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The Impact of Firm Heterogeneity in Aggregated Productivity: Firm Entry, Financial Selection, and Capital Misallocation

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Abstract
Aggregated productivity is the primary source of long-run economic growth. Therefore, understanding the nature of productivity accumulation is crucial to promoting welfare and development across nations. Recent literature has turned to the micro-foundation of aggregated productivity by studying the role of firms and entrepreneurs in shaping this process, which is the focus of my dissertation. This dissertation consists of three chapters, each of which investigates how heterogeneous firms' decision making determines aggregated productivity.

The first chapter studies the role of the financial system in selecting and developing the most promising business plans. In particular, more developed financial sectors are able to better allocate resources and foster cohorts of firms that are more productive. This chapter shows that considering firm heterogeneity is fundamental when studying the effects of financial development in long-run growth. In fact, the financial system determines not only the size of a new cohort of firms but also the productivity of the new entrants.

The second chapter enriches the former model by studying the effects of financial crises in the long-run level of aggregated productivity. The main mechanism of the first chapter is embedded into a standard stochastic small open economy model, commonly used to study international financial crises. The model suggests that during crises, smaller cohorts of firms arise, but the average contribution of those cohorts to aggregated productivity should be higher than during normal times. This prediction is verified using firm level data from Chile spanning the period of crisis triggered by the Russian sovereign default of 1998. The calibrated model suggests that heterogeneity is crucial when assessing the long-run impact of financial crises in aggregated productivity.

The third chapter focuses on the allocation of capital between heterogeneous firms. Firms in the United States have access to unequal tax benefits tied to physical capital and firms that lobby for taxation issues enjoy larger benefits than the rest. A heterogeneous firm dynamics model with endogenous lobbying decisions is developed and calibrated to firm level data. Although only a small fraction of firms lobby, the effect on aggregated productivity is sizeable.

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To my wife Daniela and our son Damián.

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ABSTRACT

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Chapter 1

Project Heterogeneity and Growth: The Impact of Financial Selection on Firm Entry

This chapter is co-authored with Sînâ T. Ateş.

Abstract

In the classical literature of innovation-based endogenous growth, the main engine of productivity growth is firm entry. Nevertheless, when projects are heterogeneous, and good ideas are scarce, a mass-composition trade-off is introduced into this link: larger cohorts have a lower average contribution to aggregated productivity. Because one of the roles of the financial system is to screen the quality of projects, the ability of financial intermediaries to detect promising projects shapes the strength of this trade-off. We build a general equilibrium endogenous growth model with project heterogeneity, and financial screening to study this relationship. We use two quantitative experiments to illustrate the relevance of our analytic results. First, we show that accounting for heterogeneity and selection allows the model to conciliate two well documented and apparently contradictory effects of corporate taxation. Corporate taxation has a strong detrimental effect on firm entry while affecting the long-run growth only mildly. A second illustration studies the effects of financial development on growth. This experiment shows that size based measures of financial development (e.g. domestic credit over GDP) are not always good proxies for the ability of the financial system to select the most promising projects. Finally, we propose a novel firm level measure to assess the accuracy of financial selection across countries.

1.1 Introduction

The link between financial development and long-run economic growth is a long-lasting question in the literature. In his seminal survey, Levine (2005) summarizes the growth-enhancing functions of the financial system into five channels: *i*) ex-ante information production about investment opportunities and capital allocation, *ii*) monitoring investments and providing corporate governance, *iii*) diversification and management of risk, *iv*) pooling and channelling savings, and *v*) facilitating the exchange of goods and services. Among those, *pooling savings and providing capital to investments* has drawn most of the attention in the theoretical and empirical literature. However, in a world with vast heterogeneity among potential investments, selecting the most productive uses to allocate resources is crucial. This chapter contributes on theoretical grounds to the analysis of this selection channel and illustrate its relevance for theoretical and empirical research.

