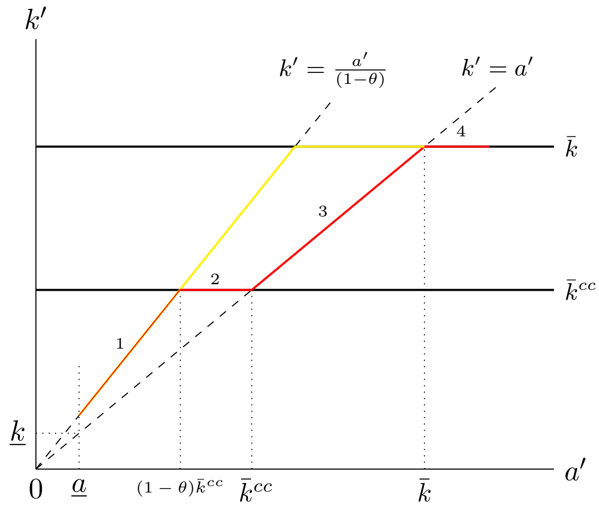
$$p_h'(a') = \left[\frac{[(p')^\sigma y' + e(p^*)^\sigma \zeta^{1-\sigma} y^*]^\alpha}{z\,(k'(a',z))^\alpha \left[\frac{1-\alpha}{w'\varsigma}\right]^{1-\alpha}} \right]^{\frac{1}{1+\alpha(\sigma-1)}} \tag{20}$$

$$\frac{k'}{n'}(a') = \left[\frac{\varsigma}{(1-\alpha)z} \left(\frac{w'}{p_h'(a',z)} \right) \right]^{1/\alpha} \tag{21}$$

$$MRPK(a') = \frac{\alpha z}{\varsigma} \frac{p_h'(a',z)}{\left[\frac{k'}{n'}(a',z)\right]^{1-\alpha}}. \tag{22}$$

[23] The interpretation of CCs as size-dependent policies is evident in the similarity of this plot with the one Guner et al. (2008) derived for firm size restrictions represented as taxes on capital above a given level of k.

Figure 1: Static Effects of Capital Controls
(second-stage optimal k' as a function of a')



For given $(a', z; y', p', w')$, the lower $k'(a')$ in the CC regime implies that firms charge higher $p'_h(a')$ (condition (20)) and this lowers $\frac{k'}{n'}(a')$ because it reduces the firm-specific real wage (condition (21)). These two effects increase $MRPK(a')$ (condition (22)). This result can be summarized by defining the static effect of CCs on MRPK as $\Delta MRPK(a') \equiv MRPK_{CC}(a') - MRPK_{NCC}(a')$ and then using condition (22) we obtain:

$$\Delta MRPK(a') = \frac{\alpha z}{\varsigma} \left[\frac{p'_{h,CC}(a')}{\left[\frac{k'}{n'}_{CC}(a')\right]^{1-\alpha}} - \frac{p'_{h,NCC}(a')}{\left[\frac{k'}{n'}_{NCC}(a')\right]^{1-\alpha}} \right] \geq 0, \tag{23}$$

$\Delta MRPK(a') > 0$ in regions 2-3 because CCs raise firm prices and reduce capital-labor ratios relative to those in the *NCC* regime.

Figure 1 yields another key result: While with the standard collateral constraint the OSGs are decreasing in a', CCs create a region in which OSGs are invariant in a' (region 2). As a' increases, a firm's OSG falls monotonically in the NCC regime until it vanishes when the firm reaches its optimal scale. In contrast, in the CC regime, the OSG falls with a' in region 1, then it is constant as a' rises in region 2 (since $k(a')$ is constant), and then it decreases again in region 3 until it vanishes (since this region is akin to region 1 but with $\theta = 0$). As a result, the difference in OSGs between the NCC and CC regimes is non-monotonic in a'. OSGs are the same in both regimes with either a' low enough to be in region 1 or high enough to be at the optimal scale, and their difference is at their largest when a' is in region 2. For the same reason, $\Delta MRPK(a')$ is non-monotonic in a': there is zero change in misallocation for firms in regions 1 and 4, and the firms with the largest increase in misallocation are found where $a' = \overline{k}^{CC}$ (for each level of z). As we discuss later, this result is important for the quantitative and empirical results examined in Sections 5 and 6.

Condition (23) characterizes the static effects of CCs on MPRKs in "physical" terms. Using condition (16), we can express them in terms of prices and shadow values. In region 2, where firms are borrowing and the collateral constraint may or may not bind in the NCC regime but is not binding in the CC regime, we obtain:

$$\Delta MRPK|_{d'_{CC}>0}(a') = \left(p'_{CC} - p'_{NCC}\right)(r^* + \delta) + \nu p'_{CC} - \eta_{NCC}(a')(1-\theta). \tag{24}$$

This expression splits the effect of CCs on MRPK into three terms: (1) differences in $\overline{MRPK}$ due to changes in p, but evaluated at a common price (since we are abstracting from general equilibrium effects), we can disregard this term; (2) MRPK rises because CCs increase market borrowing costs for all firms by $\nu p'_{CC}$; (3) the gap in MRPKs between the CC and NCC regimes *falls* to the extent that the collateral constraint binds in the latter (i.e., $\eta_{NCC}(a') > 0$). Since $\eta_{NCC}(a')$ is decreasing in a', however, the differences in MRPKs grow larger as a' rises.[24]

In region 3, where firms hit the no-borrowing constraint in the CC regime and again the collateral constraint may or may not bind in the NCC regime, we obtain:

$$\Delta MRPK|_{d'_{CC}\leq 0}(a') = \left(p'_{CC} - p'_{NCC}\right)(r^* + \delta) + \mu_{CC}(a') - \eta_{NCC}(a')\left(1-\theta\right). \tag{25}$$

Disregard again the first term of this expression, since we are abstracting from general equilibrium changes in p. For firms that are already at their optimal scale in the NCC regime, we obtain $\Delta MRPK|_{d'_{CC}\leq 0}(a') = \mu_{CC}(a') > 0$, with the MRPKs of firms that are more constrained by the CCs rising more. If the collateral constraint binds in the NCC regime, the excess of the MRPK under CC relative to NCC depends on how much tighter is the no-borrowing constraint in the former than the collateral constraint in the latter.[25]

The trade status of firms also matters for these results. Exporters have larger optimal scales than non-exporters for a given z. The effects of CCs for firms that are below their optimal scale depend on their net worth. If a' is small enough so that an exporter and a nonexporter are in region 1, they both choose the same k', but the exporter charges a higher price, because of the effect of

[24] $\nu p'_{CC} > \eta_{NCC}(a')(1-\theta)$ for a given a' (and z) because, as we showed before, there is more capital and lower MRPK in the NCC regime, and thus $\Delta MRPK|_{d'_{CC}>0}(a') > 0 \Leftrightarrow \nu p'_{CC} > \eta_{NCC}(a')(1-\theta)$.

[25] $\mu_{CC}(a') > \eta_{NCC}(a')$ for a given a' (and z) because, if firms in the NCC regime are constrained, the collateral constraint allows for more debt $(a'/(1-\theta))$ than the no-borrowing constraint in the CC regime (a').

foreign demand on p'_h (see condition (20)), and thus it also has a lower capital-output ratio and these two effects result in a higher MRPK. Since all firms face the same $\overline{MRPK}$, misallocation is higher for the exporter. If the non-exporter is in region 2 or 3, however, the exporter (or a firm that switches to become an exporter) chooses a larger k' than the non-exporter. As condition (20) shows, this tends to offset the effect pushing for a higher price because of the foreign sales. The price may rise less or even fall and thus the capital-output ratio may fall less or even rise. Hence, MRPK of the exporter may be larger or smaller than for the nonexporter. If a' is large enough for the non-exporter to be in region 4, it has reached its optimal scale and remains there since it has no incentive to grow its net worth further (as we show below). Hence, it remains a nonexporter until it dies and it has no misallocation. In contrast, an exporter with the same (a', z) but still below its optimal scale has higher k' than the nonexporter but less than its own optimal scale, so it has positive misallocation and thus more misallocation than the nonexporter.

4.4 Dynamic and general equilibrium effects

The static effects do not take into account changes in net worth a' (i.e., *dynamic effects*) and in the aggregate variables (w', p', y') (i.e., *general equilibrium* (*GE*) *effects*). We now extend the analysis to incorporate these effects.

The dynamic effects capture differences in the optimal net-worth decision rule that solves the entrepreneurs' first-stage optimization problem, $a'(m, z)$, across the CC and NCC regimes. These differences imply different locations along the horizontal axis of Figure 1 and hence different $k'(a'(m, z))$ choices. Applying the envelope theorem to problem (12) yields this Euler equation:

$$u'(c) = \beta u'(c') \frac{\delta \tilde{m}'(a', z; y', p', w')}{\delta a'}. \tag{26}$$

Differentiating (13) and simplifying using conditions (15)-(16), we find that:

$$\frac{d\tilde{m}'(a', z; y', p', w')}{da'} = \mathbb{1}_{d'>0} \left[\hat{R} + \frac{\eta}{p'} \right] + \mathbb{1}_{d' \leq 0} \left[R^* + \frac{\mu}{p'} \right], \tag{27}$$

with the caveat that this derivative is not defined at the kinks where the $k'(a')$ function changes regions, since $k'(a')$ is piece-wise linear and changes slope at the kinks.

Combining the above two results yields the result that both the collateral constraint and the CCs incentivize entrepreneurs to grow their net worth faster, because they increase the marginal benefit of saving above the world interest rate, R^*. The effective return on savings in region 1 is $\hat{R} + \frac{\eta}{p'}$; in region 2, $\hat{R}$; and in region 3, $R^* + \frac{\mu}{p'}$. Only in region 4, where both financial constraints are not binding, the return on savings equals R^*.

In region 1, entrepreneurs borrow at $\hat{R}$ and are credit-constrained. Since the optimality conditions of the second-stage problem hold too, we obtain:

$$\frac{u'(c)}{\beta u'(c')} = \hat{R} + \frac{\eta}{p'} = \left[\frac{MRPK'}{p'} + 1 - \delta + \theta \frac{\eta}{p'} \right]. \tag{28}$$

Hence, the increase in the effective return on savings is due to the CCs, since $\hat{R} > R^*$, and to the collateral constraint, since $\eta/p' > 0$. Moreover, the latter varies across firms affecting more firms that are more constrained and thus have higher $MRPK$.

All firms in region 2 have a stock of debt $d' = \hat{R}(\bar{k}^{cc} - a')$ contracted at $\hat{R} > R^*$ because of the CCs, but they are unaffected by the collateral constraint and they are gradually paying down their debt to zero as a' reaches $\bar{k}^{cc}$. Since $\beta\hat{R} > 1$, these entrepreneurs are at the pseudo-steady state for capital but the dynamic effect is still at work because they desire to reallocate consumption into the future by growing their net worth.

In region 3, entrepreneurs hit the no-borrowing constraint at R^*, and again since the optimality conditions of the second-stage problem hold, we obtain:

$$\frac{u'(c)}{\beta u'(c')} = R^* + \frac{\mu}{p'} = \left[\frac{MRPK'}{p'} + 1 - \delta \right]. \tag{29}$$

Hence, the increase in the effective return on savings is due only to the CCs, because they prevent firms from borrowing at R^* and this constraint binds ($\mu/p' > 0$). This effect varies across firms affecting more those that are more constrained and thus have higher $MRPK$.

Regions 1 and 3 are analogous in that an entrepreneur's intertemporal marginal rate of substitution (IMRS), return on savings, and net marginal return on capital accumulation are equalized using an endogenous effective interest rate that is determined by the multipliers μ or η. Because of this, there is no Fisherian separation of the consumption/saving choice from the investment choice.

Region 4 yields the familiar result from small open economy models without financial frictions: Entrepreneurs that have reached their optimal scale are unaffected by CCs and collateral constraints and make optimal saving plans so as to equate their IMRS in consumption with the world's real interest rate R^*. Since $\beta R^* = 1$, their consumption and net worth are stationary.

We can summarize the dynamic effects of CCs as follows: In regions 1-3, CCs push the

IMRS above R^* which strengthens the entrepreneurs incentive to reallocate consumption into the future by increasing a'. As eqs. (28)-(29) show, this effect is stronger for entrepreneurs borrowing at $\hat{R}$ and affected by the collateral constraint (region 1) and more so for those who are more constrained (for them, $IMRS_i = \hat{R} + \frac{\eta_i}{p'} > \hat{R}$). CCs tighten the collateral constraint, increasing both the contractual interest rate (from R^* to $\hat{R}$) and the effective interest rate inclusive of the shadow value of the constraint. Firms in region 2 are free from the collateral constraint and hold debt at $\hat{R}$ that is gradually paid out (with $IMRS_i = \hat{R} > R^*$). The contractual rate rises to $\hat{R}$ without affecting borrowing capacity but saving incentives still strengthen, albeit less than in region 1. Firms in region 3 are prevented from borrowing at R^* by the CCs (with $IMRS_i = R^* + \frac{\mu_i}{p'} > R^*$). They cannot borrow but again saving incentives strengthen, although less than in regions 1 and 2. Finally, firms in region 4 are unaffected.

Because of these dynamic effects, even though the static effects predict lower $k'(a')$ and higher $MRPK(a')$ in the CC than the NCC regime for a common a', firms have the incentives to build their net worth and grow their capital faster. At equilibrium, we may observe a larger fraction of firms in regions 2 and 3 than 1, but the reason is because of the stronger dynamic effects in region 1. Moreover, it is possible that for some firms the dynamic effects could be sufficiently strong to offset the static effects. In this case, an entrepreneur with some (m, z) may have saved sufficiently more in the regime with CCs (i.e., $a'^{CC}(m, z) > a'^{NCC}(m, z)$) so that eqs. (20)-(22) would predict that MRPK is higher *without* CCs.

It is worth noting that, while $\hat{R}$ and R^* are exogenous, the effective interest rates faced by credit-constrained firms in regions 1 and 3 are endogenous (they depend on η and μ, see eqs. (28)-(29)). This is akin to a model in which each firm faces an endogenous interest rate and the resulting set of interest rates decentralizes an outcome where lenders do not impose credit constraints but instead tailor the interest rate at which each firm borrows so as to satisfy the credit constraints.

Consider next the GE effects of CCs. These effects alter both the optimal scale of firms and the stringency of the credit constraints, but they are difficult to characterize in analytic form. They reflect differences in (w', p', y') due to changes in the firms' optimal plans and their aggregate effects, which affect aggregate demand and supply of final goods, intermediate goods and labor. Even for firms in region 4, MRPKs differ across regimes because differences in final goods prices alter $\overline{MRPK} = p(r^* + \delta)$. For the same reason, once we allow for GE effects, changes in misallocation (deviations of $MRPK$ from $\overline{MRPK}$) differ from changes in $MRPK$. MRPNs also differ, since w also differs.

The interaction of the static and GE effects on misallocation can be illustrated by rewriting conditions (24)-(25) in terms of $\Delta mis \equiv \Delta(MRPK - p(r^* + \delta))$. In region 2, we obtain $\Delta mis|_{d'_{CC}>0}(a') = \nu p'_{CC} - \eta_{NCC}(a')(1-\theta)$. There is a first-order GE effect by which the magnitude of the effect of CCs increasing misallocation by hiking the interest rate varies with p'_{CC}. In region 3, we obtain $\Delta mis|_{d'_{CC}\leq 0}(a') = \mu_{CC}(a') - \eta_{NCC}(a')\,(1-\theta)$. There are only second-order effects: changes in (y, p, w) across the NCC and CC regimes affect the optimal scales of firms, which alters the tightness of the collateral constraint in the NCC regime $(\mu_{CC}(a'))$ and the no-borrowing constraint in the CC regime $(\eta_{NCC}(a'))$. If firms have larger optimal scales in the CC regime, as is the case in our calibrated model because p and w fall, the no-borrowing constraint tightens and amplifies misallocation. Something similar happens in region 1. In this case, $\Delta mis|_{d'_{CC}>0}(a') = [\eta_{CC}(a') - \eta_{NCC}(a')](1-\theta)$. There is no static effect of CCs because firms make the same decisions in the two regimes $(\eta_{CC}(a') - \eta_{NCC}(a') = 0)$, but with GE effects, the larger optimal scales with CCs imply that, at the same a', $[\eta_{CC}(a') - \eta_{NCC}(a')] > 0$, so misallocation rises. Keep in mind that in the full model solution the dynamic effects are also interacting with these GE and static effects, by altering the fraction of firms with a given a' across regimes.

One caveat of this analysis is that it did not consider the existence of a domestic credit market. Appendix F extends the model in this direction. Entrepreneurs can trade domestic bonds b at a price q^b, with an interest rate $R^b = 1/q^b$. These bonds are in zero net supply so as to clear the market internally. Net worth and the collateral constraint become $a' = k' - qd' + q^b b'$ and $qd' - q^b b' \leq \theta k$, respectively. We obtain two key results: (1) If $R^b > \hat{R}$, the analysis as presented in this Section goes through: Firms that borrow always borrow from abroad so $b' = 0$ for all firms, and those that have attained $a' = \bar{k}^{cc}(z)$ move into region 3 because there is no supply of domestic bonds and the marginal return on saving exceeds R^*.[26] (2) If $R^* < R^b \leq \hat{R}$, CCs move the economy to financial autarky, region 3 disappears but region 2 widens and firms never reach the optimal scale consistent with R^*, instead they remain at the steady-state of capital determined by R^b. Aggregate misallocation can be larger or smaller than in the model without domestic debt market depending on whether R^b is closer to $\hat{R}$ or R^*.

[26]The results also hold if we assume that domestic bonds are taxed so that the after-tax return is R^*. This is reasonable because CCs are a form of financial repression, which implies the existence of wedges between saving and lending rates.

5 Quantitative Analysis

We analyze in this Section the quantitative predictions of the model. The solution method is described in Appendix B. We calibrate the NCC regime using Chilean data for 1990-1991, before the *encaje* was introduced. A subset of the parameter values is set to widely-used values or to estimates from the related literature and the rest are set so that the NCC stationary equilibrium matches selected data moments. We then construct the CC regime by setting the value of ν to the mean of the tax-equivalent of the Chilean *encaje*.

5.1 NCC calibration & steady state

The parameters assigned commonly-used values or taken from the literature are $\{\gamma, \beta, \sigma, \delta, \rho, r^*\}$. The coefficient of relative risk aversion and the subjective discount factor are set to standard values of $\gamma = 2$ and $\beta = 0.96$. Hence, $R^* = 1/\beta = 1.04167$. The rate of depreciation $\delta = 0.06$ is taken from Midrigan and Xu (2014). The elasticity of substitution across varieties $\sigma = 4$ is from Leibovici (2021), who also calibrated his model to Chilean data and used this value based on estimates from Simonovska and Waugh (2014). The exit rate of firms is $\rho = 0.08$ which is the average exit rate in the Chilean dataset described below over the 1990-2007 period.

We set the capital injection to newborn firms as a fraction κ of their steady-state capital: $\underline{k}(z) = \kappa \bar{k}(z)$, taking into account that $\bar{k}(z)$ is higher for exporters.[27] Also, in order to capture the empirical fact that exporters have better access to credit (e.g., Muuls (2015)), we set the fraction of capital that they can pledge as collateral higher than for non-exporters by the percent θ_f (i.e., $\theta^E = (1 + \theta_f)\theta^{NE}$). We discretize $f(z)$ over ten nodes, z_i for $i = 1, ..., 10$, using the Gaussian quadrature algorithm QWLOGN from Miranda and Fackler (2004).

The parameter values determined by targeting data moments are $\{\zeta, \omega_z, F, \theta_f, \theta^{NE}, \kappa, \alpha\}$. The targets are: (1) the share of firms that export (0.18); (2) the sales of exporters divided by those of non-exporters (8.55); (3) the ratio of sales of five- to one-year-old firms, among new firms that survive at least five years (1.26); (4) aggregate exports as a fraction of total sales (0.21); (5) credit to the manufacturing sector as a fraction of manufacturing value added (0.33); (6) the aggregate capital stock divided by the wage bill (6.6); and (7) the ratio of the investment shares in value added of exporters to non-exporters (1.84).

[27] The analysis of the firm-size distribution shows that the share of exporters increases significantly with firm size. While the share of exporters is only 3% for firms in the lowest 25th percentile, it increases to 30% for firms in the highest 75th percentile and to 54% for firms in the highest 95th percentile

The above data targets are averages for the 1990-1991 period, since the *encaje* was introduced in mid-1991 and, arguably, did not affect the data for those years. All but the ratio of credit to the manufacturing sector as a fraction of manufacturing value added were computed using Chile's *Encuesta Nacional Industrial Anual* (ENIA). The ENIA has data on all manufacturing establishments with more than ten employees. It includes approximately 4,500 observations per year and provides detailed information on characteristics such as total workers, payroll, domestic sales, exports, inputs, physical assets, etc. The ENIA does not report credit data. Thus, to construct the ratio of credit to the manufacturing sector as a fraction of manufacturing value added, we first compute the ratio of manufacturing credit over total commercial credit for 2000-2005 using data from the Superintendencia de Bancos e Instituciones Financieras de Chile (these data are not reported before 2000), and estimate the 1990-1991 values by linear extrapolation. Then we multiply the results by the ratio of the share of commercial credit in GDP, calculated using data from the Central Bank of Chile, to the share of manufacturing value added in GDP, reported by the World Bank.

The calibration uses an SMM algorithm with equal weight on each parameter (i.e., minimizing the squared differences of model moments from data targets). The resulting parameter values are reported in Table 1. Table 2 shows the data targets and their model counterparts. The calibration delivers model moments quite close to the data moments.

For the CC regime, the value of ν is the 1991-1998 average of the tax-equivalent of the Chilean *encaje* computed with the methodology proposed by De Gregorio et al. (2000) applied to a 12-months loan maturity (see Appendix A.1) and the calibrated value of r^* (0.0416). This yields $\nu = 0.0175$, which is sizable relative to the value of r^*.