The main source of long-run growth is improvements in aggregated productivity; hence, a study of the impact of financial development on growth needs to focus on the mechanisms that link the financial system with the productivity process of the economy. Early models of innovation such as Grossman and Helpman (1991) and Aghion and Howitt (1992) provide micro-foundations of productivity growth incorporating the Schumpeterian notion of *creative destruction* into this literature. In a nutshell, entrepreneurs with a new invention (creativity) have lower production costs; and when they enter the market, they replace the former leader (destruction). Therefore, firm entry plays a central role in the determination of long-run growth.[1] But new firms need external finance in order to access the market.[2] This suggests a first link between finance and growth: more developed financial systems are able to pool more funds to finance more start-ups, allowing more creative destruction and

[1]Bartelsman et al. (2009) use firm level data for 24 countries to study firm dynamics and the sources of productivity growth. They document that between 20% and 50% of the overall productivity growth is explained by net entry.

[2]For instance, Nofsinger and Wang (2011) document that 45% of the start ups in their 27 country panel use external funding.

therefore more long-run growth. Nevertheless, good ideas are scarce.[3] Therefore, selecting the most promising projects is not a trivial task.

In this sense, the financial system creates value not only by pooling funds, but also by allocating resources efficiently. In fact, Fracassi et al. (2012) document a loan approval rate of only 18.2% for start-ups, using loan application data for a major venture capital in United States.[4] Moreover, the allocation of credit is not random. In fact, funded start-ups in their sample survive longer and are more profitable than rejected ones. This suggests that financial intermediation is not only about the quantity (*mass*) of the entrant cohort, but also about its quality (*composition*). Thus, a model that studies the link between the financial system and long-run economic growth needs to include both dimensions.

In order to understand how the mass and the composition of the cohorts of new firms shape long-run productivity growth, we modify the quality-ladder framework of Grossman and Helpman (1991) along two dimensions. First, we introduce *ex ante* project heterogeneity that is translated into *ex post* firm heterogeneity in the intermediate good sector. Second, we introduce a financial system, with access to a screening technology. The accuracy of the screening device represents the level of financial development of the economy. Our analytical characterization of the unique interior balanced growth path shows how creative destruction is shaped by the interaction between mass and composition of the entering cohort.

Two quantitative experiments illustrate both the strength and the relevance of the composition effect introduced in this chapter. The first experiment relates to the empirical literature on corporate taxation, firm entry, and growth. The model is able to generate mild responses in growth for a wide range of corporate taxes, and at the same time match the strong detrimental effect on entry rates. In fact, in the model, when taxes increase, a large set of projects are not enacted. Nevertheless, for financially developed economies, the

[3] Silverberg and Verspagen (2007) document that both patent citation and returns to patenting are highly skewed toward relatively few patents.

[4] See also Benfratello et al. (2008). They use Italian firm level data to show how the development of banking affected the probability of firm innovation.

marginal contribution of those forgone entrants to economic growth is negligible. However, as tax rates increase further, the contribution of the marginal entrant rises rapidly. This implies a non-linear effect of corporate taxation on economic growth.

The second quantitative illustration revisits the classical link between financial development and growth. In line with the empirical literature, the model suggests that the main source of economic growth in more financially developed economies is the efficiency in the allocation of resources rather than the mass of resources allocated. Moreover, this experiment also shows that the accuracy of the financial system is non-monotonically related to the amount of resources allocated in the economy. In particular, for countries characterized by high entry rates, an increase in the accuracy of the financial system might lead to lower domestic credit over GDP and lower entry rates. Therefore, mass related proxies are potentially misleading when trying to capture the allocative aspect of financial development.

As a first step to address the insufficiency of mass related variables to capture the selection margin of financial development, this chapter proposes a variable that could be used in the empirical literature to complement the existing proxies. Our model implies that the accuracy of the financial system is inversely related to the skewness of the ratio of value added to cost of the firms operating in the economy. The intuition behind this result is that with better selection entrants below a profitability threshold are observed infrequently. Therefore, the *bad* tail of the distribution gets thinner.