Table 1: Parameter Values in the NCC Calibration

Predetermined parameters				SMM calibration		
β	Discount factor	0.96	Standard	ζ	Iceberg trade cost	3.7134
γ	Risk aversion	2	Standard	ω_z	Productivity dispersion	0.4289
σ	Substitution elasticity	4	Leibovici (2021)	F	Sunk export entry cost	1.5564
δ	Depreciation rate	0.06	Midrigan and Xu (2014)	θ^{NE}	non-exporters collateral coefficient	0.0610
ρ	Death probability	0.08	Chilean data	θ_f	Exporters collateral factor	1.6977
				α	Capital intensity	0.4673
				κ	Fraction of steady-state capital as initial capital	0.3002

To provide additional validation for the calibration of the model as a reasonable approximation to Chilean data upon which to build our quantification of the effects of the *encaje* policy,

Table 2: SMM Data Target Moments & Model Counterparts

Moment	Data target (1990-1991) (1)	Model solution (NCC regime) (2)
Share of exporters	0.18	0.18
Average sales (exporters/non-exporters)	8.55	8.55
Average sales (age 5 / age 1)	1.26	1.27
Aggregate exports / sales	0.21	0.21
Aggregate credit / Value added	0.33	0.33
Aggregate capital stock / wage bill	6.60	6.61
(Investment /VA)$_{exporters}$ / (Investment/VA)$_{non-exporters}$	1.84	1.85

we examine the extent to which the model's firm-size distribution matches the data. Table 3 shows the distribution of capital across Chilean firms by quintiles as of 1990 (before the policy was introduced) and in 1997 (the last year the policy was in place) and in the stationary distributions of the NCC and CC regimes in the model.[28] Figure 2 plots the Lorenz curves of the same distributions.

Table 3 and Figure 2 yield three interesting results. First, the model's firm-size distributions in the NCC and CC regimes approximate well those observed in the data in 1990 and 1997, respectively. Second, both distributions display significant heterogeneity and concentration of capital ownership in the top quintile of the distribution. In the NCC (CC) regime, the Gini coefficients are 0.705 (0.671) and 0.634 (0.632) in the data and in the model, respectively. Similarly, the fraction of capital held by each quintile of firms in the data and in the model are very similar, with the lowest quintile holding less than 2% of aggregate capital, while the top quintile holds about 70%. Third, in both model and data the Gini coefficient is lower when CCs are in place.

It is worth noting that, although the misallocation caused by CCs reduces firm sizes, this does not change much how the (smaller) aggregate capital stock is distributed across firms. This is in part because the size of firms in each stationary distribution that are in Region 1 is the same and firms take some time to transit into Regions 2 and 3, where their size is smaller with CCs.

Endogenous trade participation plays a central role in the model's ability to match the observed firm-size distribution. This is because exporters are a small share of all firms (18%) but they are much larger than non-exporters. The distribution of capital across non-exporters is more equally distributed than across all firms, despite the fact that the productivity of these firms can

[28] The firm-size distribution in the data is constructed using the *ENIA* dataset and the definitions of capital and the OSG described in Section 6. To make data and model comparable, firms with optimal scale gaps exceeding 0.7 are excluded, since newborn firms in the calibrated model receive a capital transfer of 30% of their optimal scale.

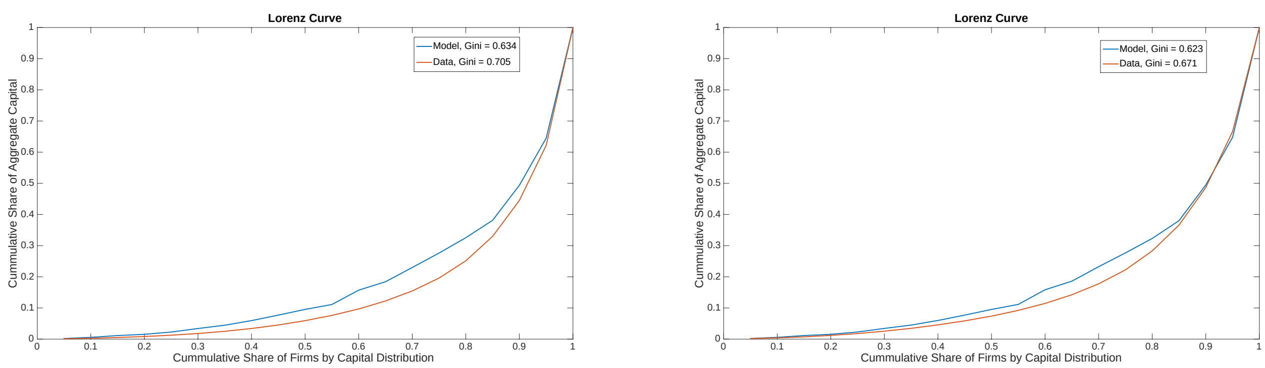
differ sharply. The same is true for exporters.[29] Hence, it is the heterogeneity between exporters and non-exporters what enables the model to produce a distribution of capital across all firms as unequally distributed as in the data.

Table 3: Distribution of Capital by Quintiles

Quintile of firms	Data (1990) (1)	Model (NCC regime) (2)	Data (1997) (3)	Model (CC regime) (4)
0.2	0.0084	0.0154	0.0119	0.0154
0.4	0.0257	0.0441	0.0337	0.0444
0.6	0.0627	0.0977	0.0689	0.0986
0.8	0.1545	0.1684	0.1685	0.1647
1	0.7487	0.6745	0.7169	0.6769

Figure 2: Lorenz Curves of the Firm Size Distribution - Data and Model

(a) NCC regime (b) CC regime



Note: The distribution of capital in the data excludes firms for which $OSG > 0.7$ to be consistent with the fact that, in the model, newborn firms receive a transfer of capital equal to 30% of their optimal scale. Firms in the top 1% of the distribution are also excluded.

5.2 Positive effects of capital controls

Column (1) of Table 4 shows the effects of CCs on aggregate variables in the calibrated (benchmark) economy. The magnitude of the changes highlights the relevance of the general equilibrium effects, particularly since they are permanent changes (i.e., in the stationary equilibrium). As explained below, these effects play an important role in the responses of misallocation and welfare to CCs. Output, final good prices and wages fall by 0.85%, 0.36% and 1.06%, respectively. Hence, the real wage in units of final goods (w/p) falls by 0.7%, a similar order of magnitude as the 0.73% fall

[29]The Gini coefficients for non-exporters and exporters in the model are 0.44 and 0.37, respectively.

in consumption. Investment declines 1.46%, domestic sales of inputs 0.94% and the share of firms that are exporters falls sharply by 5.74%. Interestingly, exports themselves decrease only 0.82%, as the fall in prices embodies lower firm prices for both domestic and foreign sales, so the larger exporter firms become more competitive. The reduction of 4.24pp in the credit-value added ratio shows the effectiveness of the CCs as a policy for reducing credit.

Table 4: Effects of Capital Controls on Aggregate Variables
(percent changes relative to NCC regime)

	CC regime (1)	$\nu = 6\%$ (2)	LTV regulation (3)	Tax rebates (4)
Exports	-0.82%	-5.54%	-0.94%	-0.28%
Share of exporters	-5.74%	-6.90%	-1.62%	3.67%
Domestic Sales	-0.94%	-1.71%	-0.21%	-0.43%
Investment	-1.46%	-6.52%	-0.91%	-1.80%
Consumption	-0.73%	-0.88%	-0.08%	-0.27%
Final goods output	-0.85%	-1.78%	-0.21%	-0.51%
Real GDP	-0.56%	-2.81%	-0.38%	-0.72%
Real wage	-0.70%	-2.99%	-0.42%	-0.63%
Wage	-1.06%	-2.68%	-0.40%	-0.31%
Price level (Real ex. rate)	-0.36%	0.31%	0.02%	0.33%
Agg. credit/Value Added	$-4.24pp$	$-30.0pp$	$-4.24pp$	$-4.04pp$

Note: The change in the credit-value added ratio is shown as the difference in percentage points (pp).

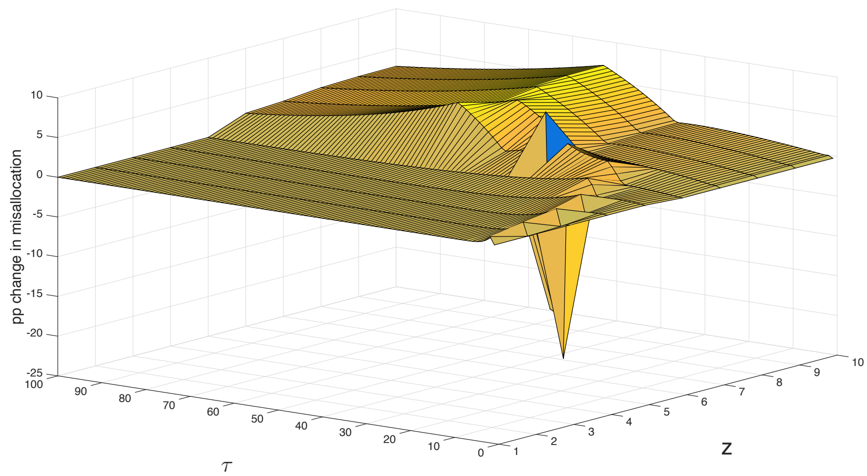
To quantify the effects on misallocation, we first measure misallocation for each firm i in the CC and NCC regimes as the absolute value of the deviation of the log of the firm's MRPK relative to the log of the long-run level (recall that $\overline{MRPK} = p(r^* + \delta)$):

$$mis_i^j = \mid log(MRPK_i^j) - log(\overline{MRPK}) \mid, \tag{30}$$

where $j = \{NCC, CC\}$. Since both terms are in logs, mis_i^j is the percent deviation from each regime's $\overline{MRPK}$. Figure 3 shows a surface plot of the difference $mis_i^{CC} - mis_i^{NCC}$ (i.e., the change in percentage points in mis when moving from the NCC to the CC regime) across firms of different productivity and age, including all 10 values of z and cohorts of τ from 0 to 100 years of age. We truncate at this age because older firms have negligible values in $\phi(\tau, z)$.

This Figure combines the static, dynamic and GE effects. Still, the four regions identified in Figure 1 to characterize the static effects are visible. At birth, firms are generally in region 1 (for $z \geq z_3$), borrowing to finance investment subject to the collateral constraint as they grow their net worth. Misallocation worsens gradually with τ for each z and only because of the dynamic and

Figure 3: Effects of Capital Controls on Misallocation: Benchmark Model



Note: Misallocation for a firm i is computed as $mis_i = \mid log(MRPK_i) - log(\overline{MRPK}) \mid$, where $\overline{MRPK}$ is the steady-state level of MRPK. The chart plots $mis_i^{CC} - mis_i^{NCC}$ for each firm i including firms for all z values and $\tau \in [0, 100]$.

GE effects, since the static effects do not alter the MRPKs of firms in region 1 across the NCC and CC regimes (see Figure 1). When firms reach their pseudo steady state in the CC regime (region 2), misallocation worsens at a sharply faster rate. Firms with $z \leq z_2$ start near this region.[30] As firms move from region 1 into regions 2, 3 and 4, the pattern of the misallocation effects shown in this Figure also follows the non-monotonic pattern of the changes in MRPKs shown in Figure 1. Misallocation peaks at the vertex between regions 2 and 3 and then starts declining until it converges to a minimum at the vertex of regions 3 and 4, as firms first repay debt and then self-finance investment until they reach their optimal scale in region 4, where there is no misallocation.

The pattern with which the misallocation effects of CCs change with age is qualitatively similar for each z, but there are important quantitative differences due to interactions with the trade participation choice and the age distribution of firms. The role of the former is reflected in the discrete jump for firms with $z \geq z_6$. This occurs because firms with $z \leq z_5$ are always non-exporters, those with z_6 are switchers (at ages 27 and 31 in the NCC and CC regimes, respectively), and those with $z \geq z_7$ are switchers from birth. Exporters have larger optimal scales and thus go through longer transitions to reach them. Hence, for younger (older) firms, the misallocation effect suddenly drops (rises) as we move to higher z values. The large negative effect (i.e., $mis^{NCC} > mis^{CC}$) for the firm with z_6 and $\tau = 27$ is because it delays four more periods the decision to become exporter in the CC regime. Thus, at age 27, this firm's MRPK as a switcher in the NCC

[30]Entrepreneurs with low z still collect labor income w, and if this is large relative to their optimal investment choice, these firms do not need to borrow to accumulate capital even when they are very young.

regime is much higher than as a non-exporter in the CC regime. Conversely, at age 31, this firm's MRPK as an exporter in the NCC regime is markedly lower than as a switcher in the CC regime.

The age distribution of firms matters because it assigns higher probability mass to younger firms. As noted above, firms with low z start out close to region 2, so they arrive earlier in their life cycle to the area where the misallocation effect of CCs is strongest, and the mass of firms is larger. Firms with higher z, have larger and more persistent changes in misallocation as they transit across regions, but the largest effects occur when they are older and their mass smaller. These differences are reflected in the aggregations of misallocation effects across firms, as we explain next.

Table 5 shows the change in aggregate misallocation from the NCC to the CC regime in the benchmark economy (column 1), as well as changes for groupings by trade status, OSG and productivity. Aggregate misallocation in each regime is the mean deviation of firm-specific misallocation: $\sum_\tau \sum_z mis^j(\tau, z)\phi(\tau, z)$, for $j = NCC, CC$. To break it down by trade status and OSG, since these differ with age across regimes, we use the results of the CC regime to classify firms accordingly, and then aggregate the change in misallocation for each group using the resulting conditional distributions.[31] For example, for exporters we use the switching time of firms in the CC regime, so that the fraction of all firms that are non-exporters is $\sum_z \left(\sum_{\tau=0}^{\hat{\tau}^{CC}(z)} \phi(\tau, z)\right)$, where $\hat{\tau}^{CC}(z)$ is the date in which firms with productivity z switch to become exporters in the CC regime (notice, this counts switchers as non-exporters). This is then used to compute the conditional probability distributions of exporters and non-exporters which are used to construct the corresponding group moments. These moments would differ using the NCC results because $\hat{\tau}^{NCC}(z) < \hat{\tau}^{CC}(z)$.

Capital controls increase aggregate misallocation by 0.5pp. As it is evident from Figure 3, however, there is substantial heterogeneity across firms. Breaking down firms by z, we again observe the non-monotonic effect of CCs on misallocation: For relatively low z, the percent change in misallocation increases with z and peaks at z_5, and then it stays relatively flat for high levels of z.[32] The intuition for this result is the same provided for Figure 3: Firms with very low z experience small increases in misallocation, even at the peak, because they reach their optimal scales quickly. As z increases, this takes longer and regions 2 and 3, where the misallocation effects of CCs are larger, expand. Firms with high z, however, spend several periods in region 1, where misallocation

[31] An alternative way to compute changes in misallocation for groups of firms is to first classify firms of economy j with $j = \{NCC, CC\}$ with the distribution for this economy, compute an aggregate measure of misallocation and then compute the change in misallocation between the CC and NCC regimes. We prefer the computation described in the text because it is closer in spirit to the empirical exercise of Section 6. The results using the latter specification are qualitatively and quantitatively similar.

[32] The lower effect for $z = z_6$ is due to the large negative misallocation effect at age 27 because of the delay in the decision to switch, as shown in Figure 3.

worsens less, and thus reach regions 2 and 3 later in life, when the fraction of surviving firms is small. This explains why, despite the large firm-specific increases in misallocation for high-z-firms shown in Figure 3, misallocation actually worsens slightly less as z rises from z_7 to z_{10} in Table 5.

Capital controls worsen misallocation for exporters ($1.25pp$) much more than non-exporters (0.34 pp) and the economy as a whole ($0.5pp$). The intuition is similar as for high- v. low-z firms, since the former are exporters and the latter not: The longer transitions of exporters to their larger optimal scales makes them more financially dependent and thus more vulnerable to the distortions caused by CCs. Similarly, Table 5 shows that CCs worsen misallocation more for firms with larger than smaller OSGs ($0.51pp$ v. $0.23pp$).[33] This is also evident in Figure 3. The relation between OSG and the misallocation caused by CCs is also non-monotonic, because very young firms with the largest OSGs are typically in region 1, where the change in misallocation is small.

Table 5: Effects of Capital Controls on Misallocation & Welfare

	Capital controls		LTV regulation		Tax rebates	
	misallocation (1)	welfare (2)	misallocation (3)	welfare (4)	misallocation (5)	welfare (6)
All firms	$0.50pp$	-0.61%	$0.29pp$	-0.20%	$0.74pp$	-0.23%
Exp. status						
Exporters	$1.25pp$	-1.82%	$0.91pp$	-0.15%	$1.55pp$	0.89%
Non-exporters	$0.34pp$	-0.56%	$0.16pp$	-0.20%	$0.55pp$	-0.23%
OSG						
Large	$0.51pp$	—	$0.31pp$	—	$0.76pp$	—
Small	$0.23pp$	—	$0.04pp$	—	$0.23pp$	—
Productivity						
1	$0.11pp$	-0.69%	$0.02pp$	-0.42%	$0.12pp$	-0.62%
2	$0.22pp$	-0.67%	$0.05pp$	-0.41%	$0.23pp$	-0.59%
3	$0.43pp$	-0.59%	$0.10pp$	-0.39%	$0.43pp$	-0.51%
4	$0.61pp$	-0.47%	$0.18pp$	-0.33%	$0.61pp$	-0.37%
5	$0.64pp$	-0.44%	$0.25pp$	-0.22%	$0.63pp$	-0.27%
6	$0.24pp$	-0.89%	$0.21pp$	-0.11%	$0.88pp$	0.01%
7	$0.67pp$	-1.13%	$0.70pp$	0.11%	$0.81pp$	-0.56%
8	$0.60pp$	-1.20%	$0.72pp$	0.19%	$0.73pp$	-0.51%
9	$0.58pp$	-1.22%	$0.73pp$	0.21%	$0.71pp$	-0.49%
10	$0.57pp$	-1.23%	$0.73pp$	0.22%	$0.70pp$	-0.49%

In Section 6, we provide empirical evidence in favor of the model's prediction indicating that the Chilean capital controls worsened misallocation more for firms that were more productive, exporters or had larger OSGs. We also provide evidence of the non-linearity indicating a stronger

[33]We define firms with small OSGs as those with a capital stock within 5% of their optimal scale.

(weaker) effect of CCs on misallocation as productivity rises for non-exporters (exporters).

5.3 Welfare effects of capital controls

We measure the effect of CCs on social welfare using a utilitarian social welfare function. The welfare weights correspond to the fraction of entrepreneurs of a particular age cohort and productivity that exists in the stationary state, as given by $\phi(\tau, z)$. The metric to assess welfare is a compensating (percent) consumption variation applied to the CC solution, constant across entrepreneurs, such that social welfare in the CC and NCC regimes is the same (i.e., an increase in each entrepreneur's consumption that makes society indifferent to whether CCs are implemented or not):

$$G = \left[\frac{\sum\limits_{\tau} \sum\limits_{z} V^{CC}(\tau, z)\phi(\tau, z)}{\sum\limits_{\tau} \sum\limits_{z} V^{NCC}(\tau, z)\phi(\tau, z)} \right]^{\frac{1}{1-\gamma}} - 1, \tag{31}$$

It is straightforward to compute analogous measures for each value of z, since z is exogenous: $G(z) = \left[\frac{\sum_{\tau} V^{CC}(\tau,z)\phi(\tau,z)}{\sum_{\tau} V^{NCC}(\tau,z)\phi(\tau,z)} \right]^{\frac{1}{1-\gamma}} - 1$. We also compute welfare measures for exporters G^E and non-exporters G^{NE}, which are more involved because the date at which firms switch to become exporters varies across regimes. As before, we use the switching time $\hat{\tau}^{CC}(z)$ of firms in the CC regime to classify a firm as exporter:

$$G^{NE} = \left[\frac{\sum\limits_{z} \left(\sum\limits_{\tau=0}^{\hat{\tau}^{CC}(z)} V^{CC}(\tau, z)\phi(\tau, z) \right) / \sum\limits_{z} \left(\sum\limits_{\tau=0}^{\hat{\tau}^{CC}(z)} \phi(\tau, z) \right)}{\sum\limits_{z} \left(\sum\limits_{\tau=0}^{\hat{\tau}^{CC}(z)} V^{NCC}(\tau, z)\phi(\tau, z) \right) / \sum\limits_{z} \left(\sum\limits_{\tau=0}^{\hat{\tau}^{CC}(z)} \phi(\tau, z) \right)} \right]^{\frac{1}{1-\gamma}} - 1, \tag{32}$$

$$G^{E} = \left[\frac{\sum\limits_{z} \left(\sum\limits_{\tau=\hat{\tau}^{CC}(z)+1}^{\infty} V^{CC}(\tau, z)\phi(\tau, z) \right) / \sum\limits_{z} \left(\sum\limits_{\tau=\hat{\tau}^{CC}(z)+1}^{\infty} \phi(\tau, z) \right)}{\sum\limits_{z} \left(\sum\limits_{\tau=\hat{\tau}^{CC}(z)+1}^{\infty} V^{NCC}(\tau, z)\phi(\tau, z) \right) / \sum\limits_{z} \left(\sum\limits_{\tau=\hat{\tau}^{CC}(z)+1}^{\infty} \phi(\tau, z) \right)} \right]^{\frac{1}{1-\gamma}} - 1. \tag{33}$$

Since these welfare measures are driven by the entrepreneurs' income profiles, we shed some light on the determinants of the welfare effects by analyzing differences in labor and capital income across entrepreneurs in the CC and NCC regimes. Since all entrepreneurs supply one unit of labor, their labor income falls uniformly with the fall in the real wage. The shares of labor v. capital income and the changes in capital income, however, differ sharply across entrepreneurs.

To characterize changes in capital income, we use the optimality conditions of the entrepreneurs' second-stage problem to obtain these expressions:

$$\frac{p^h(\tau,z)}{p} = \frac{\varsigma(r+\delta)^\alpha}{(1-\alpha)^{1-\alpha}\alpha^\alpha z}\left(\frac{w}{p}\right)^{1-\alpha}\left(\frac{MRPK(\tau,z)}{p(r+\delta)}\right)^\alpha \tag{34}$$

$$\frac{\pi(\tau,z)}{p} = \frac{y + e\frac{1}{\zeta^{\sigma-1}}\left(\frac{p^*}{p}\right)^\sigma y^*}{\left(\frac{p^h(\tau,z)}{p}\right)^{\sigma-1}}\left[1-\frac{(1-\alpha)}{\varsigma}\right], \tag{35}$$

where $\pi/p \equiv [p^h y^h + p f^y f - wn]/p$ are real profits (i.e., capital income) of an entrepreneur. Condition (34) shows that a firm's relative price is a geometric weighted average of the real wage and the ratio of its MRPK relative to the efficient one (i.e., its misallocation). Since MRPK changes non-monotonically as firms age (for a given z) in the CC regime relative to the NCC regime, as shown in Figure 3, the effect on relative prices is also non-monotonic. The -0.7% drop in real wages dominates for firms with low misallocation. These firms charge lower prices and collect higher profits in the CC regime. This applies to low-z firms of all ages, but for them profits are a tiny share of total income, and to cohorts of young firms with higher z and small enough misallocation for p^h/p to still fall. In contrast, for old enough firms with high enough z, higher misallocation dominates the lower real wage, so they charge higher p^h/p and collect lower profits in the CC regime. Hence, the misallocation caused by capital controls redistributes income (and consumption) across firms of different ages and productivity.