This chapter is structured as follows. Section 1.2 reviews some of the related contributions in the endogenous growth literature, then Section 1.3 presents the model and the analytical results. Section 1.4 show the two quantitative experiments that illustrate the relevance of the mechanism. Section 1.5 presents the analysis of the skewness measure, and section 1.6 concludes.

1.2 Related Literature

The role of a financial structure that evaluates investment projects has been considered in the growth literature for a long time.[5] Greenwood and Jovanovic (1990) introduced this idea into an externality driven endogenous growth model inspired by Romer (1986) to study the interdependence between financial development and economic growth. One study in that strand to which the current work particularly relates is Bose and Cothren (1996). They study how improvements in the screening technology of the financial system affect the growth rate of the economy. They develop a two type (borrowers and lenders) overlapping generation model where young borrowers seek resources to start heterogeneous projects. Financial intermediaries use screening and credit rationing to allocate the resources of the lenders. Projects differ only in their success probability (low or high), and the economy growth rate is driven by the externality generated by the average capital stock in the economy. They show that cost reducing improvements in the screening technology can decrease economic growth. Notice that heterogeneity and financial selection influence growth only through the mass of successfully enacted projects. Moreover, this class of models rely on aggregate externalities to generate an endogenous growth process, rather than providing micro-foundations for the increases in productivity.

An early innovation based endogenous growth model with heterogeneity and financial selection is proposed by King and Levine (1993a). They introduce heterogeneity to the original Aghion and Howitt (1992) model dividing the population between agents that are capable to manage an innovative project and agents that are not. The role of the financial system is to pool resources and try to identify capable individuals in order to put them in charge of projects. Hence, the better the screening device the larger the mass of firms entering the economy. Anotehr paper by Jaimovich and Rebelo (2012) builds on the non-Schumpeterian innovation tradition of Romer (1990), including heterogeneous agents as in

[5]We can trace this idea back to Bagehot (1873) and Schumpeter (1934), but a more formal exposition can be found on Boyd and Prescott (1986).

Lucas (1978) to study the non-linear relationship between taxation and long-run growth. In their model every successfully enacted project enlarges the measure of intermediate good varieties by the same amount. Nevertheless, entrepreneurs are heterogeneous in their ability to enact projects. As the ability distribution is skewed, only a few of them account for most of the generation of new varieties and, thus, output growth. Hence, as taxation discourages relatively unproductive entrepreneurs, both the mass of firms created and the growth rate of the economy decrease very mildly for a wide range of tax rates.

None of the endogenous growth models discussed above attempt to link the *ex-ante* heterogeneity with *ex-post* differences on the production side. Hence, the impact of financial selection is only driven by the mass of entrants. In particular, these models imply a monotonic relationship between firm entry and growth: the larger the mass of an entrant cohort, the higher the growth rate of the economy. In contrast, instead of using heterogeneity on the success rate, our model includes *ex ante* project heterogeneity that is also translated into *ex post* firm heterogeneity, generating a non-linear relationship between entry and growth rates.

1.3 Model

This model builds on the classical endogenous growth literature of quality-ladder models. In line with the seminal contributions of Grossman and Helpman (1991) and Aghion and Howitt (1992), a continuum of intermediate good varieties, indexed by $j \in [0, 1]$, are used for final good production and the producer with the lower marginal cost monopolizes the production of its variety.[6] The engine of economic growth is the creative destruction generated by successfully enacted projects where the former leader is replaced by a newcomer with lower marginal cost. In order to disentangle the mass and composition effect of financial intermediation, we modify this framework to allow for project heterogeneity and

[6] For a recent review of the relevance and scope of this framework see Aghion et al. (2013).

financial selection. A representative financial intermediary owns a unit mass of projects, indexed by $e \in [0,1]$, and collects deposits from the representative household to enact a portion of them. First, we introduce heterogeneity in both projects and marginal cost improvements. In particular, after enaction a successful project can generate either a drastic or an incremental innovation that leads to cost reduction in a product line. This implies that leaders have heterogeneous cost advantages over their followers. Moreover, since projects are characterized by their idiosyncratic probability of generating a drastic innovation, there is also heterogeneity before enaction. Second, we introduce financial selection by allowing the financial intermediary to access a costless yet imperfect screening device. In this section, we introduce the components of the model, define a competitive equilibrium and a balanced growth path, and derive the analytical characterization of the model.