Profits are also affected by the GE declines in y and p and the trade status of firms. Lower y reduces profits for all firms as demand for all inputs shrinks. For exporters, however, the effect is weaker because they sell some of their output abroad, where y^* is unchanged, and also the real depreciation (as p falls -0.36%) increases profits because the real value of exports rises as p^*/p rises.

Table 5, column (2) shows the welfare measures for the benchmark economy. Capital controls reduce social welfare by 0.61%. This is a sizable loss, considering that it is due to a 175-basis-points hike in the interest rate and a 424-basis-points cut in the credit-value added ratio. Welfare costs for exporters are roughly three-times larger than for non-exporters, at 1.82% v. 0.56%. As discussed before, exporters are high-productivity firms that experience much higher misallocation and for longer periods than non-exporters (or low-z firms), so their profits fall more as they transit to their optimal scales. Given that $\rho = 0.08$, firms younger than 50 years have nontrivial weights in $\phi(\tau,z)$, and Figure 3 shows that this includes the entire region where CCs worsen misallocation.

The welfare effects by productivity show that all firms suffer losses. The losses, however, are non-monotonic in z, reflecting the income re-distribution mentioned earlier. They fall as z rises up to $z = z_5$. This occurs because firms with the lowest z collect mainly labor income and suffer the brunt of the -0.7% drop in w/p, but as z rises profits start to matter and misallocation is not large enough to prevent profits from rising as w/p falls. The welfare costs then jump to 0.89% for firms with $z = z_6$ (which includes the switcher cohort) and worsen as z rises further.[34] Firms with $z > z_6$ have larger welfare costs as z rises because their higher misallocation causes their profits to fall, and by more as their misallocation peaks. These entrepreneurs suffer the most because their income from both labor and capital falls. Note also that the fall in y caused by CCs reduces profits for all firms, but for those that are exporters, the 0.36% real depreciation allows them to increase exports and thus moderate the fall in profits. These results are also indicative of the relevance of the GE effects on w/p, y and p in affecting labor and capital income and welfare.

5.4 Counterfactuals: Tighter capital controls, LTV regulation & tax rebates

We examine next three important counterfactual experiments: (1) tighter CCs (higher tax rates on inflows); (2) LTV regulation (a cut in θ that yields the same 4.24pp drop in the credit-value added ratio as the CCs); and (3) rebates of the revenue of the debt tax ν to entrepreneurs.

Tighter capital controls: Studying values of ν higher than the 1.75% calibrated to the 1990s Chilean *encaje* is important because estimates of average optimal debt taxes from the macroprudential policy literature are sharply higher, in the 3-to-12% range.[35] In this experiment, we compare taxes set to $\nu = 1.75\%$ and $\nu = 6\%$. Columns (1) and (2) of Table 4 compare the effects on aggregate variables, and Table 6 compares results for misallocation and welfare.

The effects of CCs on aggregate variables worsen sharply with $\nu = 6\%$ (see column (4) of Table 4). Importantly, output, investment, exports, and real wages fall much more, and the price level rises 0.31% instead of falling -0.36%. Note that in this case the ratio of aggregate credit to value added is reduced by 30pp. Columns (1) and (7) of Table 6 show that the effects on misallocation for all firms, for exporters and non-exporters, for firms with large OSGs, and for firms at

[34] The jump for z_6 is due to the one-time switching cost paid by the switcher firm. In addition, since CCs delay the switching date from $\tau = 27$ to 31, the firm at age 28 is already exporting and generating higher income in the NCC regime but remains a non-exporter in the CC regime.

[35] 3.6% in Bianchi and Mendoza (2018) using a model with land as collateral, 3% to 6% in Bianchi (2011) for different nontradable-GDP shares and collateral coefficients, 5.1% in Bianchi et al. (2016) using a model with news shocks, 5% to 12% in Hernandez and Mendoza (2017) using a model with production and intermediate goods.

all levels of z are also much larger. Intuitively, as ν rises, $\bar{k}^{cc}(z)$ falls, and regions 1 and 2 shrink, creating a larger area where misallocation exists.

Columns (3) and (9) of Table 6 show that the social welfare loss is 2.3 times larger with $\nu = 6\%$ (1.41% v. 0.61% in the benchmark case). However, the result that welfare falls more for exporters than non-exporters reverses. Exporters make a small gain and the loss for non-exporters rises from 0.56% to 1.45%. As we explain below, these results are due to the stronger GE effects and to the aggregation with the firm-age distribution. To help us explain why, we added to Table 6 results computed in partial equilibrium (PE), by imposing the values of (p, y, w) from the NCC solution in the solutions with CCs, and welfare evaluations aggregating only over newborn firms.

Comparing columns (1) and (2) or (7) and (8) shows that aggregate misallocation rises more when GE effects are included for both values of ν. It also rises more for non-exporters and for firms with small and large OSG, but it rises less for exporters. Examining the breakdown by z, we see that GE effects worsen misallocation only for firms with $z \leq z_6$, while for firms with higher z it falls slightly or is nearly unchanged. Since all firms with $z \geq z_7$ ($z \leq z_5$) are exporters (non-exporters) at all times, this result reflects the way in which GE effects affect non-exporters v. exporters, and it also accounts for the increase (fall) in misallocation for the former (latter). The declines in y, w and w/p affect exporters less because of their foreign sales, and their static effects get weaker (see eqs. (20)-(22)). With $\nu = 6\%$, GE effects reduce the increase in exporters' misallocation by 6 basis points (5.38pp in GE v. 5.43pp in PE), whereas for non-exporters the increase in misallocation is 40 basis points larger (1.66pp in GE v. 1.26pp in PE).

To analyze how the aggregation method and the GE effects affect the welfare measures, consider first the results with $\nu = 1.75\%$. Columns (3) and (5) of Table 6 show that the social welfare loss is only slightly larger aggregating with the firm-age distribution v. newborn firms, at 0.61% and 0.58%, respectively. However, the costs for exporters and non-exporters, and the result that the costs are larger for the former, change sharply. The firm-age distribution yields costs of 1.82% and 0.56% for exporters and non-exporters, respectively, compared with 0.44% and 0.66% aggregating across newborn firms. The key difference between the two aggregations is in that the firm-age distribution assigns some weight to the lifetime utility of entrepreneurs of all age cohorts for each z (with exponentially decreasing weights for older cohorts given by $\phi(\tau, z)$), and each cohort is at a different point in the four regions identified in Figures 1 and 3. In contrast, the aggregation over newborn firms values only the lifetime utility of entrepreneurs for each z as of their birth date, with weights given by $f(z)$. Non-exporters are low-z firms and their welfare costs are bigger when aggregating by newborn firms because they are born close to their optimal scales and the early periods during which their consumption is more affected by higher MRPKs (lower profits) weigh more in their lifetime utility. In contrast, exporters are high-z firms and their costs are smaller aggregating across newborn firms because, as Figure 3 shows, the region in which their MRPKs rise sharply (profits fall more) is distant into the future, and thus more heavily discounted in their lifetime utility. Hence, exporters fare better (worse) than non-exporters aggregating over newborn firms (the firm-age distribution).

A key element in the above argument is that the GE effects on capital and profits are relatively weak with $\nu = 1.75\%$. The optimal scale of capital and the associated gross and net profits rise 0.38% and 0.27% relative to the NCC regime for exporters and non-exporters, respectively.[36] As we show next, the strong GE effects with $\nu = 6\%$ turn the losses of exporters and high-z firms lower than those of non-exporters and low-z firms even aggregating with the firm-age distribution, and they can even produce welfare gains.

The social welfare cost of setting $\nu = 6\%$ is large regardless of the aggregation method (see columns (9) and (11), although it is a bit lower aggregating with the firm-age distribution instead of newborn firms (1.41% v. 1.87%). Welfare costs are also lower aggregating with the firm-age distribution for firms at each level of z and for exporters and non-exporters. Exporters and firms with $z \geq z_8$ actually obtain welfare gains relative to the NCC regime.

These results are due to the much stronger GE effects with the 6% tax: Real wages fall 2.99% instead of 0.7% and net profits at the optimal scale of capital rise 3.11% and 3.09% for exporters and non-exporters, respectively, instead of 0.38% and 0.27%. The larger drop in real wages hurts non-exporters and low-z firms because most of their income is labor income. They have even larger welfare losses aggregating across newborn firms because their higher future profits are more heavily discounted, while aggregating with $\phi(\tau, z)$ includes cohorts with higher profits, even if those profits are a small share of their income. In contrast, exporters and high-z firms benefit from both the higher profits and the drop in real wages (since it props up profits and wages are a small share of their income). Note that, as firms age, MRPKs still follow a trajectory for each z qualitatively similar to that of Figure 3, so profits fall and then rise, but with two key differences: Profits rise to reach a level 3% higher than in the NCC regime at the optimal scale of capital and, because regions

[36]The percent change in $\bar{k}(z)$ across a policy regime i and the NCC regime is given by $ln(\bar{k}^i(z)) - ln(\bar{k}^{NCC}(z)) = ln(\tilde{y}^i) - ln(\tilde{y}^{NCC}) - (\sigma - 1)(1 - \alpha)[ln((w/p)^i) - ln((w/p)^{NCC})]$, where $\tilde{y} = y + e\zeta^{1-\sigma}(p^*/p)^{\sigma} y^*$. Hence, $\bar{k}(z)$ changes by the same percentage for all firms that are exporters and all firms that are non-exporters. This is because $MRPK = p(r^* + \delta)$ at the optimal scale for all firms. The associated steady-state profits and net profits (i.e., profits net of taxes and inclusive of depreciated capital) are linear in $\bar{k}(z)$ and hence they increase by the same percentage.

1 and 2 shrink, now even high-z firms reach the region of increasing profits when they are young.

Comparing columns (9) with (10) and (11) with (12) shows that removing GE effects reduces sharply the social welfare costs of tighter CCs regardless of the aggregation method, from 1.41% (1.87%) to 0.22% (0.37%) aggregating with the firm-age distribution (newborn firms). Without GE effects, (w, p, y), the optimal scales of capital, net profits at the optimal scale, and initial capital transfers are the same with and without CCs. Moreover, exporters now fare worse than non-exporters, and by a large margin, 2.84% (0.81%) v. 0.28% (0.13%) with the firm-age distribution (newborn firms). Also, the ranking of welfare costs by productivity reverses, with much smaller losses for low-z firms and larger losses for high-z firms. Aggregating with the firm-age distribution, firms with $z \leq z_5$ make welfare gains. Aggregating over newborn firms, the welfare of firms with $z \leq z_2$ is nearly unchanged, because their misallocation rises very little.[37] Conversely, high-z firms no longer benefit from GE effects via lower real wages and higher profits, so their welfare costs due to sizable misallocation are larger.

Summing up, these results show not only that tighter CCs have significantly larger adverse effects on misallocation and social welfare, but that these larger effects are due to strong general equilibrium effects on real wages and profits. Moreover, they also show that the welfare effects of CCs are affected by the interaction of these general equilibrium effects with the method used to aggregate welfare valuations. The result that social welfare costs rise sharply with tigther CCs is independent of the aggregation method, but welfare comparisons across exporters and non-exporters and across firms with different productivity change sharply. Aggregating with the firm-age distribution, cohorts of high-productivity or exporting firms sufficiently advanced in their transition to sharply higher profits can be better off with CCs than without.

LTV regulation: In this experiment, we set $\nu = 0$ and reduce θ^{NE} to a value θ^{LTV} such that the model yields the same cut of 4.24pp in the credit-value added ratio obtained in the CC benchmark. This requires setting $\theta^{NE} = \theta^{LTV} = 0.0545$, 82 basis points lower than the 0.0627 of the NCC calibration. Since we keep θ_f unchanged, this also reduces θ^E.

Column (3) of Table 4 shows that the effects of LTV regulation on aggregate variables are much weaker than those of CCs in the benchmark case. The real wage falls 0.42% (instead of 0.7%),

[37]In the PE solution, none of the newborn firms can make welfare gains because the choices they make with CCs remain feasible in the NCC regime (e.g., they can choose not to borrow and move to region 3 under CCs). This is not the case in general equilibrium. In particular, the 3% increase in $\bar{k}(z)$ with $\nu = 6\%$ is due to the effect of lower w/p dominating that of lower $\tilde{y}$. Higher $\bar{k}(z)$ also implies larger capital transfers to newborn firms. This makes little difference for low-z firms, which collect mainly labor income, but for high-z firms it implies higher wealth.

Table 6: Effects of Capital Controls on Misallocation & Welfare at Different Tax Rates.

	$\nu = 1.75\%$						$\nu = 6\%$					
	Misallocation		Welfare by age		Welfare newborn		Misallocation		Welfare by age		Welfare newborn	
	GE (1)	PE (2)	GE (3)	PE (4)	GE (5)	PE (6)	GE (7)	PE (8)	GE (9)	PE (10)	GE (11)	PE (12)
All firms	$0.50pp$	$0.44pp$	-0.61%	-0.31%	-0.58%	-0.18%	$2.28pp$	$1.90pp$	-1.41%	-0.22%	-1.87%	-0.37%
Exp. status												
Exporters	$1.25pp$	$1.29pp$	-1.82%	-3.27%	-0.44%	-0.38%	$5.38pp$	$5.43pp$	0.03%	-2.84%	-0.90%	-0.81%
Non-exporters	$0.34pp$	$0.28pp$	-0.56%	-0.25%	-0.66%	-0.07%	$1.66pp$	$1.26pp$	-1.45%	-0.28%	-2.39%	-0.13%
OSG												
Large	$0.51pp$	$0.45pp$	—	—	—	—	$2.36pp$	$1.97pp$	—	—	—	—
Small	$0.23pp$	$0.21pp$	—	—	—	—	$0.27pp$	$0.19pp$	—	—	—	—
Productivity												
1	$0.11pp$	$0.11pp$	-0.69%	0.01%	-0.70%	0.00%	$0.15pp$	$0.11pp$	-2.96%	0.01%	-2.97%	0.00%
2	$0.22pp$	$0.21pp$	-0.67%	0.03%	-0.70%	0.00%	$0.41pp$	$0.30pp$	-2.90%	0.03%	-2.95%	0.00%
3	$0.43pp$	$0.40pp$	-0.59%	0.09%	-0.69%	-0.01%	$0.84pp$	$0.62pp$	-2.71%	0.09%	-2.88%	-0.01%
4	$0.61pp$	$0.56pp$	-0.47%	0.16%	-0.68%	-0.03%	$1.43pp$	$1.08pp$	-2.29%	0.20%	-2.70%	-0.04%
5	$0.64pp$	$0.58pp$	-0.44%	0.08%	-0.65%	-0.10%	$1.97pp$	$1.58pp$	-1.58%	0.21%	-2.22%	-0.17%
6	$0.24pp$	$0.16pp$	-0.89%	-0.99%	-0.45%	-0.27%	$1.92pp$	$1.38pp$	-0.64%	-0.84%	-0.89%	-0.41%
7	$0.67pp$	$0.69pp$	-1.13%	-1.74%	-0.38%	-0.99%	$4.59pp$	$4.61pp$	-0.10%	-2.00%	-0.97%	-2.83%
8	$0.60pp$	$0.61pp$	-1.20%	-2.05%	-0.37%	-1.21%	$5.15pp$	$5.16pp$	0.39%	-2.35%	-0.68%	-3.39%
9	$0.58pp$	$0.59pp$	-1.22%	-2.15%	-0.36%	-1.29%	$5.30pp$	$5.30pp$	0.56%	-2.50%	-0.57%	-3.58%
10	$0.57pp$	$0.58pp$	-1.23%	-2.18%	-0.36%	-1.31%	$5.34pp$	$5.34pp$	0.61%	-2.54%	-0.53%	-3.64%

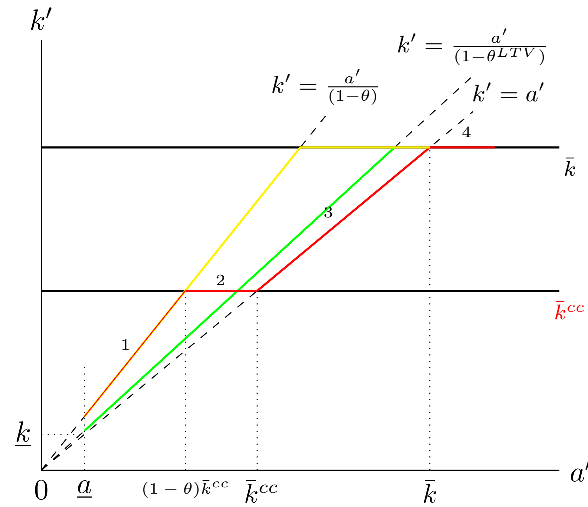
p is nearly unchanged (instead of falling 0.36%), so that exporters no longer benefit from a slight real depreciation, and output and consumption also fall less, by 0.38% and 0.08%, respectively (instead of 0.56% and 0.73%). Exports fall about the same but the share of exporters falls much less (1.62% instead of 5.74%). In contrast with the tighter CCs experiment, where *stronger* aggregate effects coincided with higher $\bar{k}(z)$, in this case *weaker* aggregate effects coincide with higher $\bar{k}(z)$. Relative to the NCC regime, the optimal scales of capital and net profits at the optimal scales rise by 0.46% and 0.47% for exporters and non-exporters, respectively. This is nearly twice as much as in the CC benchmark and is again due to the effect of lower w/p dominating the change in $\tilde{y}$.

Column (5) of Table 5 shows the LTV effects on misallocation. Aggregate misallocation worsens much less than with CCs (by $0.29pp$ instead of $0.5pp$). Misallocation also worsens much less for both exporters and non-exporters and for firms with large and small OSGs. Examining the breakdown by z, however, misallocation worsens less than with CCs for firms with $z \leq z_6$ but more for those with $z \geq z_7$. Thus, as in the case of higher ν, this pattern reflects differential effects across exporters and non-exporters. It is worth noting that the $0.91pp$ rise in misallocation for exporters reflects the sharp increase in mis_i for the cohorts with $z = 6$ that are old enough to be exporters. This is not visible in the overall misallocation of firms with $z = 6$ because the younger cohorts are non-exporters for which misallocation falls and these have higher probability mass.

The above results can be explained by studying how the static effects change with LTV regulation, as shown in Figure 4. The capital decision rule of the LTV regime when the collateral constraint binds is the ray from the origin $k' = a'/(1 - \theta^{LTV})$. It must be flatter than the one corresponding to region 1 in the CC regime because increasing θ reduces credit for firms that were in region 1 and a subset of region 2 but increases it for those in the remainder of region 2 and all of region 3. Hence, to yield the *same* aggregate credit reduction of the CC regime, it must be that $\theta^{LTV} > \theta$, so that the total extra credit that the latter group of firms gain (relative to the CC regime) is exactly matched by the credit cut to the former group. Intuitively, the burden of reducing aggregate credit is distributed more evenly with LTV than CCs. Firms that were in region 1 with CCs, and those in region 2 close to the vertex with 1, have larger OSGs and higher misallocation with the LTV, while region-2 firms far enough from the vertex with region 1 and all those in region 3 have the opposite, including some that now reach their optimal scale at lower a' (i.e., sooner).

The above analysis explains the quantitative results showing smaller increases in misallocation with LTV than with CCs for firms with $z \leq z_6$ and the opposite for those with $z \geq z_7$ (i.e., the latter includes more firms that were in region 1 or 2 close to the vertex with 1 with CCs, and the

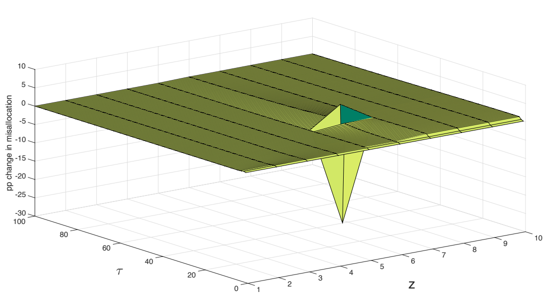
Figure 4: Static Effects of LTV & Capital Controls
(second-stage optimal k' as a function of a')



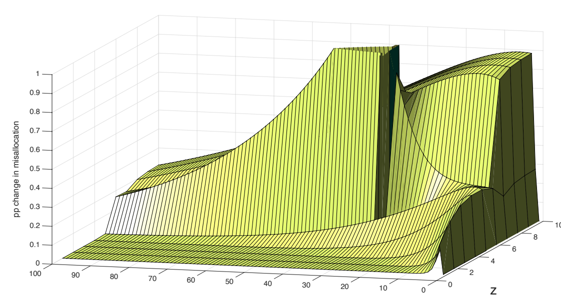
former includes more region-2 firms away from that vertex and in region 3). Since there is a larger fraction of firms with $z \leq z_6$, aggregate misallocation falls. Keep in mind, however, that these results show the combined static, dynamic and GE effects. The different static effects of LTV regulation relative to CCs reflect changes in the tightness of the credit constraint across entrepreneurs, which alter saving incentives and thus the dynamic effects. Also, the marked changes in misallocation across firms imply changes in firm pricing decisions and in aggregate demands for capital and labor and in supply of intermediate goods that affect aggregate variables.

Figure 5: Effects of LTV Regulation on Misallocation

(a) Full scale



(b) Truncated scale



Note: Misallocation for a firm i is computed as $mis_i = \mid log(MRPK_i) - log(\overline{MRPK}) \mid$, where $\overline{MRPK}$ is the steady-state level of MRPK. The chart plots $mis_i^{LTV} - mis_i^{NCC}$ for each firm i including firms for all z values and $\tau \in [0, 100]$.

The combined static, dynamic and GE effects are illustrated in Figure 5, which shows the change in mis with the LTV relative to the NCC regime by age and productivity. Since the full plot

(Plot (a)) hides important details because of the large drop associated with switching firms, Plot (b) shows a version of the plot with the vertical axis truncated.[38] Misallocation worsens more for firms with higher z as they are more credit constrained and take more time to reach their optimal scales. Since the same is true for exporters, this also explains why misallocation worsens more for exporters, $0.91pp$, than non-exporters, $0.16pp$. The Figure also shows that, since regions 2 and 3 disappear, most firms (except the switcher firm with $z = z_6$), start out in the segment of the LTV capital decision rule where misallocation peaks and starts to fall with age.