1.3.1 The Representative Household

The representative household lends assets (a_{t+1}) to the financial intermediary at the interest rate r_{t+1} and receives the profits of the financial intermediary (π_t) as well as the revenue generated by corporate taxation (T_t), which the government levies on intermediate firms. The household supplies L units of labor inelastically, and future utility is discounted at rate β. We assume constant relative risk aversion utility to allow for a balanced growth path in equilibrium, and the inter-temporal elasticity of substitution is $\frac{1}{\gamma} \leq 1$. In particular, given the sequences of wages, interest rates, profits, lump sum transfers of tax revenue $\{w_t\,, r_{t+1}\,, \Pi_t\,, T_t\}_{t=0}^{\infty}$, and initial asset a_0, the representative household chooses consumption, assets $\{c_t\, ,\, a_{t+1}\}_{t=0}^{\infty}$ to solve: [7]

$$\max_{\{c_t\, ,\, a_{t+1}\}_{t=0}^{\infty}} \left\{ \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\gamma}}{1-\gamma} \right\} \tag{1.1}$$

sbj. to

$$c_t + a_{t+1} \leq w_t L + a_t(1+r_t) + \Pi_t + T_t \tag{1.2}$$

$$a_{t+1} \geq 0 \tag{1.3}$$

As shown in equation (1.2), the price of consumption is set to unity since we use final good as the *numeraire*. The interior first order condition that characterizes this program is

$$\left(\frac{c_{t+1}}{c_t}\right)^{\gamma} = \beta\,(1 + r_{t+1})\,. \tag{1.4}$$

1.3.2 Final Good Sector

Using a constant returns to scale technology, the representative final good producer combines intermediate inputs to produce the final good

$$\ln Y_t = \int_0^1 \ln x_{j,t}^D dj,$$

which in turn provides resources for consumption. In particular, given input prices and wages $\{w_t\, ,\, p_{j,t}\}$, the final good producer demands intermediate varieties $\left\{\left\{x_{j,t}^D\right\}_{j\in[0,1]}\right\}$ every period in order to solve

$$\max_{\left\{\left\{x_{j,t}^D\right\}_{j\in[0,1]}\right\}\geq 0} \left\{ exp\left(\int_0^1 \ln x_{j,t}^D dj\right) - \int_0^1 x_{j,t}^D p_{j,t} dj \right\}, \tag{1.5}$$

[7]Subject to the standard transversality condition.

The solution to this problem is fully characterized by the following interior set of first order conditions:

$$x_{j,t}^{D} = \frac{Y_t}{p_{j,t}}. \tag{1.6}$$

1.3.3 Intermediate Good Sector

In line with the endogenous growth literature, we assume that the amount of the intermediate good j produced, $x_{j,t}$, is linear in labor $l_{j,t}$, with constant marginal productivity $q_{j,t}$. Thus,

$$x_{j,t} = l_{j,t} q_{j,t}. \tag{1.7}$$

The efficiency of labor in the intermediate good production evolves with each technological improvement generated by successful innovation. Innovations are heterogeneous in their capacity to improve the existing technology. In particular, the evolution of technology follows

$$q_{j,t} = I_{j,t}^{d} \times q_{j,t-1}\left(1+\sigma^{d}\right) + \left(1 - I_{j,t}^{d}\right) \times q_{j,t-1}; \quad d \in \{L, H\} \tag{1.8}$$

where $I_{j,t}^{d}$ is an indicator function that equals to 1 if the product line j receives an innovation in period t of type d, and 0 otherwise implying that this period, the level of productivity is the same as in the last period. Moreover, σ^{d} is the heterogeneous step size of the innovation, with $\sigma^{H} > \sigma^{L} > 0$.[8] This implies that *high* type projects (H) improve the productivity of labor more than *low* type projects (L). Therefore, leaders are heterogeneous in their absolute distance from their closest follower.[9]

In line with the literature, we assume Bertrand monopolistic competition. This set-up implies that the competitor with the lower marginal cost dominates the market by

[8] Incumbent heterogeneity has been introduced in step by step models even with rich incumbent dynamics, for example in Akcigit and Kerr (2010), but that literature has not studied financial selection.