The welfare effects of LTV regulation are also very different from those of CCs. Column (6) of Table 5 shows that the social welfare cost is smaller by a factor of 3 (at 0.2%). Like in the case of $\nu = 6\%$, non-exporters have a larger loss than exporters, but both groups have much smaller losses than in the CC regime. In the productivity breakdown, all firms also fare better than in the CC regime and we obtain again the result that high-z firms ($z \geq z_7$) obtain small welfare gains, in the 0.11%-0.22% range. As before, the GE effects and the aggregation using $\phi(\tau, z)$ play a key role in these results, and the changes in the profile of misallocation as firms age matter too because all firms (except the switcher, $z = z_6$) start out at or near where misallocation peaks and starts to fall (profits at their lowest and start to rise), as shown in Figure 5. Hence, weighing with $\phi(\tau, z)$, a nontrivial mass of firms of each cohort is already in the region where misallocation is low enough for profits to be higher than in the NCC regime. The smaller losses for low-z firms, which collect most income from labor, are due to the smaller drop in real wages and smaller rise in misallocation. Firms with $z \geq z_7$, which are all exporters, make welfare gains because they attain higher profits than in the NCC regime at a young age, and thus when aggregating with the firm-age distribution we have a large set of young cohorts with higher lifetime utility than in the NCC regime.

Overall, these findings indicate that, as a tool for reducing credit, LTV regulation is far superior to CCs. LTV regulation worsens much less both aggregate misallocation and the misallocation of firms that are exporters and nonexporters, as well as those with larger and smaller optimal scale gaps. Misallocation worsens, however, for high-productivity firms that are more credit constrained with LTV regulation than with capital controls. Social welfare also falls much less, and the welfare of exporters and non-exporters, and cohorts of firms at all productivity levels also fall less. The main reason for these results is that LTV regulation distributes the burden of reducing credit more evenly across firms: Low-net-worth firms unaffected by CCs share in the credit reduction with the

[38] As with CCs, there is a large drop in misallocation for the firm with $z = z_6$ because the LTV induces a delay in the decision to become an exporter, followed by a large increase the next period, once the firm becomes an exporter.

LTV and firms with higher net worth have improved credit access.

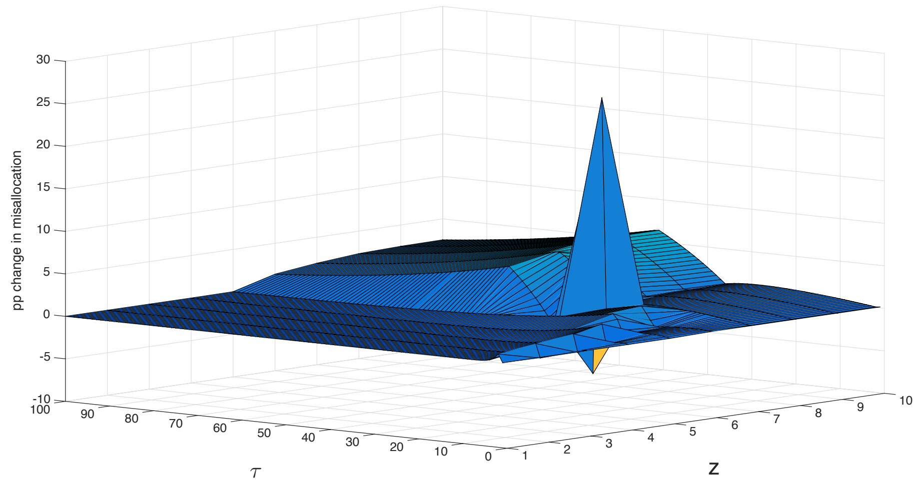
Tax rebates: We now introduce lump-sum transfers to entrepreneurs that rebate the debt taxes paid by each, so as not to introduce redistribution among entrepreneurs. Firms in regions 1 and 2 receive a rebate of $\nu(1-\rho)pqd(\tau,z)$ and firms in regions 3 and 4, which carry zero debt, do not receive a rebate. We can infer from Figure 3 and the firm-age distribution $\phi(\tau,z)$ that a large fraction of firms carry debt, particularly very young cohorts with $z \leq z_5$ and cohorts up to 50 years old with $z \geq 6$. Hence, the rebates should alter the results. In practice, however, the benchmark results without rebates are more representative of the effects of CCs, because these are generally in the form of quantitative restrictions on capital flows, mandated exchange-rates or, as in the case of the Chilean *encaje*, compulsory, unremunerated reserve requirements.

Column (4) of Table 4 shows the effects of CCs on aggregate variables. Interestingly, w falls much less than in the CC regime (-0.31% instead of -1.06%) but since p rises 0.33% instead of falling 0.36%, the fall in the real wage is about the same (0.63% instead of 0.7%). Final goods output and consumption fall 0.51% and 0.27%, respectively, 34 and 46 basis points less that in the CC regime. The trade effects also differ. Exports fall 0.28% (instead of 0.82%) and the share of exporters *rises* 3.67% (instead of falling -5.7%). The drop in credit as a share of value added is about the same, at 4.04pp. The optimal scales of capital and associated net profits relative to the NCC regime increase by similar magnitudes as with LTV regulation, by 0.48% and 0.51% for exporters and non-exporters, respectively, roughly twice as much as in the benchmark CC regime.

Although real wages, long-run profits and aggregate credit change by similar magnitudes with the rebates as with LTV regulation, the effects on misallocation and welfare differ because with the rebates the capital decision rule still displays the four regions implied by the presence of CCs. Figure 6 shows that misallocation effects across firms with different (τ, z) display a similar qualitative pattern as in the benchmark CC regime, with one key difference: With the tax rebates, firms with $z = z_6$ make the decision to start exporting at age 25, one period earlier than in the NCC regime, so there is a positive spike in misallocation for z_6 instead of a negative one as in Figure 3.

Column (5) of Table 5 shows that overall misallocation rises more with rebates than without, $0.74pp$ instead of $0.5pp$. Misallocation also worsens more for exporters (1.55pp v. 1.25pp), non-exporters (0.55pp v. 0.34pp) and firms with large OSG (0.76pp v. 0.51pp), but is nearly unchanged for firms with small OSG. Comparing Figures 3 and 6 shows that the increase in misallocation with the rebates is larger and peaks at higher values than in the CC regime for firms with

Figure 6: Effects of Capital Controls on Misallocation with Tax Rebates



Note: Misallocation for a firm i is computed as $mis_i = \mid log(MRPK_i) - log(\overline{MRPK}) \mid$, where $\overline{MRPK}$ is the steady-state level of MRPK. The chart plots $mis_i^{TR} - mis_i^{NCC}$, where TR denotes the regime with tax rebates, for each firm i including firms for all z values and $\tau \in [0, 100]$.

$z \geq z_6$, and also that misallocation peaks when firms are younger (i.e., for cohorts with higher probability mass in the firm-age distribution).

In line with Figure 6, the breakdown of misallocation effects by productivity in Table 5 shows little to no change for firms with $z \leq z_5$, which reach regions 3 and 4 quickly and thus receive no rebates, and marked increases for those with $z \geq z_6$, which reach region 2 faster and have weakened incentives to save, as we explain below. Since the set of non-exporters is made of all firm cohorts with $z \leq z_5$ for which misallocation barely changes, plus those with $z = z_6$ younger than the switching age, it follows that the higher misallocation of non-exporters is mainly due to the latter group and in particular to the cohort that makes the switch a period earlier than in the NCC regime. Misallocation worsens for firms with $z \geq z_6$ because these are the more credit-constrained firms and the tax rebates thus go mainly to them, reducing their financial dependence and the tightness of their collateral constraints. As a result, these firms reach regions 2 and 3 sooner and in this region misallocation is higher. This also weakens the dynamic effects for these firms, since their multipliers of the collateral constraint (η_i) fall.

Column (6) of Table 5 shows that the social welfare cost of CCs is much smaller with rebates (0.23% v. 0.61%). Welfare falls less for exporters and non-exporters and firms across all values of z, with exporters and firms with $z = z_6$ making welfare gains. The slightly smaller drop in w/p explains again the (slight) reduction in welfare costs for non-exporters and low-z firms. Exporters and high-z firms fare much better because of the reduced tightness of their credit constraints with the rebates and the higher long-run profits that start accruing earlier. For firms with $z = z_6$, we capture an additional sizable gain from the rebates, because they switch to export sooner and thus start collecting the extra profits from foreign sales when they are younger. Combined with the benefit of the smaller drop in real wages when they are very young, the result for all firms with $z = z_6$ is a welfare gain of 0.01%.

6 Cross-Sectional Empirical Analysis

This Section provides empirical evidence showing that the Chilean *encaje* had effects consistent with the model's key predictions. In particular, more-productive firms experienced an increase in misallocation relative to less-productive firms, and the same happened to exporters relative to non-exporters and for firms with larger optimal scale gaps. Moreover, the nonlinear effect indicating that misallocation changes relatively less with a firm's productivity for exporters than non-exporters is also present in the data.

6.1 Data

The three variables needed for the empirical analysis are: a proxy for the CCs policy, firm-level estimates of misallocation and firm- and aggregate-level data for a set of control variables. The empirical proxy for the Chilean *encaje* is the same debt-tax-equivalent implied by the CCs used in the calibration (see Appendix A for details). This tax hovered around a peak of roughly 2.7% between 1994 and 1997, and averaged 1.98% over the eight years the policy was in place. The sharp, sudden increase in 1991 and removal in 1998 is crucial to identify the effects of the CCs. These fluctuations came mainly from policy changes (the fractional reserve requirement and the holding period) and less so from changes in the risk-free rate.

We construct firm-level measures of capital and productivity using the ENIA data. A firm's fixed capital (the proxy for k) is defined as the sum of cars, machinery, land and buildings deflated by the price of capital. Since ENIA does not have depreciation data before 1995, we use a standard annual depreciation rate of 6% for the 1990-1994 period. Moreover, the data needed to construct this estimate of k is unavailable before 1992, so we impute it using investment and the 6% depreciation rate. We follow Wooldridge (2009) to measure productivity at the establishment level, deflating the relevant variables using 4-digit NAICS code deflators and the price of capital provided by ENIA.[39] Additionally, we use the wholesale price and fuel price indexes reported by the *Instituto Nacional de Estadística* (INE) to deflate electricity and fuel use, respectively.

Misallocation is measured by first constructing MRPK estimates. Following Gopinath et al. (2017) and Hsieh and Klenow (2009), we combine the condition that defines MRPK in the model with the firm-level data. Rewriting condition (16), a firm's MRPK is:

$$MRPK = \frac{(\sigma - 1)}{\sigma}(p_h y_h + p_f y_f)\frac{\alpha}{k}. \tag{36}$$

Since in the model intermediate-goods producers do not use intermediate goods themselves but in the data they do, our baseline specification proxies $p_h y_h + p_f y_f$ using the firm's value added, so that the model and data definitions of MRPK are compatible. To show that this does not matter for our findings, we also report results using total sales instead of value added to calculate MRPK. σ and α are set to the values calibrated in the previous Section. Also in line with the previous Section, misallocation for a firm i in industry j at date t is constructed as $mis_{ijt} =\mid log(MRPK_{ijt}) - log(\overline{MRPK_{jt}}) \mid$, with the yearly industry mean as a proxy for $\overline{MRPK_{jt}}$. We define industries at the 4-digit ISIC code. All firm-level variables used in the regressions are expressed in logs.

6.2 Panel estimation results

We estimate a set of panel regressions aimed at studying how the CCs had differential effects on firm-level misallocation depending on the firms' TFP, OSGs and exporter status. The main regression model is the following:

$$\begin{aligned} mis_{ijt} = \omega_0 + \omega_1 CC_{t-1} * log\_TFP_{ijt} + \omega_2 CC_{t-1} * OSG_{ijt} + \omega_3 CC_{t-1} * Exp_{ijt} \\ + \omega_4 X_{ijt} + A_i + B_t + \epsilon_{ijt}, \end{aligned} \tag{37}$$

CC_{t-1} denotes the tax-equivalent CCs, lagged one period. OSG_{ijt} is the percentage gap between the firm's capital in period t with respect to the year average capital of the firms older than 10 years old. Thus, if we interpret the latter as a proxy of the steady-state size of firms in the industry, OSG_{ijt} is an estimate of the firm's distance from its steady-state size. We classify as exporters ($Exp_{ijt} = 1$) all firms that export in the current period.[40]

X_{ijt} is a set of time-varying firm characteristics that includes the direct effect of TFP_{ijt},

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

[40] The results are robust to using backward- and forward-looking definitions of exporters instead (see Appendix H).

OSG_{ijt} and Exp_{ijt}, as well as other standard firm-level controls–i.e., fixed capital, payroll and the ratio of interest expenditures to total capital, as a proxy for a firm's debt.[41] A_i is a vector of firm-level dummy variables that account for firm fixed effects to 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 bias the results. Note that these time fixed effects absorb the direct effect of the CCs and the effect of any other aggregate time-varying change.[42] Although this strategy has the disadvantage of only allowing us to identify the firm-level heterogeneous effects of CCs, it also has the desirable feature of considerably reducing potential endogeneity problems due to omitted variables. Standard errors are clustered at the firm level.

Table 7 presents the regression results. Columns (1) to (3) show results using value added to calculate MRPK, and columns (4) to (6) show results using total sales.[43] Columns (1) and (4) use the full (unbalanced) panel of firms and Columns (2) and (5) used a balanced panel with firms that existed between 1990 and 2003 and fixing the values for TFP, Export status and OSG in 1990. Finally, columns (3) and (6) show results restricting the sample to firms not born around the period of the Russian crisis of 1998 and its aftermath –i.e, between 1998 and 2000.

In line with the findings of the quantitative analysis (see Figure 3 and Table 5), the main insight from Table 7 is that CCs caused a larger increase in misallocation for more productive firms relative to less productive firms. Namely, assuming the direct effect of CCs on misallocation was positive (negative), misallocation rose more (fell less) for firm with higher productivity. The same happened to firms that were relatively further away from their optimal scale–i.e., that have a larger OSG–and for exporters with respect to non-exporters. The three interaction coefficients are statistically significant in all the regressions.

The regression results are similar using value added or total sales to measure misallocation. Comparing balanced and unbalanced panels (i.e., column (1) with (2) and column (4) with (5)), the results are qualitatively similar, suggesting that the findings derived from the full sample are not driven by the possibility of endogenous firm entry or exit nor by changes in the interacted variables driven by the introduction of CCs. Also, the coefficients of the balanced panel are markedly larger, suggesting that the results with all firms may be a lower bound of the actual effects.

Columns (3) and (6) show that the results are also robust to restricting the sample to

[41] Table G.6 presents the summary statistics of these variables.

[42] Hence, the empirical analysis and the quantitative experiments differ in that the former can only speak to firm-level effects of CCs while the latter covers both firm-level and aggregate effects.

[43] There a fewer observations using total sales because 3931 firm-year observations report value added but zero total sales. The results are robust to dropping them from the value-added regressions too.

firms born outside the periods around the Russian crisis of 1998 (when Chile experienced a Sudden Stop). The three interaction coefficient estimates are about the same and with very similar t-statistics. This is relevant since there is important evidence from the work by Ates and Saffie (2021) showing that firms born during this period are different in size (30 percent smaller) and productivity (64 percent more productive) than the average firm born in normal times.

In regressions reported in Appendix H, we show that the results are also robust to: (i) introducing the interaction of macroeconomic controls with the firms' characteristics; (ii) winsorizing the top and bottom 1% observations of the database with respect to alternative dimensions–i.e., dependent variable, controls, and sectors' productivity; (iii) using backward- and forward-looking definitions of exporters;[44] and (iv) using data at the industry level instead of the firm level.

Table 7: Heterogeneous Effects of the Chilean *Encaje*: TFP, OSG and Export Status

	MRPK (Value Added)			MRPK (Sales)		
VARIABLES	All firms	Balanced Panel	W/o crisis cohort	All firms	Balanced Panel	W/o crisis cohort
	(1)	(2)	(3)	(4)	(5)	(6)
CC*TFP	0.876***	1.363***	0.883***	0.713***	1.108***	0.728***
	(0.130)	(0.197)	(0.135)	(0.083)	(0.196)	(0.085)
CC*Exp	0.224***	0.296***	0.208***	0.317***	0.410***	0.299***
	(0.032)	(0.062)	(0.032)	(0.033)	(0.066)	(0.034)
CC*OSG	0.248***	0.309***	0.244***	0.255***	0.380***	0.250***
	(0.033)	(0.058)	(0.033)	(0.034)	(0.062)	(0.034)
TFP	-6.190***		-6.190***	-2.263***		-2.263***
	(0.236)		(0.237)	(0.181)		(0.182)
Export Decision	-0.323***		-0.292***	-0.505***		-0.471***
	(0.060)		(0.060)	(0.064)		(0.064)
Fixed Capital	0.425***	0.636***	0.435***	0.441***	0.608***	0.454***
	(0.019)	(0.040)	(0.020)	(0.019)	(0.041)	(0.021)
OSG	-1.000***		-0.995***	-0.990***		-0.976***
	(0.105)		(0.108)	(0.099)		(0.102)
Int.Exp_Fixed_K	0.119***	0.184**	0.139***	0.168***	0.245***	0.195***
	(0.027)	(0.075)	(0.028)	(0.029)	(0.068)	(0.030)
Payroll	-0.392***	-0.505***	-0.396***	-0.431***	-0.372***	-0.435***
	(0.030)	(0.069)	(0.031)	(0.031)	(0.068)	(0.032)
Observations	91,374	22,204	90,359	87,469	21,935	86,524
R-squared	0.624	0.579	0.625	0.600	0.573	0.601
Firm FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES

Note: Columns (1) and (3) include the full sample of firms, columns (2) and (5) use the 1990-2003 balanced panel with TFP, OSG and Exp fixed at their 1990 values. Finally, columns (3) and (6) use the subsample that leaves out the cohort of firms born between 1998 and 2000. All regressions include a constant term, firm and time fixed effects, and standard errors clustered at the firm level in parenthesis. ***, **, and * indicate significance at the 1%,5%, and 10% level.

Next, we explore whether the data validates the non-linearity of the quantitative results in terms of misallocation rising relatively less with a firm's productivity for exporters than non-

[44]The former aims at capturing that firms that exported in the past can be differently affected as they typically have higher steady-state capital and are more productive. The latter 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 CCs.

exporters. We do this by adding triple-interaction terms and by splitting the panel into exporters and non-exporters. Both results are reported in Table 8. Columns (1)-(3) add the triple interactions, $CC_{t-1} * TFP_{ijt} * Exp_{ijt}$ and $CC_{t-1} * OSG_{ijt} * Exp_{ijt}$. In columns (1) and (2) we add them one at a time, and in column (3) we add both. Columns (4) and (5) shows results for the original regression specification splitting the panel into non-exporters and exporters, respectively.

The results show that becoming an exporter changes how TFP alters the effect of CCs on misallocation in the direction predicted by the model. The quantitative exercise (see Table 5) shows that the increase in misallocation caused by CCs increases with TFP until firms become exporters, while it falls or becomes constant for exporters–i.e. firms with productivity higher or equal than z_6. In line with this result, the triple interaction $CC_{t-1} * TFP_{ijt} * Exp_{ijt}$ has a negative sign in columns (1) and (3), and the coefficient for the interaction $CC_{t-1} * TFP_{ijt}$ becomes non-significant in the subsample of exporters but is significant and positive in the subsample of non-exporters in columns (4)-(5). For the case of OSG, the empirical exercise does not capture a significant difference in terms of the behavior of exporting and non-exporting firms with respect to the OSG.

Table 8: Heterogeneous Effects of the Chilean *Encaje* by Export Status

VARIABLES	All firms (1)	All firms (2)	All firms (3)	Non-Exporters (4)	Exporters (5)
CC*TFP	0.990***	0.880***	0.995***	1.029***	0.243
	(0.142)	(0.130)	(0.144)	(0.135)	(0.236)
CC*Exp	1.326**	0.215***	1.339**		
	(0.523)	(0.046)	(0.540)		
CC*OSG	0.246***	0.237***	0.248***	0.268***	0.220***
	(0.032)	(0.036)	(0.037)	(0.037)	(0.073)
CC*TFP*Exp	-0.500**		-0.501**		
	(0.240)		(0.244)		
CC*TFP*OSG		0.010	-0.032		
		(0.072)	(0.073)		
Observations	91,374	91,374	91,374	72,751	17,755
R-squared	0.624	0.624	0.625	0.658	0.578
Controls	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES

Note: Columns (1-3) include the following triple interactions $CC_{t-1} * TFP_{ijt} * Exp_{ijt}$ and $CC_{t-1} * OSG_{ijt} * Exp_{ijt}$ first one at a time in columns (1) and (2) and then together in column (3). Columns (4-5) explore whether the heterogeneous effect of CC changes between the subsamples of exporters and non-exporters. All regressions include a constant term, firm and time fixed effects, and errors clustered at the firm level in parenthesis. ***, **, and * indicate significance at the 1%,5%, and 10% level.

7 Conclusions

This paper examines the effects of capital controls on misallocation and welfare through the lens of a dynamic general equilibrium model with heterogeneous firms, monopolistic competition, endogenous participation in external trade and financial frictions. The focus is on comparing stationary equilibria between an economy already distorted by collateral constraints and one in which capital controls are introduced. The episode of the Chilean *encaje* (an unremunerated reserve requirement imposed between 1991 and 1998) is used as a natural experiment for exploring the model's quantitative predictions and for conducting empirical analysis.

In the model, capital controls affect misallocation via three effects: Static effects (i.e., keeping net worth and aggregate variables unchanged) that unambiguously worsen misallocation by tightening the firms' financial constraints, which increase their MRPKs as their capital-labor ratios fall and their prices rise; dynamic effects that weaken misallocation as tighter financial constraints incentivize firms to accumulate net worth faster, and thus spend less time at points in which misallocation is large; and general equilibrium effects due to changes in wages, aggregate output and the price of final goods that can go in different directions. Moreover, the static effects of capital controls on misallocation differ from the effects of collateral constraints in that they do not weaken monotonically as net worth rises. Instead, the effects are irrelevant for firms with either little net worth (or very young) and for firms with enough net worth (or old enough) to be close to reaching their optimal scale than for firms in between. This occurs because the capital controls effectively make the severity of financial frictions vary with firm size.

The model's quantitative predictions are examined using a calibration to Chilean data from before the *encaje* period and then comparing the resulting stationary equilibrium with the one produced by adding a debt-tax-equivalent of the *encaje*. The model predicts that capital controls worsened aggregate misallocation by about 0.5pp, with much larger effects for exporters (1.25pp) and larger effects also for firms with high productivity or large optimal scale gaps. Exports and the share of firms that are exporters also fall, and strong general equilibrium effects result in sizable drops in real wages and aggregate output. Misallocation effects across firms of different productivity displays the non-monotonic pattern of the static effects, increasing first gradually and then rapidly as firms age and then falling gradually until they vanish as firms reach their optimal scale.