[9] We allow only two types in order to summarize the composition of the product line with only one variable, the fraction of leaders with σ^{H} advantage.

following a limit pricing rule, i.e. she sets her price, $p_{j,t}$ equal to the marginal cost of the closest follower. Denote the efficiency of the closest follower, by $\tilde{q}_{j,t}$, then:[10]

$$p_{j,t} = \frac{w_t}{\tilde{q}_{j,t}}. \tag{1.9}$$

In any product line j, the owner of the latest successful project of type d reaps profits $\pi^d_{j,t}$ at time t. Profits are subject to the corporate tax rate τ. A firm owner collects after-tax profits in the current period. In the next period, this firm will continue to produce if it is not replaced by a new leader. A mass M_{t+1} of projects is enacted at time $t+1$, and each of them becomes a firm with fixed probability λ. As entry is undirected, an incumbent firm will continue to produce with probability $1 - \lambda M_{t+1}$. Then, given interest rate r_{t+1}, the value $V^d_{j,t}$ of owning the product line j at time t for a type d leader is given by

$$V^d_{j,t} = (1-\tau)\pi^d_{j,t} + \frac{1-\lambda M_{t+1}}{1+r_{t+1}} V^d_{j,t+1}. \tag{1.10}$$

In this framework, incumbents are randomly replaced by more efficient entrants. This is the engine of economic growth in the model, the Schumpeterian creative destruction. Although we abstract from incumbent firms' dynamics, this channel captures an important driver of productivity growth as documented by Bartelsman et al. (2009).

1.3.4 Projects

Projects are indexed by $e \in [0,1]$. The fixed cost of enacting a project is κ units of labor. An enacted project is successful with probability λ in generating an innovation. In Aghion and Howitt (1992) potential entrants are homogeneous, and of infinite mass. One of the key novelties in this model is how heterogeneity and scarcity are introduced into this framework, and how the *ex ante* heterogeneity of projects is related to the *ex post* heterogeneity of incumbents. In this economy, projects are heterogeneous in their expected

[10]Note that, because there is no efficiency improvement by incumbents, we have $q_{j,t} = (1+\sigma^d)\tilde{q}_{j,t}$. This framework can be easily extended to allow for undirected incumbent innovations.

cost reduction, and the ones with large expected reductions are scarce.[11] In particular, every project has an unobservable idiosyncratic probability $\theta(e) = e^{\nu}$ of generating a drastic improvement on productivity characterized by σ^H. As shown in Figure 1, the higher the index e is, the more likely it is for project e to generate a drastic (type-H) innovation, and hence, the higher the expected cost reduction. In this sense, e is more than an index, it is a ranking among projects based on their idiosyncratic $\theta(e)$, which is unobservable *ex-ante*.