The welfare implications are significant. The model predicts that the *encaje* reduced social welfare by 2/3rds of a percent, in terms of a compensating variation in permanent consumption across all entrepreneurs that equates utilitarian social welfare with and without capital controls. Welfare losses are much larger for exporters (1.82%). The non-monotonic misallocation effects across firms, an endogenous delay in the decision to start exporting, and sizable general equilibrium effects on real wages and output, play a key role in these findings and induce significant heterogeneity in welfare effects. Entrepreneurs that rely mostly on labor income are hurt by the fall in real wages without being affected much by misallocation. Those with some capital income but weak misallocation effects suffer less than them because the fall in wages also pushes up their profits and their misallocation is not large enough to undo this gain. But those with large misallocation are hurt the most because their profits shrink as the large misallocation outweighs the benefit of lower wage costs, and their labor income falls too.

A counterfactual experiment with debt taxes set at the average level predicted by the literature on optimal macroprudential capital controls yields significantly larger misallocation effects and welfare losses. In contrast, a second experiment in which LTV regulation (i.e., a cut in the fraction of capital pledgeable as collateral) is used to reduce the credit-value added ratio by the same amount as capital controls shows that LTV regulation is a far superior policy. It has much weaker effects on misallocation and a third of the social welfare cost. This is because LTV regulation distributes more evenly the burden of reducing credit across firms, whereas the CCs affect disproportionally more indebted firms with intermediate levels of net worth.

We also conduct a detailed cross-sectional empirical analysis using a large firm-level dataset for the Chilean manufacturing sector. The results provide strong and robust evidence indicating that, in line with the model's quantitative predictions, the Chilean *encaje* increased misallocation more for firms that were more productive, for exporters and for those with larger optimal scale gaps. Moreover, in line with the non-linearities predicted by the model, the misallocation effects of capital controls as productivity increases are weaker for exporters than non-exporters.

The findings of this paper have implications beyond capital controls. The model's theoretical predictions apply to the broader question of the effects of financial repression (i.e., situations in which borrowing and lending rates differ), capital income taxation and the effects of size-dependent industrial policies. The analysis also sheds light on the misallocation, trade and real-exchange-rate implications of altering the degree of financial openness in an economy.

References

ALFARO, L., A. CHARI AND F. KANCZUK, "The real effects of capital controls: Firm-level evidence from a policy experiment," *Journal of International Economics* 108 (2017), 191–210.

ANDREASEN, E., S. BAUDUCCO AND E. DARDATI, "Capital controls and firm performance," Mimeo, 2022.

ASRIYAN, V., L. LAEVEN, A. MARTIN, A. V. DER GHOTE AND V. VANASCO, "Falling Interest Rates and Credit Reallocation: Lessons from General Equilibrium," Working Paper 1268, Barcelona School of Economics, July 2021.

ATES, S. T. AND F. E. SAFFIE, "Fewer but Better: Sudden Stops, Firm Entry, and Financial Selection," *American Economic Journal: Macroeconomics* 13 (July 2021), 304–56.

BAI, Y., K. JIN AND D. LU, "Misallocation Under Trade Liberalization," NBER Working Papers 26188, National Bureau of Economic Research, Inc, August 2019.

BEKAERT, G., C. HARVEY AND C. LUNDBLAD, "Financial openness and productivity," *World Development* 39 (2011), 1–19.

BERTHOU, A., J. J.-H. CHUNG, K. MANOVA AND C. S. D. BRAGARD, "Trade, productivity and (mis)allocation," CEP Discussion Papers dp1668, Centre for Economic Performance, LSE, January 2020.

BIANCHI, J., "Overborrowing and systemic externalities in the business cycle," *American Economic Review* 101 (2011), 3400–3426.

BIANCHI, J., C. LIU AND E. G. MENDOZA, "Fundamentals News, Global Liquidity and Macroprudential Policy," *Journal of International Economics* 99 (2016), S2–15.

BIANCHI, J. AND E. MENDOZA, "Optimal Time-Consistent Macroprudential Policy," *Journal of Political Economy* 126 (2018), 588–634.

———, "A Fisherian approach to financial crises: Lessons from the Sudden Stops literature," *Review of Economic Dynamics* 37 (2020), S524–283.

BROOKS, W. AND A. DOVIS, "Credit market frictions and trade liberalizations," *Journal of Monetary Economics* 111 (2020), 32–47.

Buera, F., J. Kaboski and Y. Shin, “Finance and development: a tale of two sectors,” *American Economic Review* 101 (2011), 1964–2002.

Buera, F. and B. Moll, “Aggregate implications of a credit crunch: the importance of heterogeneity,” *American Economic Journal: Macroeconomics* 7 (2015), 1–42.

Cavalcanti, T. V., J. P. Kaboski, B. S. Martins and C. Santos, “Dispersion in Financing Costs and Development,” Working Paper 28635, National Bureau of Economic Research, April 2021.

Chen, K. and A. Irarrázabal, “The role of allocative efficiency in a decade of recovery,” *Review of Economic Dynamics* 18 (2015), 523–550.

Darracq-Paries, M., S. Fahr and C. Kok, “Macroprudential space and current policy trade-offs in the euro area,” in *Financial Stability Review* (European Central Bank, 2019).

De Gregorio, J., S. Edwards and R. Valdés, “Controls on capital inflows: do they work?,” *Journal of Development Economics* (2000).

Finlay, J., “Exporters, Credit Constrains, and Misallocation,” Mimeo, 2021.

Forbes, K., “One cost of the Chilean capital controls: Increased financial constraints for smaller traded firms,” *Journal of International Economics* 71 (2007), 294–323.

Gopinath, G., S. Kalemni-Ozcan, L. Karabarbounis and C. Villegas-Sanchez, “Capital allocation and productivity in South Europe,” *Quarterly Journal of Economics* 132 (2017), 1915–1967.

Guner, N., G. Ventura and Y. Xu, “Macroeconomic Implications of Size- Dependent Policies,,” *Review of Economic Dynamics* 11 (2008), 721–734.

Hernandez, J. and E. Mendoza, “Optimal v. Simple Financial Policy Rules in a Production Economy,” *Ensayos Sobre Politica Economica* 35 (2017), 25–39.

Hsieh, C.-T. and P. J. Klenow, “Misallocation and Manufacturing TFP in China and India,” *The Quarterly Journal of Economics* 124 (2009), 1403–1448.

Larraín, M. and S. Stumpner, “Capital account liberalization and aggregate productivity: The role of firm allocation,” *The Journal of Finance* 72 (2017), 1825–1858.

Leibovici, F., “Financial development and international trade,” Mimeo, 2021.

Levinsohn, J. and A. Petrin, "Estimating Production Functions Using Inputs to Control for Unobservables," *Review of Economic Studies* (2003).

Midrigan, V. and D. Y. Xu, "Finance and misallocation: evidence from plant-level data," *American Economic Review* 104(2) (2014), 422–458.

Miranda, M. J. and P. L. Fackler, *Applied Computational Economics and Finance* (MIT Press, 2004).

Muuls, M., "Exporters, Importers and Credit Constraints," *Journal of International Economics* 95 (2015), 333–343.

Oberfield, E., "Productivity and Misallocation During a Crisis: Evidence from the Chilean Crisis of 1982," *Review of Economic Dynamics* 16 (January 2013), 100–119.

Restuccia, D. and R. Rogerson, "Policy distortions and aggregate productivity with heterogeneous establishments," *Review of Economic Dynamics* 11 (2008), 707–720.

Simonovska, I. and M. E. Waugh, "The elasticity of trade: Estimates and evidence," *Journal of International Economics* 92 (2014), 34–50.

Varela, L., "Reallocation, Competition and Productivity: Evidence from a Financial Liberalization Episode," *Review of Economic Studies* 85 (2017), 1279–1313.

Wooldridge, J. M., "On estimating firm-level production functions using proxy variables to control for unobservables," *Economics Letters* 104 (September 2009), 112–114.

Appendix

A The Chilean "encaje" of the 1990s

The resumption of capital flows to emerging market economies after the Latin American debt crisis of the 1980s led to a surge in inflows into Chile that 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. This capital control was an obligation to hold at the central bank an unremunerated fixed-term reserve deposit for a fraction of the capital that a private entity was bringing into the country. Hence, it was analogous to a tax per unit of time that declined with the permanence or maturity of the affected capital inflow (see Appendix A.1 for a detailed derivation of the equivalent tax rate).[45]

We focus our analysis on the *Chilean encaje* because it provides a useful laboratory for exploring the firm-and industry-level consequences of CCs for several reasons. First, the *Chilean encaje* was one of the most well-known examples of market-based capital controls, –i.e. reserve requirements, as opposed to administrative controls with which the authority limits some specific assets, and the market is not allowed to operate. During the 2000s, many countries, such as Colombia, Thailand, Peru and Uruguay, imposed CCs with similar features. 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)).[46] Finally, the CCs period in Chile was long enough to generate sufficient variation in the data to conduct the empirical analysis and to calibrate the model for the quantitative analysis. As Table A.1 shows, various features of the *Chilean encaje* were altered during its existence. These modifications, together with changes in the foreign interest rate, generated significant variability on the effective cost, or tax-rate-equivalent, of the CCs over time.

[45]The equivalence with a debt tax can also be interpreted as if foreign investors were required to pay the central bank an up-front fee for borrowing from abroad, instead of making the unremunerated reserve deposit.

[46]In terms of the macroeconomic effects of Chilean *encaje*, 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.

Table A.1: 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).

A.1 Tax-equivalent of the Chilean *encaje*

Intuitively, capital controls alter the effective interest rate faced by domestic private agents abroad, 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^*. But, if they want to borrow, the effective interest rate they face is higher and given by $r^* + \nu$, where ν is the tax-equivalent of the CC for funds borrowed with a g-months maturity. The methodology we describe below, based on the work of De Gregorio et al. (2000), constructs an estimate of ν derived from a no-arbitrage condition that factors in the requirement to make the reserve deposit at the central bank.

To compute ν, we first define r_g as the annual risk-fee return that funds borrowed for g-months invested in Chile need to yield in order for an investor to make zero profits: $r_g = r^* + \nu$. Let u be the fraction of a foreign loan that an investor has to leave as an unremunerated reserve deposit and h the period of time that this deposit must be kept at the Central Bank. Then, if the investment period is shorter than the maturity of the deposit–, i.e., $g < h$–, borrowing one dollar abroad at an annual rate of r^* to invest at an annual rate r_g in Chile for g months generates the following cash flows:

1. At $t = 0$, the entrepreneur can invest $(1 - u)$ at r_g.

2. At $t = g$, repaying the foreign loan implies the following cash flow: $-(1 + r^*)^{g/12}$.

3. At $t = h$, the reserve requirement is returned generating a cash flow u.

Because of arbitrage, it follows that r_g must be a rate such that the investor is indifferent between investing at home and abroad (computing all values as of time h, when u is returned):

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

Since $r_g = r^* + \nu$, we can use this expression to solve for ν as the value that satisfies:

$$(1 + r^* + \nu)^{g/12} = \frac{(1 + r^*)^{g/12} - u(1 + r^*)^{(g-h)/12}}{1 - u}$$

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 of the unremenurated reserve requirement is found by solving the following linear equation for ν:

$$1 + gr^* - u(1 + (g - h)r^*) = (1 - u)(1 + g(r^* + \nu)),$$

which yields:

$$\nu = r^* \frac{u}{1 - u} \frac{h}{g}. \tag{A.1}$$

Based on the above description, computing ν requires data on the evolution of the reserve requirement (the value of u) and the length of the holding period for which the reserves had to remain at the central bank (h). These are reported in Table A.1. We also need a proxy for the risk-free interest rate at which the borrowed funds could have been invested abroad r^*, for which we used the value used in the calibration of Section 5 of the paper and a value for the targeted maturity of the funds invested in Chile g, for which we used 12 months.

B Solution Method

To solve for the model's recursive stationary equilibrium, we solve for aggregate prices $\{w, p\}$, final goods output $\{y\}$, entrepreneurs' decision rules $\{c'(\tau, z), a'(\tau, z), n'(\tau, z), \tilde{m}'(\tau, z), p'_h(\tau, z), p'_f(\tau, z), y'_h(\tau, z), y'_f(\tau, z), d'(\tau, z), k'(\tau, z), e(\tau, z)\}$, lump-sum taxes $T(z)$, and value functions $v(\tau, z)$, $v^{NE}(\tau, z), v^S(\tau, z), v^E(\tau, z)$ such that equilibrium conditions (1)–(5) of Section 3.4 hold.

The productivity process $f(z)$ is discretized by means of a Gauss-Hermite quadrature algorithm. We include $n_z = 10$ nodes and use the QWLOGN algorithm from Miranda and Fackler (2004). To solve the second-stage problems of exporters, non-exporters and switchers, we use analytic solutions.[47] The first-stage problems of exporters and switchers are solved using the endogenous grids method (EGM) proposed by Carroll (2006), and for non-exporters we use the discrete-choice augmented version of EGM developed by Iskhakov et al. (2017). The algorithm exploits the fact that the entrepreneurs' problems are effectively deterministic. Two properties of the model yield this outcome. First, productivity is stochastic only when firms are born, and is observed before they make their first-period decisions. Second, the Blanchard-Yaari OLG structure includes an insurance environment that allows entrepreneurs to perfectly diversify this risk.

The algorithm is as follows:

1. Initialize aggregate quantities and prices (w, p, y).

2. Given a guess for (w, p, y), solve the entrepreneur's problem for each $z \in Z$ as follows:

   (a) Initialize the entrepreneur's steady-state exporting status to $\overline{e}(z) = 1$ if $z > \hat{z}$ and $\overline{e}(z) = 0$ otherwise, where $\hat{z}$ is a guess for the highest z such that all entrepreneurs with productivity $\hat{z}$ are non-exporters for all relevant m.[48]

   (b) Given $\overline{e}(z)$, compute steady-state capital $\overline{k}(z)$, capital endowments for newborn firms $\underline{k}(z) = \kappa\overline{k}(z)$, and lump-sum taxes $T(z)$ that balance the government budget $T(z) = \rho p\underline{k}(z)$.

   (c) Define grids for future net-worth $a'_\vartheta(z)$ for each exporting state $\vartheta \in \Theta$[49,50] and compute

[47]Note that the FOCs yield analytic expressions in all regions for the benchmark ALCC case. For region 1 in the ELCC case, where this is not the case, we solve for the capital policy function $k'(\tau, z)$ using Newton's method.

[48]Note that low productivity entrepreneurs can be ruled out from exporting if they cannot afford the exporting fixed-cost in a non-exporting steady-state, that is, $\overline{e}(z) = 0$ when $\overline{m}_N(z) - (1-\rho)\overline{a}_N(z) < \frac{w}{p}F$.

[49]$\vartheta \in \Theta \equiv \{E, S, N\}$ denotes the entrepreneur's exporting-state—respectively exporters, switchers, and non-exporters—and $\mathbb{1}_S(\vartheta)$ denotes an indicator function for switching. Since exporting is irreversible and delayed by one period, the entrepreneur's exporting-state ϑ is described by: $\vartheta_t = E$ if $e_t = 1$; $\vartheta_t = S$ if $e_t = 0$ and $e_{t+1} = 1$; and $\vartheta_t = N$ otherwise.

[50]We define equally spaced grids $A'_\vartheta(z)$ over $[\kappa_0\underline{k}(z), \kappa_1\overline{a}_\vartheta(z)]$, where $\overline{a}_\vartheta(z)$ denotes the 2nd-stage policy functions'

the associated 2nd-stage grids for cash-on-hand $\widetilde{m}'_\vartheta(a', z)$; debt $d'_\vartheta(a', z)$; and collateral- and debt- constraint multipliers—$\eta'_\vartheta(a', z)$ and $\mu'_\vartheta(a', z)$—using the FOCs.

(d) Given grids $a'_\vartheta(z)$, $\widetilde{m}'_\vartheta(a', z)$, $d'_\vartheta(a', z)$, $\eta'_\vartheta(a', z)$, and $\mu'_\vartheta(a', z)$ for $\vartheta \in \Theta$:[51]

i. Solve for $a'_E(m, z)$ and $c_E(m, z)$ using the EGM to iterate on the 1st-stage exporter's Euler-equation. Compute the exporter's value function $v^E(m, z)$ through iteration on the converged policy functions.

ii. Given $a'_E(m, z)$, solve for $a'_S(m, z)$ and $c_S(m, z)$ using the EGM on the switcher's 1st-stage Euler-equation. Compute the switcher's value function $v^S(m, z)$ using $v^E(m, s)$ and these policy functions.

iii. Given $a'_S(m, z)$ and $v^S(m, z)$, solve for $a'_N(m, z)$, $c_N(m, z)$, $e'_N(m, z)$, and $v^N(m, z)$ by applying the DC-EGM to the non-exporter's 1st-stage Euler-equation iteration, and compute the cash-on-hand switching threshold $\widehat{m}(z)$ given by $v^S(\widehat{m}, z) > v^N(\widehat{m}, z)$.

(e) Given $k_0(z) = \underline{k}(z), T(z)$, and $\widehat{m}(z)$, solve the entrepreneur's initial life-cycle states: compute the newborn firm's cash on hand $m_0(z) = \underline{m}(z)$ and determine the initial exporting state $\underline{\vartheta}(z)$ using the switching threshold $\widehat{m}(z)$.

(f) Given initial states $m_0(z) = \underline{m}(z)$ and $\vartheta_0(z) = \underline{\vartheta}(z)$; policy functions $\{a'_\vartheta(m, z), m'_\vartheta(a', z)\}_{\vartheta \in \Theta}$; and the switching threshold $\widehat{m}(z)$, map the solutions obtained for the state space (m, z, e) into (τ, z) by recursive substitution as follows: When a firm is born ($\tau = 0$), its choices are given by $a'(0, z) = a'(\underline{m}(z), z)$ and $m'(0, z) = m'(a'(0, z), z)$, respectively. Its choices at age 1 are therefore $a'(1, z) = a'(m'(0, z), z)$ and $m'(1, z) = m'(a'(1, z), z)$. Hence, for any age τ the firm's choices are $a'(\tau, z) = a'(m'(\tau - 1, z), z)$ and $m(\tau, z) = m'(a'(\tau, z), z)$. For $0 \leq \tau < \hat{\tau}(\hat{m}(z))$, use the non-exporter's decision rules, for $\tau = \hat{\tau}(\hat{m}(z))$, use the switcher's, and for $\tau > \hat{\tau}(\hat{m}(z))$, use the exporter's.

(g) If $e(T + 1, z) = 0$, update $\bar{e}(z) = 0$ and return to step 2b.

3. Construct the following system of equations $\mathbf{h}(w, p, y) = \epsilon$ by using the market-clearing conditions of the problem:

$$\sum_\tau \sum_z n(\tau, z)\phi(\tau, z) + F \sum_z \hat{\tau}(\hat{m}(z)) f(z) - 1 = \epsilon_1,$$

steady-state kink conditional on exporting state $\vartheta \in \Theta$, $0 < \kappa_0 < 1$ and $\kappa_1 > 1$. In most applications we use $n_{a'} = 20.000$ points and set $\kappa_0 = 0.75$ and $\kappa_1 = 1.25$.

[51]The net-worth policy functions $a'_\vartheta(m, z)$ are linearly interpolated and extrapolated, and the value functions $v^\vartheta(m, z)$ are interpolated linearly and extrapolated using cubic splines where needed.

$$\sum_{\tau}\sum_{z}[c(\tau,z)+\rho\underline{k}(z)+x(\tau,z)]\phi(\tau,z)-y=\epsilon_2,$$

where $c(\tau,z)=m(\tau,z)-(1-\rho)a'(\tau,z)-\mathbb{1}_{\tau=\hat{\tau}(\hat{m}(z))}wF$ and $x(\tau,z)=(1-\rho)k'(\tau,z)-(1-\delta)k(\tau,z)$, and

$$\left[\sum_{\tau}[y_h(\tau,z)^{\frac{\sigma-1}{\sigma}}]\phi(\tau,z)+y_m^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}-y=\epsilon_3.$$

4. Solve for $\mathbf{h}(w,p,y)\approx\mathbf{0}$ using Broyden's method, where the convergence criterion is set such that $|\epsilon|\leq 1e-12$.

5. Check for convergence of the guess (w,p,y) used in Step 2 and the solutions from Step 4. If convergence fails, update the guess and return to Step 2.

C Marginal Revenue Products

A firm's revenue is defined by the value of its sales: $RV\equiv p_h y_h+p_f y_f$. Hence, the MRPs of labor and capital are given by $MRPN\equiv\delta RV/\delta n$ and $MRPK\equiv\delta RV/\delta k$, respectively. The results for the two MRPs used in conditions (15) and (16) are obtained as follows.

First, taking derivatives of RV with respect to n and k, we obtain:

$$MRPN=[p_h+y_h(\delta p_h/\delta y_h)](\delta y_h/\delta n)+[p_f+y_f(\delta p_f/\delta y_f)](\delta y_f/\delta n) \tag{C.1}$$

$$MRPK=[p_h+y_h(\delta p_h/\delta y_h)](\delta y_h/\delta k)+[p_f+y_f(\delta p_f/\delta y_f)](\delta y_f/\delta k) \tag{C.2}$$

Solving the demand functions faced by the entrepreneur (2)-(3) for p_h and p_f, respectively, yields $p_h=(y_h/y)^{-1/\sigma}p$ and $p_f=(y_f/y^*)^{-1/\sigma}p^*$, and from these expressions we obtain:

$$\frac{\delta p_h}{\delta y_h}=\frac{-1}{\sigma}\left(\frac{y_h}{y}\right)^{-(\frac{1}{\sigma})-1}\frac{p}{y},\qquad\frac{\delta p_f}{\delta y_f}=\frac{-1}{\sigma}\left(\frac{y_f}{y^*}\right)^{-(\frac{1}{\sigma})-1}\frac{p^*}{y^*},$$

which multipliying by y_h and y_f, respectively, and simplifying yields:

$$\frac{\delta p_h}{\delta y_h}=\frac{-p_h}{\sigma},\qquad\frac{\delta p_f}{\delta y_f}=\frac{-p_f}{\sigma},$$

Substituting these expressions into (C.1)-(C.2) and simplifying using the equilibrium condition

$p_f = \zeta p_h$ we obtain:

$$MRPN = \frac{p_h}{\varsigma}\left(\frac{\delta y_h}{\delta n} + \zeta \frac{\delta y_f}{\delta n}\right), \qquad MRPK = \frac{p_h}{\varsigma}\left(\frac{\delta y_h}{\delta k} + \zeta \frac{\delta y_f}{\delta k}\right), \tag{C.3}$$

where, as defined in the paper, $\varsigma = \sigma/(\sigma - 1)$.

Now, differentiate the market-clearing condition $y_h + \zeta y_f = zk^\alpha n^{1-\alpha}$ with respect to n and with respect to k to obtain:

$$\frac{\delta y_h}{\delta n} + \zeta \frac{\delta y_f}{\delta n} = z(1-\alpha)\left(\frac{k}{n}\right)^\alpha, \qquad \frac{\delta y_h}{\delta k} + \zeta \frac{\delta y_f}{\delta k} = z\alpha\left(\frac{n}{k}\right)^{1-\alpha}$$

Substituting these results into those obtained in (C.3) yields the expressions used in conditions (15) and (16) of the paper:

$$MRPN = \frac{p_h}{\varsigma} z(1-\alpha)\left(\frac{k}{n}\right)^\alpha,$$
$$MRPK = \frac{p_h}{\varsigma} z\alpha\left(\frac{n}{k}\right)^{1-\alpha}.$$

D Social Planner's Problem

We analyze the optimization problem of a utilitarian social planner. For simplicity, and since the planner will remove the distortions resulting from monopolistic competition in the domestic markets of intermediate goods, we assume that the planner participates in export markets as a price-taker. In addition, since the entry cost to become an exporter is assumed to represent administrative costs, we assume that the planner incurs only the physical cost of exporting (i.e., the iceberg costs) but not the entry costs. These two assumptions are inessential for the main result of the planner's problem, namely that there is no misallocation in capital and labor across firms.

The social planner's optimization problem is:

$$\max_{c_{t,\tau}(z), k_{t+1,\tau}(z), y^h_{t,\tau}(z), n_{t,\tau}(z), y^m_t, D_{t+1}} \sum_{t=0}^{\infty} \beta^t \left[\sum_{\tau,z} u(c_{t,\tau}(z))\phi(\tau,z)\right] \tag{D.1}$$

subject to the following sequence of constraints for each $t = 0, ..., \infty$:

$$\sum_{\tau,z} \left[c_{t,\tau}(z) + k_{t+1,\tau}(z) - (1-\delta)k_{t,\tau}(z)\right]\phi(\tau,z) + \rho\sum_{z}\underline{k}_0(z) = \left[\sum_{\tau,z} y^h_{t,\tau}(z)^{\frac{\sigma-1}{\sigma}}\phi(\tau,z) + y_{m,t}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \quad \text{(D.2)}$$

$$\sum_{\tau,z} n_{t,\tau}(z)\phi(\tau,z) = 1, \quad \text{(D.3)}$$

$$\sum_{\tau,z} \frac{\eta^f(z)}{\zeta}\left[zk_{t,\tau}(z)^{\alpha}n_{t,\tau}(z)^{1-\alpha} - y^h_{t,\tau}(z)\right]\phi(\tau,z) - \eta^m y^m_t = D_t - qD_{t+1}, \quad \text{(D.4)}$$

where t denotes the time period, τ the age of an agent and z the agent's productivity draw at birth. D_{t+1} denotes the planner's external borrowing (notice the planner is assumed not to face credit constraints) and $\eta^f(z)$ and η^m are the world-determined relative prices in units of final goods at which the planner exports the domestic input varieties and imports foreign inputs, respectively (recall also that the debt is denominated in units of final goods).

Constraint (D.2) is the economy's resource constraint in final goods and carries the Lagrange multiplier λ^{SP}_t. Since there is no world trade in final goods, all domestic production is absorbed by domestic consumption, domestic investment and the planner's allocations of initial capital to newborn firms. Constraint (D.3) is the aggregate labor resource constraint with multiplier ω^{SP}_t. Constraint (D.4) is the external resource constraint (with multiplier ψ^{SP}_t), which equates the trade balance (exports minus imports of intermediate goods) with the change in the external debt position net of interest. In this constraint, the technological constraint on production of each input ($y^h_{t,\tau}(z) + \zeta y^f_{t,\tau}(z) = zk_{t,\tau}(z)^{\alpha}n_{t,\tau}(z)^{1-\alpha}$) has been used to substitute for exports of domestically-produced inputs ($y^f_{t,\tau}(z)$).

The first-order conditions of the planner's problem at each date t are:

$$\lambda_t = u'(c_{t,\tau}(z)), \quad \text{(D.5)}$$

$$\frac{\lambda_t}{\psi_t} = \frac{\eta^f(z)}{\zeta}\left[\frac{y^h_{t,\tau}(z)}{y_t}\right]^{1/\sigma}, \quad \text{(D.6)}$$

$$\frac{\lambda_t}{\psi_t} = \eta^m\left[\frac{y^m_t}{y_t}\right]^{1/\sigma}, \quad \text{(D.7)}$$

$$\psi_t \frac{\eta^f(z)}{\zeta}(1-\alpha) z k_{t,\tau}(z)^{\alpha} n_{t,\tau}(z)^{-\alpha} = \omega_t, \tag{D.8}$$

$$\lambda_t = \beta \lambda_{t+1} \left[(1-\delta) + \frac{\psi_{t+1}}{\lambda_{t+1}} \frac{\eta^f(z)}{\zeta} \alpha z k_{t+1,\tau}(z)^{\alpha-1} n_{t+1,\tau}(z)^{1-\alpha} \right], \tag{D.9}$$

$$\psi_t = \beta R \psi_{t+1}. \tag{D.10}$$

Conditions (D.5), (D.8) and (D.9) have three important implications. First, it is evident from (D.5) that, at any date t, the planner allocates the same consumption to all agents, regardless of their age and productivity. Second, (D.8) and (D.9) imply that, also at any date t, there is no misallocation in labor and capital (the returns in units of final goods are equalized acroos all firms). To see this, use conditions (D.6), (D.8) and (D.9) to obtain these results:

$$\left[\frac{y^h_{t,\tau}(z)}{y_t} \right]^{-1/\sigma} (1-\alpha) z k_{t,\tau}(z)^{\alpha} n_{t,\tau}(z)^{-\alpha} = \frac{\omega_t}{\lambda_t},$$

$$\left[\frac{y^h_{t+1,\tau}(z)}{y_t} \right]^{-1/\sigma} \alpha z k_{t+1,\tau}(z)^{\alpha-1} n_{t+1,\tau}(z)^{1-\alpha} = \frac{\lambda_t}{\beta \lambda_{t+1}} - 1 + \delta.$$

Moreover, these real returns are the same as the marginal revenue products of labor and capital under perfect competition. Recall that the demand functions for each input are given by $y^h_{t,\tau}(z) = \left[\frac{p^h_{t,\tau}(z)}{p_t} \right]^{-\sigma} y_t$, hence $\left[\frac{y^h_{t,\tau}(z)}{y_t} \right]^{-1/\sigma} = \frac{p^h_{t,\tau}(z)}{p_t}$, so the above results reduce to:

$$p^h_{t,\tau}(z)(1-\alpha) z k_{t,\tau}(z)^{\alpha} n_{t,\tau}(z)^{-\alpha} = \frac{\omega_t}{\lambda_t} p_t,$$

$$p^h_{t+1,\tau}(z) \alpha z k_{t+1,\tau}(z)^{\alpha-1} n_{t+1,\tau}(z)^{1-\alpha} = \left[\frac{\lambda_t}{\beta \lambda_{t+1}} - 1 + \delta \right] p_{t+1}.$$

The left-hand-sides of these expressions correspond to the marginal revenue products of labor and capital, respectively, as the solution of the monopolistic competition setup converges to perfect competition (i.e., as $\sigma \to \infty$). In addition, the planner's shadow value of final goods λ_t should match p_t and the shadow value of labor ω_t should match the wage w_t in the competitive equilibrium without distortions.

So far, we have established that the social planner's allocations support zero consumption dispersion and zero labor and capital misallocation across firms of different age and productivity at any given date, and also that the MRPs will be the same as in the equilibrium without monopolistic competition. To prove Proposition 2, however, we still have to show that the planner's MRPs are constant over time and are the same as those of the decentralized equilibrium without financial frictions.

D.1 Proof of Proposition 2

Proposition 2 *If $\beta R = 1$, the marginal revenue products of capital and labor of the decentralized equilibrium without financial frictions (as $\sigma \to \infty$) match the efficient real returns on capital and labor attained by a utilitarian social planner free of financial frictions. These MRPs are time-invariant, constant across firms regardless of age and productivity, and MRPK equals $p(r+\delta)$.*

Proof. To prove this proposition, we assume that (a) the initial capital allocations $\underline{k}_0(z)$ are the same in the decentralized equilibrium and the planner's problem and (b) the exogenous world relative prices in units of final goods faced by the planner ($\eta^f(z)$ and η^m) are constant over time (since we are interested in stationary equilibria) and across ages (since for given z all producers sell the same input variety) and also support internal solutions for $y^f_{t,\tau}(z)$ (these could be the competitive equilibrium prices as $\sigma \to \infty$ such that $\eta^f(z) = \zeta$).[52]

Since $\beta R = 1$, condition (D.10) implies that $\psi_t = \psi_{t+1} = \bar{\psi}$ (the shadow value of the balance-of-payments equilibrium condition is constant across time, age and productivity). Because final goods are not traded internationally, however, there is no direct arbitrage of the domestic marginal rate of substitution in consumption ($\lambda_t/\beta\lambda_{t+1}$) and the real interest rate R. But since the planner can borrow or save abroad to finance any gap between exports and imports of intermediate goods, there is an implicit no-arbitrage condition that follows from combining conditions (D.9) and (D.10), considering that $\psi_t = \bar{\psi}$ for all t:

$$\frac{\lambda_{t+1}}{\lambda_t}\left[\frac{\bar{\psi}\eta^f(z)}{\lambda_{t+1}\zeta}\alpha z k_{t+1,\tau}(z)^{\alpha-1} n_{t+1,\tau}(z)^{1-\alpha} + 1 - \delta\right] = R.$$

The term in the left-hand-side is the real return on investing capital to produce intermediate goods in units of final goods, which requires taking into account how the shadow value of final goods changes over time (λ_{t+1}/λ_t), and R in the right-hand-side is the opportunity cost in units of final goods.

Next we show that λ_t is also constant over time. First, note that conditions (D.6) and (D.7)

[52]This result follows from the fact that $\eta^f(z) \equiv p^f_{t,\tau}(z)/p$, $p^f(z) = \zeta p^h(z)$ and as $\sigma \to \infty$ $p^h(z) \to p$. Since it also follows that $p^f(z) \to p^*$, it is also true that $\eta^f(z) = p^*/p = \zeta$.

imply:

$$\frac{y^h_{t,\tau}(z)}{y^m_t} = \left[\frac{\eta^m \zeta}{\eta^f(z)}\right]^\sigma.$$

Then, factor out y^m_t from the CES production function of final goods to obtain

$$y_t = y^m_t \left[\sum_{\tau,z} \left(\frac{y^h_{t,\tau}(z)}{y^m_t}\right)^{\frac{\sigma-1}{\sigma}} \phi(\tau, z) + 1\right]^{\frac{\sigma}{\sigma-1}},$$

and then combine the two results to obtain:

$$\frac{y^m_t}{y_t} = \left[\sum_z \left(\frac{\eta^m \zeta}{\eta^f(z)}\right)^{\sigma-1} f(z) + 1\right]^{\frac{\sigma}{1-\sigma}}.$$

Hence, the ratio y_t/y^m_t is constant over time and then condition (D.7) yields:

$$\lambda_t = \bar{\psi}\eta^m \left[\sum_z \left(\frac{\eta^m \zeta}{\eta^f(z)}\right)^{\sigma-1} f(z) + 1\right]^{\frac{1}{1-\sigma}},$$

which implies that $\lambda_t = \bar{\lambda}$ for all t (with $\bar{\lambda}$ defined by the right-hand-side of the expression).

Since λ_t and ψ_t are constant, the no-arbitrage condition for returns on capital becomes:

$$\frac{\bar{\psi}\eta^f(z)}{\zeta} \alpha z k_{t+1,\tau}(z)^{\alpha-1} n_{t+1,\tau}(z)^{1-\alpha} = \bar{\lambda}(r + \delta),$$

and condition (D.8) can be rewritten as:

$$\frac{\bar{\psi}\eta^f(z)}{\zeta}(1-\alpha) z k_{t,\tau}(z)^\alpha n_{t,\tau}(z)^{-\alpha} = \omega_t.$$

Note that the no-arbitrage condition implies that capital-labor ratios do not vary with τ and t and the labor optimality condition implies that they cannot vary with z either (since the shadow value of labor is the same across firms). Hence, capital-labor ratios are constant over time, age and productivity. The planner's allocations move all firms to their optimal scales immediately. The common, time-invariant capital-labor ratio across firms of all ages and productivity is:

$$\overline{\left(\frac{k}{n}\right)} = \frac{\alpha}{1-\alpha} \frac{\omega}{\bar{\lambda}(r + \delta)}.$$

The above results match the marginal revenue product conditions of the decentralized equilibrium as it approaches the competitive equilibrium ($\sigma \to \infty$). In this case, the decentralized equilibrium is efficient, the planner's shadow values of final goods and trade in intermediate goods must satisfy $\bar{\lambda} = \bar{\psi} = p$, the shadow value of labor must satisfy $\omega = w$, and the relative prices of the planner's problem and the decentralized equilibrium must satisfy $\eta^f(z) = p^f(z)/p$, $\eta^m = p^m/p$, and $p^f(z) = \zeta p^h(z)$. Under these conditions, the above optimality conditions can be rewritten as follows:

$$p^h(z)\alpha z\left(\frac{\overline{k}}{n}\right)^{\alpha-1} = p(r+\delta),$$

$$p^h(z)(1-\alpha)z\left(\frac{\overline{k}}{n}\right)^{\alpha} = w.$$

Hence, without financial frictions, the planner's optimality conditions and those of the decentralized equilibrium as $\sigma \to \infty$ support the same conditions equating MRPN to w and MRPK to $p(r+\delta)$ in all periods and across firms of different age and productivity. □

E Earnings-based Collateral Constraint

In this Section of the Appendix we examine the implications of replacing the collateral constraint linked to assets (ALCC) $qd_{t+1} \leq \theta k_{t+1}$ with an earnings-linked collateral constraint (ELCC):

$$p_{t+1}qd_{t+1} \leq \theta(p_{h,t+1}y_{h,t+1} + p_{f,t+1}y_{f,t+1} - w_{t+1}n_{t+1}). \tag{E.1}$$

Intuitively, resources borrowed at t cannot exceed a fraction θ of the firm's profits at $t+1$, which represent the net resources available for repaying. Considering this alternative formulation of credit constraints is interesting because recent empirical and theoretical studies have emphasized the relevance of credit constraints linked to cash flow.[53] This formulation is also equivalent to one in which gross resources (sales) are collateral but a fraction θ of the wage bill is financed with working capital and both intertemporal debt and working capital financing are limited by the credit constraint ($qd_{t+1} + \theta w_t n_t \leq \theta(p_{h,t}y_{h,t} + p_{f,t}y_{f,t})$).

Introducing the ELCC requires replacing the ALCC with the ELCC in the the second-stage

[53] Lian and Ma (2020) show that about 80% of debt of U.S. non-financial firms is based on cash-flow constraints. Caglio et al. (2021) document a similar finding for SMEs. Drechsel (2022) and Li (2022) study the macroeconomic implications of these type of constraints.

optimization problem of entrepreneurs. For example, for a non-exporter, this problem becomes:

$$\tilde{m}'(a',z) = \max_{k',d',p'_h,n'} \left[\frac{w' + \frac{{p'}_h^{1-\sigma}}{p'^{-\sigma}} y' - w'n' + p'(1-\delta)k' - p'd' - T(z)}{p'} \right]$$

$$\text{s.t.} \qquad \left(\frac{p'_h}{p'}\right)^{-\sigma} y' = zk'^{\alpha} n'^{1-\alpha}$$

$$a' = k' - qd' \tag{E.2}$$

$$\hat{q}d' \leq \theta \left(\frac{{p'}_h^{1-\sigma}}{p'^{-\sigma}} y' - w'n' \right) / p' \tag{E.3}$$

$$q^* d' \leq 0$$

This formulation of the credit constraint alters the static effects on the determination of k' in region 1 of the capital decision rule of the second-stage optimization problem via two effects: First, an effect akin to lowering the fraction of pledgeable assets by the share of profits in the market value of capital (π/pk). Second, a non-linear feedback effect because that share is decreasing in k' itself. In particular, the mapping from a' to k' is no longer $k'(a') = a'/(1-\theta)$. Instead, $k'(a')$ solves this non-linear equation:

$$k' = \frac{a'}{1 - \theta \frac{\pi(k',z;w',p',y')}{p'k'}}, \tag{E.4}$$

where $\pi(k', z; w', p', y')$ is the entrepreneur's profit function.

The above result is derived as follows. First, using the definition of profits for a non-exporter, $\pi' = p'_h y'_h - w'n'$, and replacing it with the optimal demand function in monopolistic competition, $p'_h = p'(\frac{y'}{y'_h})^{\frac{1}{\sigma}}$, and expression $y'_h = zk'^{\alpha} n'^{(1-\alpha)}$, we get:

$$\pi'(k', z; w', p', y') = \tilde{p_{ne}}(p, y)(zk'^{\alpha} n'^{(1-\alpha)})^{\frac{\sigma-1}{\sigma}} - w'n'$$

where $\tilde{p_{ne}}(p, y) = p'y'^{\frac{1}{\sigma}}$. Then, assuming k' is set by the collateral constraint (E.3), we can re-write it as $\hat{q}d' = \theta\pi'(k', z; w', p', y')/p'$. Using this and condition (E.2) we obtain expression (E.4). Analogous for exporters, we can show that profits can be expressed as:

$$\pi'(k', z; w', p', y') = \tilde{p_e}(p, y) \left(zk'^{\alpha} n'^{(1-\alpha)}\right)^{\frac{\sigma-1}{\sigma}} - w'n' \tag{E.5}$$

where $\tilde{p_e}(p, y) = \left[p^{\sigma} y + \tau^{1-\sigma} p^{*\sigma} y^*\right]^{1/\sigma}$. Note that $\tilde{p_{ne}}$ and $\tilde{p_e}$ is a common price to all firms, as it is the price index of a firm's output of intermediate goods powered to $1 - 1/\sigma$.

In condition (E.4), the effect lowering the effective fraction of pledgeable assets is evident in that, for a given value of θ and since $0 < \pi'/p'k' < 1$, region 1 in the ELCC case is analogous to that of the ALCC but with θ reduced by the fraction $\pi'/p'k'$. The nonlinear effect follows from the fact that $\pi\left(k', z; w', p', y'\right)/k'$ is decreasing in k' so that as k' grows the constraint tightens endogenously, in the sense that a given a' yields a smaller k'.[54] It is also possible to show that this effect depends on the degree of monopolistic competition. In the limit under perfect competition, as $\sigma \to \infty$, it vanishes because profits become linear in capital (as in Buera and Moll (2015)) and hence $\pi\left(k', z; w', p', y'\right)/k'$ becomes independent of k'. Still, the first effect reducing the share of pledgeable assets remains.

Note two important properties of the capital decision rule in region 1 of the ELCC relative to the ALCC: First, in the ELCC, the coefficient of the decision rule depends on the full model solution (i.e. it responds to general equilibrium effects depending on how CCs affect (w, p, y) and hence profits). Second, since the NCC and CC regimes have different (w, p, y), the region-1 decision rules are no longer the same at equilibrium (keeping (w, p, y) they are still the same).

The ELCC and ALCC also differ in their normative implications. The ELCC embodies pecuniary and non-pecuniary externalities by which individual firms do not internalize the effect of their borrowing decisions on aggregate variables (p, w, y) that alter borrowing capacity by affecting profits when the constraint binds. In contrast, the ALCC is not affected by externalities. The analysis of these externalities is an important topic for future research.

Switching collateral constraints also alters the dynamic and GE effects. The assets- and earnings-linked collateral constraints have different static effects because of how the latter alters the mapping from a' to k' in region 1, as explained above, and these differences affect dynamic and static effects. Changes in the tightness of the collateral constraint of firms in region 1 alter savings incentives and thus the rate at which firms grow their net worth and the time they spend in each of the different regions. The resulting changes in the stationary distribution of firms affect aggregate demand for goods and labor and thus change the GE effects on w, p, y, which affect the magnitude of misallocation and OSGs in each region.

In terms of how changing collateral constraints affects the effects of CCs (namely, how it

[54]It can be shown that the ratio of profits to capital can be expressed as $\frac{\pi(k,z;w,p,y)}{k} = \left[\frac{\varsigma}{1-\alpha} - 1\right]\left[\frac{1-\alpha}{\varsigma}\right]^{\frac{\sigma}{1+\alpha(\sigma-1)}}\left[\frac{z}{w^{1-\alpha}}\right]^{\frac{\sigma-1}{1+\alpha(\sigma-1)}}\frac{\tilde{p}_e^{\frac{\sigma}{1+\alpha(\sigma-1)}}}{(k)^{\frac{1}{1+\alpha(\sigma-1)}}}$. This expression is obtained using the first-order condition for labor from (E.5) so we get $(1-\alpha)(\frac{\sigma-1}{\sigma})\tilde{p}_e(y_h + \tau y_f) = wn$. Replacing this last equation into the profit function we get $\hat{\pi} = \tilde{p}_e(zk^\alpha n^{1-\alpha})^{\frac{\sigma-1}{\sigma}}\left(1 - (1-\alpha)\frac{1}{\varsigma}\right)$. Finally, replacing the optimal labor demand function we get the profits to capital expression as shown above. Detailed notes of this derivation are upon request.

affects the comparison across NCC and CC regimes, instead of just comparing ELCC v. ALCC for a given regime), in partial equilibrium and using the same parameter values for the ELCC and ALCC solutions, CCs have *weaker* static effects with the ELCC than the ALCC. The region-1 ray from the origin is flatter with ELCC than ALCC at the same θ, because the ELCC's reduction in the effective fraction of capital pledgeable as collateral reduces the amount of k' that a given a' can sustain. But this flatter ray is the same for both NCC and CC regimes. Since the other regions are unchanged, it follows from visualizing the effect of making region 1 flatter in Figure 1, that the area where k' is lower under CC than NCC shrinks and in the new area there is a range of values of a' for which the difference in capital stocks (and hence in MRPKs) is smaller with $ELCC$ than it was in the original area obtained with the $ALCC$. Hence, with the same calibration and considering only static effects at common (w, y, p), the model with the ELCC yields smaller static misallocation effects than the ALCC. In the full numerical solution the effects may be even weaker or could be stronger, because changes in (w, y, p) yield differences in the region-1 decision rules under the each collateral constraint, and because those differences alter dynamic effects too.

The comparison across collateral constraints also needs to consider that the ELCC model ought to be calibrated to the same data targets as the ALCC, and hence the two model calibrations would differ. This re-calibration may in fact offset part of the reduction in effective pledgeable capital that we explained above under the assumption of the same θ for ELCC and ALCC, thus pushing in the direction of making the results of the two collateral constraints more similar. This is because the ELCC needs to match the same 15-percent credit-GDP ratio as the ALCC, but since the reduction in effective pledgeable capital implies that in the NCC there is less credit with ELCC than ALCC at the same θ of the ALCC benchmark calibration, the ELCC asks for a higher θ to compensate and hit the 15-percent credit ratio target. The NCC static capital decision rules are $k' = a'/(1-\theta)$ in the ALCC and $k' = a'/[1-\theta^{ELCC}\pi(\cdot)/p'k']$ in the ELCC, and θ and θ^{ELCC} both need to support the same 15-percent aggregate credit-gdp ratio. Since $\pi(\cdot)/p'k'$ is endogenous and varies with k', the θ^{ELCC} that does this cannot be solved by just setting it so that $\theta = \theta^{ELCC}\pi(\cdot)/p'k'$. This would work under perfect competition (and partial equilibrium), because $\pi(\cdot)/p'k'$ is independent of k' and becomes a constant that depends on other parameters. But with monopolistic competition every firm would need a different θ^{ELCC} to satisfy that condition at the same θ of the ALCC.

The quantitative analysis shows that, using the same benchmark calibration and just swapping the ALCC for the ELCC, the model yields milder misallocation and welfare effects. This exercise yields a decrease in credit of 6pp, which turns out to be lower than in ALCC. Even if firms spend more time in region 2 and 3, this is not enough to compensate the static effects explained in the previous paragraph. On the other hand, recalibrating the ELCC model (instead of imposing the same calibration of the ALCC benchmark), produces quantitative results that are not very different from those of the ALCC, because the re-calibration requires a higher value of θ for the ELCC than the ALCC.

Table E.2 shows the calibration parameter values. Recalibrating the NCC regime for model with the ELCC requires re-setting θ to 0.3481. The rest of the parameters remain close to the benchmark case. Moreover, the model continues to replicate closely the calibration targets as shown in table (E.3). Table E.4 show the aggregate effect of the policy. Output, final good prices and wages fall by a 0.46%, 0.29% and 0.89%, respectively. Investment and consumption fall by 1.21% and 0.52%, respectively. Finally, exports falls by 0.86% and of exporters falls by 6.90%. These magnitudes are slightly higher than the benchmark case.

Column (1) of Table E.5 shows the effects of CCs on misallocation and welfare. In this specification, the transition of firms towards their optimal scales is shorter, which ensures that the CC policy affects credit more markedly and credit over value added decreases by $6.37pp$, around a 50% higher than before. As a result of the shorter transition, there is a larger mass of firms in regions 2 and 3 where the effects of CCs on misallocation are slightly stronger: aggregate misallocation increases by $0.67pp$. As in the benchmark case, the change in misallocation is heterogeneous on the firm's productivity, its exporter status and OSG. The results are similar to the previous model in qualitative terms, although the effects are in general slightly higher.

Welfare losses are 0.33%, half of what we found in the ALCC model. Firms of all productivity level experience lower welfare losses compared to the benchmark model. This is due to the shorter transition that implies that firms reach sooner their optimal scale. Also, y falls less than in the benchmark model which causes a smaller reduction in profits. In terms of different productivities, the ELCC model shows the same qualitative pattern we find with the ALCC constraint.

Considering alternative policies, both the CC with lump sum transfers and LTV yield the same pattern as the ALCC model.

Table E.2: Parameter Values: Earnings-based constraint

Predetermined parameters				Calibrated parameters		
β	Discount factor	0.96	Standard	ζ	Iceberg trade cost	3.8271
γ	Risk aversion	2	Standard	ω_z	Productivity dispersion	0.4350
σ	Substitution elasticity	4	Leibovici (2021)	F	Sunk export entry cost	1.3993
δ	Depreciation rate	0.06	Midrigan and Xu (2014)	θ^{NE}	non-exporters collateral coefficient	0.3481
ρ	Death probability	0.08	Chilean data	θ_f	Exporters collateral factor	1.0361
				α	Capital intensity	0.4491
				κ	Fraction of steady-state capital as initial capital	0.4012

Table E.3: Moments: Earning-based constraint

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	8.64
Average sales (age 5 / age 1)	1.26	1.24
Aggregate exports / sales	0.21	0.21
Aggregate credit / Value added	0.33	0.33
Aggregate capital stock / wage bill	6.60	6.53
(Investment /VA)$_{exporters}$ / (Investment/VA)$_{non_exporters}$	1.84	1.84

Table E.4: Aggregate effects of the CC and LTV policies: Earning-based constraint

	Benchmark ($\Delta\%$) (1)	Lump-sum ($\Delta\%$) (2)	LTV ($\Delta\%$) (3)
Exports	-0.86%	-0.12%	-1.17%
Share of exporters	-6.90%	5.75%	-1.62%
Domestic Sales	-0.71%	-0.20%	-0.22%
Investment	-1.21%	-1.55%	-1.19%
Consumption	-0.52%	-0.09%	-0.05%
Final goods output	-0.63%	-0.33%	-0.24%
Real GDP	-0.46%	-0.62%	-0.50%
Real wage	-0.61%	-0.49%	-0.53%
Wage	-0.89%	-0.01%	-0.45%
Price level (Real ex. rate)	-0.29%	0.49%	0.08%
Agg. credit/Value Added	$-6.37pp$	$-6.10pp$	$-6.37pp$

Table E.5: Effects of Capital Controls on Misallocation & Welfare
(Earnings-linked Constraint)

	Capital Controls		Lump-sum		LTV	
	misallocation (1)	welfare (2)	misallocation (3)	welfare (4)	misallocation (5)	welfare (6)
All firms	$0.61pp$	-0.33%	$0.87pp$	0.09%	$0.43pp$	-0.20%
Exp. status						
Exporters	$0.93pp$	-1.08%	$1.43pp$	2.15%	$1.12pp$	0.10%
Non-exporters	$0.55pp$	-0.30%	$0.74pp$	0.02%	$0.29pp$	-0.22%
OSG						
Large	$0.64pp$	—	$0.92pp$	—	$0.46pp$	—
Small	$0.18pp$	—	$0.18pp$	—	$0.04pp$	—
Productivity						
1	$0.08pp$	-0.60%	$0.08pp$	-0.49%	$0.02pp$	-0.53%
2	$0.25pp$	-0.58%	$0.25pp$	-0.46%	$0.06pp$	-0.52%
3	$0.40pp$	-0.51%	$0.39pp$	-0.39%	$0.13pp$	-0.49%
4	$0.57pp$	-0.36%	$0.55pp$	-0.23%	$0.24pp$	-0.41%
5	$0.65pp$	-0.22%	$0.61pp$	-0.05%	$0.36pp$	-0.25%
6	$0.69pp$	-0.36%	$1.45pp$	0.61%	$0.36pp$	-0.04%
7	$0.45pp$	-0.78%	$0.53pp$	-0.29%	$0.96pp$	0.33%
8	$0.41pp$	-0.86%	$0.48pp$	-0.26%	$0.99pp$	0.45%
9	$0.39pp$	-0.89%	$0.46pp$	-0.25%	$1.00pp$	0.49%
10	$0.38pp$	-0.89%	$0.45pp$	-0.24%	$1.00pp$	0.51%

F Model with Domestic Credit Market

This Section of the Appendix examines a simplified version of the model that introduces a domestic credit market in which entrepreneurs can buy or sell bonds, so that they can optimally choose whether they prefer to invest in their own capital or effectively lend to other firms. The model is simplified by assuming that there are no exporters, no imported inputs, and no labor market. Firms use a fixed amount of labor $\bar{n}$ so that effective productivity becomes $\tilde{z} = z\bar{n}^{1-\alpha}$, or alternatively we can think of $\bar{n}$ as non-marketable land.

Individual holdings of domestic bonds are denoted b. The price of these bonds is q^b (with return $R^b \equiv 1/q^b$). The foreign debt market is the same as in the model of the paper. The collateral constraint is now formulated in terms of the net bond position including foreign and domestic bonds:

$$qd' - q^b b' \leq \theta k'.$$

Net worth is now defined as:

$$a' = k' - qd' + q^b b'.$$

Hence, the collateral constraint in terms of net worth remains as before:

$$k' \leq \frac{a'}{1-\theta}.$$

In principle, there would seem to be a portfolio choice involving d' and b', but in fact, with one exception, the portfolio is always at the corners because of the following arguments:[55]

1. If $R^b > \hat{R}$, all firms that borrow always borrow from abroad, and therefore, there is no supply of domestic bonds. Hence, all the debt is in d' and $b' = 0$ for all firms. Here, firms that have repaid their debt (i.e., attained $a' = \bar{k}^{cc}(\tilde{z})$) move into region 3 and accumulate net worth along the ray $k' = a'$ as assumed in the paper, because (a) there is no domestic debt market and (b) since the marginal return on saving exceeds R^* firms want to grow their net worth but can only allocate it to capital.

2. If $R^* < R^b < \hat{R}$, all firms that borrow always borrow in the domestic market and therefore there are no capital inflows. Hence, all the debt is in b' and $d' = 0$ for all firms. At equilibrium,

[55] The exception is when there is excess demand for credit in the domestic market at $R^b = \hat{R}$. In this case, the gap is covered by external borrowing at the aggregate level but the portfolio structure of domestic and foreign bonds of individual borrowers is undetermined.

some firms will borrow and have $b' < 0$ and others will lend (save into bonds) and have $b' > 0$ and this bond market must clear internally at the rate R^b. Thus, CCs move the economy to financial autarky.

3. If $R^b = \hat{R}$, the two bonds are perfect substitutes for borrowers, they are indifferent which one they use to borrow. The portfolio composition depends on whether at $\hat{R}$ there is excess demand or supply of credit. If there is excess supply, since lenders cannot get $\hat{R}$ by investing abroad, the domestic interest rate falls and thus $R^b = \hat{R}$ cannot be an equilibrium. If there is excess demand, all domestic savers buy the domestic bonds they desire at $\hat{q}$ and the excess over those that borrowers still want to sell are sold abroad paying the CCs tax, so that the price is still $\hat{q}$. We can assume that the domestic market opens first (since after all CCs are in place). Borrowers step in to borrow (sell bonds) and when the domestic bond demand is covered, the rest of borrowers can borrow from abroad. In this case, however, the portfolio structure of individual borrowers is undetermined. Their net position $\hat{q}[d' - b']$ is well-defined, but the breakdown between b' and d' is not. Finally, if at $\hat{R}$ the aggregate supply and demand of bonds are equal (recalling that lenders would always lend domestically since saving into international bonds pays R^* not $\hat{R}$), there would be nobody left to borrow from abroad after the domestic market meets and thus $d' = 0$.

4. If $R^b < R^*$, firms that save would never want to save into domestic bonds, since the return is higher abroad, and therefore no firm would be able to borrow domestically at R^b. Moreover, since $\beta R^* = 1$, it must be that $\beta R^b < 1$, and thus dynamic effects will induce firms to always want to reduce their net worth. All firms would want to borrow inducing an excess demand for credit that would cause R^b to rise. Hence, $R^b < R^*$ cannot be an equilibrium.

F.1 Firms that save prefer buying domestic bonds than investing

We start the analysis by presenting a proposition that establishes that, for any $R^* < R^b \leq \hat{R}$, an entrepreneur with enough net worth to self-finance the pseudo-steady state of capital supported by CCs will prefer to save its additional net worth into domestic bonds (i.e., lend it to other firms) rather than accumulate more capital.

Proposition F.1 Assume that $R^* < R^b \leq \hat{R}$ ($q^* > q^b \geq \hat{q}$), an entrepreneur with net worth $a' \geq \bar{k}^{cc}(\tilde{z})$ increases its cash-on-hand more by investing its additional net worth into domestic bonds than by accumulating additional capital.

Proof. This proof shows that the entrepreneur's increase in cash-on-hand in response to an increase in a' is larger by investing the marginal net worth into bonds than into capital, because the marginal return of the former exceeds that of the latter.

Start with the case $R^b = \hat{R}$ (domestic bonds yield the same as the interest rate with CCs). Since $a' \geq \bar{k}^{cc}(\tilde{z})$, the firm is not borrowing, and since $R^b > R^*$, the firm sets $d = 0$ (saving abroad by setting $d' < 0$ yields a smaller return than domestic bonds). The firm will then choose from one of two strategies: (i) $b = 0$ if it sets $k' = a'$ (this is the assumption in Region 3 of the analysis in the paper), or (ii) $b = \hat{R}[a' - \bar{k}^{cc}(\tilde{z})]$ if it keeps its capital constant by setting $k' = \bar{k}^{cc}(\tilde{z})$.

Cash-on-hand is:

$$p'm' = p'^h \tilde{z}k'^\alpha + p'(1-\delta)k' + p'\hat{R}[a' - k']$$

Recall from the demand-determined output under monopolistic competition that $p^h/p = [\tilde{z}k'^\alpha/y]^{-1/\sigma}$, hence cash on hand simplifies to:

$$\begin{aligned} m' &= [\tilde{z}k'^\alpha/y]^{-1/\sigma}\tilde{z}k'^\alpha + (1-\delta)k' + \hat{R}[a' - k'] \\ &= y^{1/\sigma}[\tilde{z}k'^\alpha]^{\frac{\sigma-1}{\sigma}} + (1-\delta)k' + \hat{R}[a' - k'] \end{aligned}$$

The additional unit of a' is invested where it yields the larger increase in cash-on-hand, which can be determined by evaluating the total derivative of m' with respect to a' under each strategy. The total derivative of cash-on-hand is:

$$\frac{dm'}{da'} = y^{1/\sigma}\frac{\sigma-1}{\sigma}[\tilde{z}k'^\alpha]^{\frac{-1}{\sigma}}\alpha\tilde{z}k'^{\alpha-1}\frac{\partial k'}{\partial a'} + (1-\delta)\frac{\partial k'}{\partial a'} + \hat{R}\left(1 - \frac{\partial k'}{\partial a'}\right)$$

which using again $p^h/p = [\tilde{z}k'^\alpha/y]^{-1/\sigma}$ reduces to:

$$\frac{dm'}{da'} = \frac{p'^h}{p}\frac{\sigma-1}{\sigma}\alpha\tilde{z}k'^{\alpha-1}\frac{\partial k'}{\partial a'} + (1-\delta)\frac{\partial k'}{\partial a'} + \hat{R}\left(1 - \frac{\partial k'}{\partial a'}\right)$$

Since the marginal revenue product for a firm with productivity $\tilde{z}$ and capital k' is $MRPK(k', \tilde{z}) \equiv p'^h\frac{\sigma-1}{\sigma}\alpha\tilde{z}k'^{\alpha-1}$, we obtain that the total derivative is:

$$\frac{dm'}{da'} = \frac{MRPK(k', \tilde{z})}{p'}\frac{\partial k'}{\partial a'} + (1-\delta)\frac{\partial k'}{\partial a'} + \hat{R}\left(1 - \frac{\partial k'}{\partial a'}\right)$$

The additional m' earned by investing the extra unit of a' following strategy (i) that sets

$k' = a'$ is:

$$\frac{\partial m'}{\partial a'} = \frac{MRPK(a', \tilde{z})}{p'} + (1 - \delta)$$

and under strategy (ii) that sets $k' = \bar{k}^{cc}(\tilde{z})$ is:

$$\frac{\partial m'}{\partial a'} = \hat{R} = \frac{MRPK(\bar{k}^{cc}(\tilde{z}), \tilde{z})}{p'} + (1 - \delta),$$

where the last equality follows from the optimality condition that defines the pseudo-steady state of capital $\bar{k}^{cc}(\tilde{z})$ with CCs. Since $a' \geq \bar{k}^{cc}(\tilde{z})$ and the MRPK is decreasing in k it follows that:

$$\left.\frac{\partial m'}{\partial a'}\right|_{k'=a'} \leq \left.\frac{\partial m'}{\partial a'}\right|_{k'=\bar{k}^{cc}(\tilde{z})},$$

which holds with equality only if $a' = \bar{k}^{cc}(\tilde{z})$. Hence, the firm that has attained $a' = \bar{k}^{cc}(\tilde{z})$ still desires to increase a' because $\hat{R} > R^*$ (so that $\beta\hat{R} > 1$) but it will always prefer to keep capital constant and save at R^b than to invest in capital.

If $R^b < \hat{R}$, there is no borrowing from abroad and hence the economy is in financial autarky. There is something akin to region 2 but defined not by $a' = \bar{k}^{cc}(\tilde{z})$ but by $a' = \bar{k}^{R^b}(\tilde{z})$, where $\bar{k}^{R^b}(\tilde{z})$ is the pseudo steady-state of capital such that $R^b = \frac{MRPK(\bar{k}^{R^b}(\tilde{z}),\tilde{z})}{p'} + (1 - \delta)$. Then the same argument of the case with $R^b = \hat{R}$ applies. Any firm with $a' = \bar{k}^{R^b}(\tilde{z})$ will always prefer to save into domestic bonds at R^b keeping capital constant than investing into capital at $k' = a'$ because the marginal return of the former strategy dominates that of the latter. □

The above result shows that Region 3 as presented in the paper can only exist if either (a) the domestic credit market under financial autarky is too small, in the sense that it yields an interest rate such that $R^b > \hat{R}$; or (b) we assume restrictions that prevent firms from saving into the domestic bond market (i.e. domestic lending) at a rate higher than R^*. For instance, the government could tax domestic bond purchases so that savers can only earn R^*. This is reasonable under the interpretation that the CCs represent a form of financial repression, because by definition financial repression means that there are wedges that make interest rates on borrowing and saving different. Even relaxing this assumption so that the domestic bond market may exist, however, it does not follow that the static effects of CCs on misallocation are necessarily weaker than in the paper. The outcome depends on what interest rate is generated by the financial autarky equilibrium. This point is explained in detail in the next Section but for now consider the following intuition for two extreme cases.

On one hand, if R^b is negligibly higher than R^* it is clear that Region 3 disappears (because of what Proposition 1 proved). Firms never leave Region 2 after reaching it and Region 2 converges to Region 4, so the NCC and CC regimes would have nearly identical capital decision rules and therefore CCs would be nearly neutral. On the other hand, if R^b is negligibly lower than $\hat{R}$, the static effects would be stronger than in the paper because Region 2 is wider and there are no regions 3 and 4. Firms would never attain their efficient optimal scale. Instead, firms that are sufficiently old or have enough net worth converge to $\bar{k}^{R^b}(\tilde{z})$ and have permanently higher MRPK than the efficient one. Hence, understanding the financial autarky equilibrium is critical for determining whether the domestic credit market would strengthen or weaken the results produced by the model presented in the paper.

F.2 Credit market equilibrium in financial autarky

We study next the general equilibrium of the model with domestic credit market and what it implies for misallocation relative to the results obtained with the benchmark model in the paper. To start the analysis, note that the arguments about portfolio choice of foreign and domestic bonds presented earlier imply that domestic borrowing emerges when CCs are introduced only if $R^b \leq \hat{R}$. Moreover, they also imply that when this happens all the borrowing is domestic and the economy moves to financial autarky. As we explain below, the case $R^b = \hat{R}$ emerges only if by chance the autarky equilibrium yields a domestic interest rate equal to $\hat{R}$, and in this case we assume the domestic bond market opens first to support the equilibrium. Hence, the main case of interest for studying domestic debt is when $R^b < \hat{R}$. Before examining the implications of this case, we characterize the general equilibrium of the model.

The model is the same as in Section 3 of the paper, except for the following modifications. First, for simplicity, we assume that there are no exporters, no imported inputs, and no labor market. Firms use a fixed amount of labor $\bar{n}$ so that effective productivity becomes $\tilde{z} = z\bar{n}^{1-\alpha}$, or alternatively we can think of this fixed labor as non-marketable land. The entrepreneurs' production technology hence becomes $y_h = \tilde{z}k_h^{\alpha}$. Since there are no imported inputs, the optimization problem of final goods producers becomes:

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

$$\text{s.t.} \qquad y_t = \left[\int_0^1 y_{h,t}(i)^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{\sigma-1}},$$

where $p_t = [\int_0^1 p_{h,t}(i)^{1-\sigma} di]^{1/(1-\sigma)}$. This problem yields the same demand functions for domestic inputs as in Section 3, $y_{h,t}(i) = \left(\frac{p_{h,t}(i)}{p_t}\right)^{-\sigma} y_t$.

Second, since we now allow for the possibility of domestic borrowing, the collateral constraint becomes:

$$qd_{t+1} - q^b b_{t+1} \leq \theta k_{t+1},$$

Keep in mind, however, that as implied by the results from earlier in this Section, when the domestic credit market operates the economy moves to financial autarky, so the relevant case for this analysis is when $d_{t+1} = 0$.

The value of an individual firm (assuming financial autarky) is:

$$v(m, \tilde{z}) = \max_{a'} \left[u\left(m - (1-\rho)a'\right) + \tilde{\beta} v\left(\tilde{m}'(a', \tilde{z}), \tilde{z}\right) \right]$$

$$\tilde{m}'(a', \tilde{z}) = \max_{k', b', p'_h} \left[\frac{\frac{p'^{1-\sigma}_h}{p'^{-\sigma}} y' + p'(1-\delta)k' - p'd' - T(\tilde{z})}{p'} \right] \tag{F.1}$$

$$\text{s.t.} \left(\frac{p'_h}{p'}\right)^{-\sigma} y' = \tilde{z}k'^{\alpha} \qquad a' = k' + q^b b' \qquad k' \leq a'/(1-\theta) \tag{F.2}$$

F.2.1 Static Effects in the Second-Stage Solution

The static effects of the collateral constraint are determined by the first-order conditions of the second-stage problem, which determines $\tilde{m}'(a', \tilde{z})$. These conditions simplify to:

$$MRPK \equiv \frac{p'_h}{\varsigma} \alpha \tilde{z} (k')^{\alpha-1} = \left[p'(r^b + \delta) + \eta(1-\theta) \right]$$

$$\left(\frac{p'_h}{p'}\right)^{-\sigma} y = \tilde{z}k'^{\alpha} \qquad b' = R^b[a' - k']$$

where $\varsigma = \sigma/(\sigma-1)$ is the markup of price over marginal cost and η is the multiplier on the collateral constraint. When $\eta > 0$, the firm is borrowing and the capital and bond decision rules are:

$$k'(a') = [a'/(1-\theta)], \quad b' = -R^b \frac{\theta}{1-\theta} a',$$

When $\eta = 0$, the decision rules are:

$$k' = \bar{k}^{R^b}(\tilde{z}), \quad b' = R^b[a' - \bar{k}^{R^b}(\tilde{z})],$$

where $\bar{k}^{R^b}(\tilde{z})$ is the capital stock at which $MRPK(\tilde{z}, k') = p'(r^b + \delta)$. The firm may still be borrowing, in which case $a' < \bar{k}^{R^b}(\tilde{z})$ and $b' < 0$, otherwise the firm is saving and $b' > 0$.

The value of $\bar{k}^{R^b}(\tilde{z})$ is given by:

$$\bar{k}^{R^b}(\tilde{z}) = \left[\frac{\alpha y^{1/\sigma} \tilde{z}^{1/\varsigma}}{\varsigma(r^b + \delta)}\right]^{\frac{\varsigma}{\varsigma-\alpha}} \tag{F.3}$$

which, using the Cobb-Douglas production function, implies that $\bar{y}_h^{R^b}(\tilde{z}) = \left[\frac{\alpha y^{1/\sigma}}{\varsigma(r^b+\delta)}\right]^{\frac{\varsigma}{\varsigma-\alpha}} \tilde{z}^{\varsigma/(\varsigma-\alpha)}$. Since $p^h/p = [y_h/y]^{-1/\sigma}$, at this steady state the more productive firms have higher capital, higher output and lower prices.

F.2.2 General equilibrium

The definition of this model's equilibrium is analogous to that of the model in the paper, except that we need to add the market-clearing condition of the domestic bond market. Aggregating over net worth and $\tilde{z}$ using the stationary distribution $\phi(a', \tilde{z})$, the market-clearing condition is :

$$\sum_{a'} \sum_{\tilde{z}} \phi(a', \tilde{z}) b'(a', \tilde{z}) = 0.$$

Since $R^b > R^*$ and $\beta R^* = 1$, the dynamic effect drives all firms to grow their net worth. At the threshold net worth $\tilde{a'}(\tilde{z}) = \bar{k}^{R^b}(\tilde{z})$, firms attain zero debt and become lenders/savers. All firms with $a' < \tilde{a'}(\tilde{z})$ are borrowers and can be divided into two groups. First, in the interval $0 \leq a' \leq (1-\theta)\bar{k}^{R^b}(\tilde{z})$, firms borrow $b' = -R^b\theta a'/(1-\theta)$. Second, in the interval $(1-\theta)\bar{k}^{R^b}(\tilde{z}) < a' < \bar{k}^{R^b}(\tilde{z})$, firms borrow $b' = R^b[a' - \bar{k}^{R^b}(\tilde{z})] < 0$. All firms with $a' > \tilde{a'}(\tilde{z})$ are savers with $b' = R^b[a' - \bar{k}^{R^b}(\tilde{z})] > 0$. Hence, we can rewrite the market-clearing condition as expressing that the aggregate supply of bonds (aggregate debt) must equal the aggregate demand for bonds (aggregate credit). Thus, the negative of the sum of all negative bond positions must equal the sum of all positive bond positions:

$$\sum_{a'=0}^{(1-\theta)\bar{k}^{R^b}(\tilde{z})} \sum_{\tilde{z}} \phi(a', \tilde{z})\theta a'/(1-\theta) + \sum_{a'=(1-\theta)\bar{k}^{R^b}(\tilde{z})}^{\bar{k}^{R^b}(\tilde{z})} \sum_{\tilde{z}} \phi(a', \tilde{z})[a' - \bar{k}^{R^b}(\tilde{z})] = \sum_{a'>\bar{k}^{R^b}(\tilde{z})} \sum_{\tilde{z}} \phi(a', \tilde{z})[a' - \bar{k}^{R^b}(\tilde{z})]. \quad \text{(F.4)}$$

The above condition can be rewritten in terms of the distribution of age and productivity: $\phi(\tau, \tilde{z}) = \rho(1-\rho)^\tau f(\tilde{z})$, where ρ is the probability of death and $f(.)$ is the pdf of firm productivity drawn at birth. Define $\tau_1(\tilde{z})$ as the firm age threshold at which a firm of productivity $\tilde{z}$ builds enough net worth to reach $(1-\theta)\bar{k}^{R^b}(\tilde{z})$ (this is analogous to the vertex connecting regions 1 and 2 in the original model), and $\tau_2(\tilde{z})$ as a similar age threshold at which net worth reaches $\bar{k}^{R^b}(\tilde{z})$ (this is analogous to the vertex connecting regions 2 and 3 in the original model). The market-clearing condition can then be rewritten as:

$$\sum_{\tau=0}^{\tau_1(\tilde{z})} \sum_{\tilde{z}} (1-\rho)^\tau f(\tilde{z})\theta a'(\tau, \tilde{z}; R^b)/(1-\theta) + \sum_{\tau=\tau_1(\tilde{z})+1}^{\tau_2(\tilde{z})} \sum_{\tilde{z}} (1-\rho)^\tau f(\tilde{z})[a'(\tau, \tilde{z}; R^b) - \bar{k}^{R^b}(\tilde{z})] = \sum_{\tau=\tau_2(\tilde{z})+1}^{\infty} \sum_{\tilde{z}} (1-\rho)^\tau f(\tilde{z})[a'(\tau, \tilde{z}; R^b) - \bar{k}^{R^b}(\tilde{z})]. \quad \text{(F.5)}$$

In this expression, $a'(\tau, \tilde{z}; R^b)$ denotes that a' changes with age and productivity and depends on the interest rate on bonds that firms took as given in solving their optimization problems. At the equilibrium interest rate, R^b needs to be such that this market clearing condition holds.[56] Note that all firms aged $\tau > \tau_2(\tilde{z})$ continue to grow their net worth indefinitely, but as long as their net worth grows at a rate less than the exponential decay of $(1-\rho)^\tau$, the sum converges and aggregate demand for domestic bonds is well-defined even if very old firms have infinitely large bond positions.

The graph used to describe the static effects of CCs can be modified to draw a diagram that illustrates the equilibrium of the domestic bond market. The diagram shown in Figure F.1 assumes for simplicity that there is no collateral constraint and no differences in productivity. The shaded area in black represents the aggregate demand for domestic credit and the one in red the aggregate supply. To be an equilibrium interest rate, R^b must be such that the two are equal.[57] The threshold

[56]The aggregate variables p, y are also determinants of $a'(\cdot)$ but are omitted for simplicity, and the market clearing conditions of the markets for intermediate goods and final goods are also part of the general equilibrium solution.

[57]Mathematically, the aggregate demand and supply of credit do not correspond to the entire shaded areas but to the part of them determined by the sums of the discrete elements formed by the optimal choices of net worth determined

$\hat{a}'$ is the value of a' at which the infinite (but converging) sum in the right-hand-side of the above market-clearing condition converges. This bounds how far to the right in the horizontal axis we need to go to pin down the supply of credit. If the area in black were bigger (smaller) than the area in red, there would be excess demand (supply) of credit and R^b would rise (fall). The equilibrium interest rate R^b is the financial autarky interest rate, because it is determined entirely within the domestic economy and all credit is financed internally.

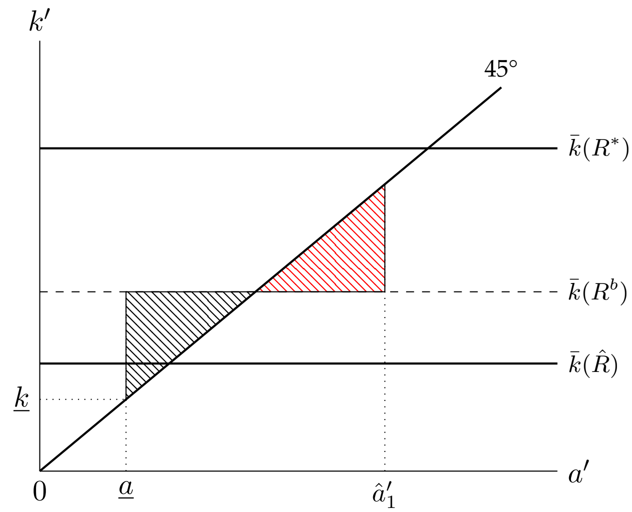


Figure F.1: Equilibrium in Domestic Bond Market

F.2.3 Effects of capital controls on misallocation

Because of Proposition 1, if $R^* < R^b < \hat{R}$, the CCs cause the domestic credit market to emerge and the economy to move to financial autarky. Without CCs, the fact that $R^* < R^b$ rules out borrowing at the autarky rate and all firms that borrow do so from abroad, and since $\beta R^* = 1$, firms stop growing net worth when they reach $a' = \bar{k}^{R^*}(\tilde{z})$, which is their optimal scale consistent with the world interest rate (or the rate of time preference since they are the same). Hence, without CCs all firms are borrowers that carry non-negative debt positions and they optimally choose to keep net worth, debt and capital constant when they reach their optimal scale. In contrast, with CCs, $R^b \leq \hat{R}$ rules out any borrowing from abroad and therefore the economy moves to the financial autarky equilibrium. Moreover, as noted in the previous subsection, firms that reach $a' = \bar{k}^{R^b}(\tilde{z})$ still want to grow their net worth, because $\beta R^b > 1$.

How do effects of CCs on misallocation vary because of the domestic credit market? As

by the decision rule $a'(\tau; R^b)$.

Figure F.1 shows, one important result is that in this environment (with $R^b \leq \hat{R}$) CCs cause permanent effects on misallocation for firms of all ages. In the model of the paper, when CCs are present, firms that build sufficient net worth reach the efficient capital stock $\bar{k}^{R^*}(\tilde{z})$ and do not have misallocation, nor do they carry any debt or savings. But if the domestic credit market exists, CCs move the economy to financial autarky, firms stay with the lower capital stock given by $\bar{k}^{R^b}(\tilde{z})$ permanently, and some firms are creditors and others debtors.

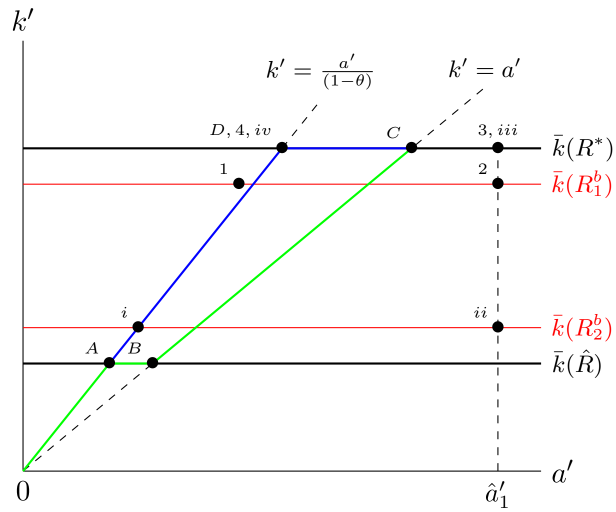


Figure F.2: Effects of Capital Controls with Domestic Bond Market

Whether CCs cause more or less misallocation in this setup with domestic credit market than in the model of the paper hinges on the value of R^b. Capital controls move the economy to financial autarky and because of this Region 3 disappears but Region 2 widens. Two possible (extreme) outcomes are illustrated in Figure F.2, which is again a variant of Figure 1 in the paper. The piece-wise linear function in blue is the capital decision rule without CCs and the one in green is the one with CCs and no domestic market, as in the paper. The magnitude of the effect of CCs on misallocation is reflected in the size of the overall decline in capital induced by the CCs, which is measured by the trapezoid formed by the vertexes A-B-C-D.

Consider now the case in which the domestic credit market exists and yields an interest rate R_1^b just above R^*. As Figure F.2 shows, the effect of CCs on misallocation is now reflected by the loss of capital measured by the trapezoid formed by the vertexes 1-2-3-4.[58] We have more firms in Region 2 than in the model of the paper but in this region the fall in capital and rise in

[58] The vertexes 3 and 4 are determined by the upper bound of net worth $\hat{a}'$ at which the sum that defines the aggregate supply of bonds converges.

misallocation are small (since R^b and R^* are close). Firms that were in the original regions 2 and most of 3 have much less misallocation, and firms close to region 4 and in region 4 will have slightly more misallocation. Hence, the overall misallocation is likely to be smaller than in the model of the paper, as comparing the size of the trapezoids A-B-C-D and 1-2-3-4 suggests.

Now consider the case in which the domestic credit market yields an interest rate R_2^b just below $\hat{R}$. The effect of CCs on misallocation is now reflected by the loss of capital measured by the trapezoid formed by the vertexes i-ii-iii-iv. Again there are more firms in Region 2 but in this region misallocation is still large (just slightly smaller than in the model of the paper). Firms that were in the original region 2 and in region 3 close to 2 have slightly less missallocation but all the rest of firms in the original regions 3 and 4 have much higher misallocation. Hence, the overall misallocation is likely to be larger than in the model of the paper, as comparing the size of the trapezoids A-B-C-D and i-ii-iii-iv suggests. Thus, CCs may induce even stronger misallocation effects with than without a domestic credit market if the latter is relatively small (i.e., if it clears at an interest rate sufficiently close to $\hat{R}$).

The severity of the CCs also matters. Given the financial autarky equilibrium, stricter CCs will yield larger misallaocation effects in the model of the paper than in the model with domestic debt market.

G Summary Statistics of Firm-level Panel and Macro Data

Table G.6: Summary statistics of firm-level panel

VARIABLES	N (1)	mean (2)	sd (3)	min (4)	max (5)
Payroll	91,374	0.384	1.429	0	80.36
Fixed Capital	91,374	2.226	30.41	0	5,717
Export Decision	91,374	0.200	0.400	0	1
TFP	91,374	2.152	0.149	-3.536	2.858
Int.Exp_Fixed_K	91,374	0.420	0.550	0	19.78
OSG	91,374	0.675	0.366	0	1

Note: Payroll and fixed capital are reported in millions of Chilean Pesos. The export status takes the value of cero when the firm does not export in the current period and 1 if it does export. TFP is calculated folowing the methodology of Wooldridge (2009). OSG is the percentage gap between the fixed capital of the firm and the year-industry average of fixed capital for firms that are older than 10 years old.

Table G.7: 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.

H Robustness of empirical results

In this section, we conduct a set of tests that document the robustness of our empirical findings. In particular, we show that our results are robust to: (i) introducing the interaction of alternative macroeconomic controls with our firms' characteristics; (ii) winsorizing the top and bottom 1% observations of our database with respect to alternative dimensions–i.e., dependent variable, controls, and sectors' productivity; (iii) introducing alternative classifications of exporters, i.e., backward- and forward-looking; (iv) using data at the industry level instead of the firm level.

Interaction with macroeconomic controls: A potentially important concern is that the estimates of the interaction terms with CCs could be capturing the effect of an interaction between TFP_{ijt}, OSG_{ijt} and Exp_{ijt} and other macroeconomic variables. To explore this issue, Table H.8 presents the results of a set of regressions adding to the baseline regression the interactions of a set of candidate macroeconomic variables (one at a time) with TFP_{ijt}, OSG_{ijt} and Exp_{ijt}. The macro variables are: the LIBOR rate, inflation, growth, the real exchange rate, the ratio of private credit to GDP and world growth. All macroeconomic variables are lagged one period. Table G.7 presents the summary statistics of these variables. All the coefficients of the interactions of the CCs are similar in size, sign and significance when the macro control interactions are introduced.

Table H.8: Interaction with macroeconomic controls

VARIABLES	Libor (1)	Inflation (2)	Growth (3)	RER (4)	PrivCreditGDP (5)	WorldGrowth (6)
CC*TFP	0.890***	0.859***	1.007***	0.494***	1.052***	0.921***
	(0.121)	(0.119)	(0.127)	(0.104)	(0.126)	(0.118)
CC*OSG	0.249***	0.255***	0.207***	0.286***	0.248***	0.258***
	(0.031)	(0.031)	(0.034)	(0.034)	(0.031)	(0.031)
CC*Exp	0.211***	0.230***	0.139***	0.273***	0.202***	0.258***
	(0.030)	(0.030)	(0.033)	(0.034)	(0.032)	(0.030)
Observations	91,374	91,374	91,374	91,374	91,374	91,374
R-squared	0.624	0.625	0.625	0.625	0.625	0.626
Controls	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES

Note: This table examines the robustness of the interaction of CC with TFP, OSG and Exp on misallocation when introducing, one at a time, the interactions of macroeconomic variables and our variables of interest, TFP_{ijt}, OSG_{ijt} and 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. We include the interactions within the vector of controls for expositional reasons. All regressions include a constant term, firm and time fixed effects, and errors clusteded at the firm level in parenthesis. ***, **, and * indicate significance at the 1%,5%, and 10% level.

Winsorize: In order to make sure that potential outliers are not driving our results columns (1)-(3) of Table H.9 present a series of exercises where we run our baseline regression after winsorizing the top and bottom 1% observations of our database with respect to alternative dimensions. Column (1) presents the results when winsorizing the dependent variable; column (2) presents the results when winsorizing the control variables; and column (3) presents the results when winsorizing all the firms in sectors whose average productivity is on the top and bottom tails of the distribution. All our results are robust to the different winsorization exercises implying that they are not driven by outliers in terms the dependent variable, controls or sectors.

Table H.9: Winsorized samples, alternative definitions of exporters & industry-level results .

VARIABLES	Wins. MRPK (1)	Wins. Controls (2)	Wins. Sectors (3)	Backward-looking (4)	Forward-looking (5)	Industry level (6)
CC*TFP	0.855***	1.289***	0.902***	0.901***	0.897***	0.033
	(0.126)	(0.093)	(0.130)	(0.121)	(0.121)	(0.133)
CC*Exp	0.229***	0.238***	0.234***	0.177***	0.156***	0.347***
	(0.019)	(0.031)	(0.030)	(0.028)	(0.029)	(0.132)
CC*OSG	0.248***	0.263***	0.246***	0.234***	0.218***	1.260***
	(0.022)	(0.031)	(0.031)	(0.031)	(0.031)	(0.133)
Observations	91,374	83,348	91,374	91,030	91,374	1,600
R-squared	0.624	0.630	0.622	0.623	0.624	0.595
Controls	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	NO
Industry FE	NO	NO	NO	NO	NO	YES

Note: This table examines the effect of the interaction of CC with TFP, OSG and Exp on misallocation while winsorizing the top and bottom 1% observations with respect to: (i) the dependent variable, column (1); (ii) the control variables, column (2); and (iii) the average productivity of the sector, column (3). Columns (4) and (5) present the results of the baseline regression while considering alternative definitions of exporters. Column (6) presents the results of our baseline regression when considering the 4-digit-industry as a unit of analysis. All regressions include a constant term, firm and time fixed effects, and errors clustered at the firm level in parenthesis (industry level for column (6)). ***, **, and * indicate significance at the 1%,5%, and 10% level.

Alternative definition of exporters: To make sure that our definition of exporters is not biasing our results columns (4) and (5) of Table H.9 replicates our baseline regression using two alternative classifications: a backward- and a forward-looking definition of exporters. The former, column (4), defines exporters as firms that report exports at least once in the previous two years, and aims at capturing that exporters can be differently affected as they typically have a higher level of capital in the steady state and are more productive. Since we do not observe the exporting decision prior to 1990, for the two first years we fix the export status to the respective firm's export status in 1992. The latter, column (5), defines exporters as firms that report exports at least once in the subsequent two years and 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 CCs. Our results are robust to both alternative classifications.

Industry level regressions: To wrap up this robustness analysis, we explore whether our firm-level findings also hold when considering the industry as the unit of analysis. To this end, we perform some additional computations. For the case of our dependent and control variables we calculate the period average at the 4-digit-industry-level. For the exporting status, TFP and OSG we create dummy variables that take the value of one when the industry's mean is above the mean of the whole distribution in 1990. Column (6) of Table H.9 presents the results of this estimation.

The results show that for exporters and OSG our insights also hold at the industry level: industries with a larger share of exporters and with a higher average OSG experience a more severe increase in misallocation. The coefficient for TFP, however is not significant. The effect on TFP as a relevant margin at the industry level is more difficult to identify as there is a high correlation at the industry level between the average TFP and the average MRPK. The fact that we are fixing the values of the dummy variables in 1990 is also a robustness to guarantee that our effects are not driven by these characteristics changing endogenously as a result of the introduction of the CC.

References

Beck, T., A. Demirgüç-Kunt and R. Levine, "A New Database on the Structure and Development of the Financial Sector," *World Bank Economic Review* 14 (September 2000), 597–605.

Buera, F. and B. Moll, "Aggregate implications of a credit crunch: the importance of heterogeneity," *American Economic Journal: Macroeconomics* 7 (2015), 1–42.

Caglio, C., R. Darst and S. Kalemli-Özkan, "Risk-taking and Monetary Policy Transmission: Evidence from Loans to SMEs and Large Firms," Working Paper 28685, NBER, 2021.

Carroll, C. D., "The method of endogenous gridpoints for solving dynamic stochastic optimization problems," *Economics Letters* 91 (2006), 312–320.

De Gregorio, J., S. Edwards and R. Valdés, "Controls on capital inflows: do they work?," *Journal of Development Economics* (2000).

Drechsel, T., "Earnings-Based Borrowing Constraints and Macroeconomic Fluctuations," Mimeo, 2022.

Gallego, F. and F. L. Hernández, "Microeconomic effects of capital controls: The Chilean experience during the 1990s," *International Journal of Finance and Economics* 8 (2003), 225–253.

Gallego, F., L. Hernandez and K. Schmidt-Hebbel, "Capital Controls in Chile: Were They Effective?," in L. Hernandez, K. Schmidt-Hebbel and N. Loayza, eds., *Banking, Financial Integration, and International Crises*volume 3, chapter 12 (Central Bank of Chile, 2002), 361–412.

Iskhakov, F., T. H. JÃžrgensen, J. Rust and B. Schjerning, "The endogenous grid method for discrete-continuous dynamic choice models with (or without) taste shocks," *Quantitative Economics* 8 (2017), 317–365.

Li, H., "Leverage and Productivity," *Journal of International Economics* 154 (2022).

Lian, C. and Y. Ma, "Anatomy of Corporate Borrowing Constraints," *The Quarterly Journal of Economics* 136 (2020), 229–291.

Miranda, M. J. and P. L. Fackler, *Applied Computational Economics and Finance* (MIT Press, 2004).

Soto, C., "Controles a los movimientos de capital: Evaluación empírica del Caso Chileno," Mimeo, Banco Central de Chile, 1997.

WOOLDRIDGE, J. M., "On estimating firm-level production functions using proxy variables to control for unobservables," *Economics Letters* 104 (September 2009), 112–114.