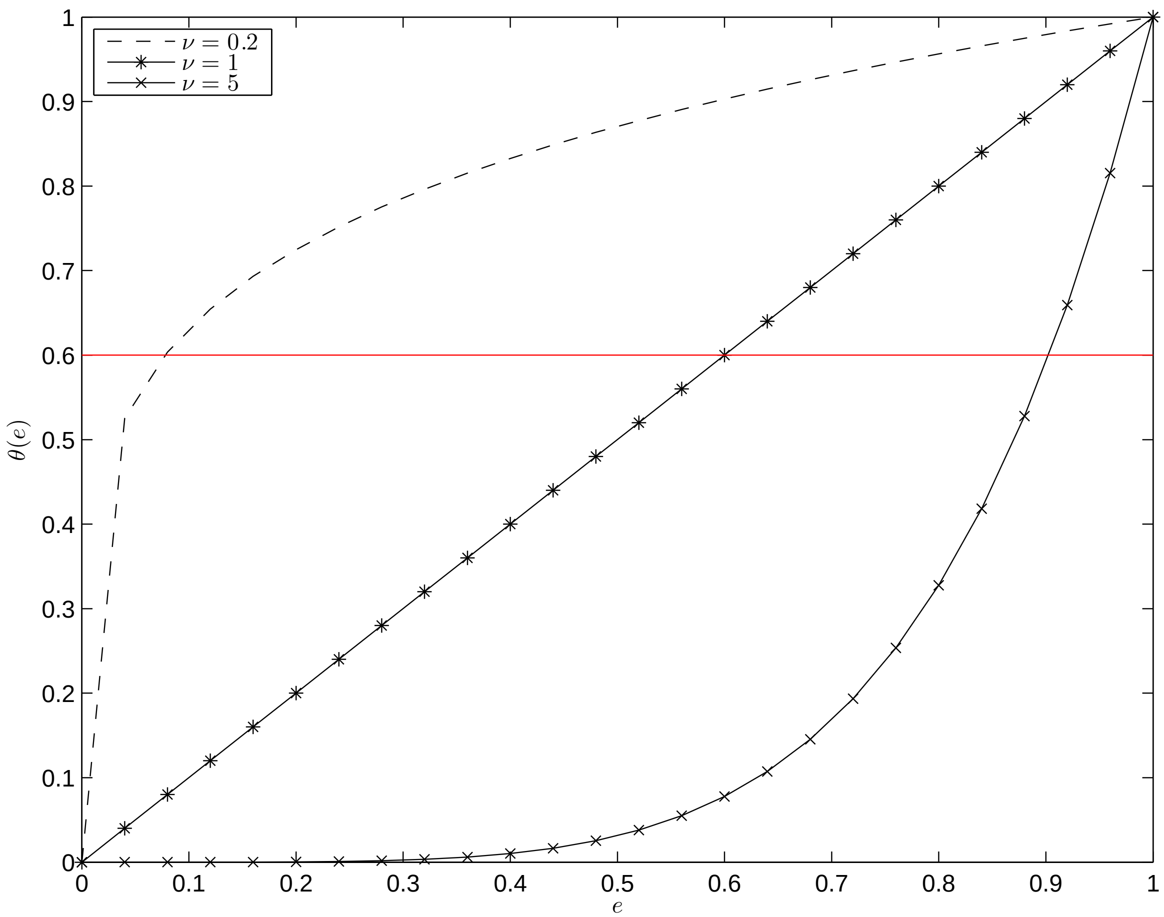


Figure 1: Project Heterogeneity

In this setting, ν governs the underlying scarcity of good projects in the economy. Figure 1 shows that for any $\bar{\theta} \in [0, 1]$, the higher the value of ν the fewer projects with a probability

[11] A similar strategy in a different framework is followed by Clementi and Palazzo (2013). They introduce *ex ante* heterogeneity linked with *ex post* firm productivity in the framework of Hopenhayn (1992) to study firm dynamics over the business cycle in a quantitative partial equilibrium model.

$\theta(e) > \bar{\theta}$ of generating a type H innovation. For example, when $\bar{\theta} = 0.6$, if $\nu = 0.2$ there is a mass 0.9 of projects that deliver a drastic innovation with probability higher than 0.6, whereas when $\nu = 5$ only a mass 0.1 is above that level. Hence, ν is a measure of the shortage of projects that are likely to produce drastic innovations. Proposition 1 translates the ranking of projects into a probability distribution for θ, the proof is provided in Appendix A.1.

Proposition 1. *We can characterize the probability distribution $f(\theta)$ by*

$$f(\theta) = \frac{1}{\nu}\left(\frac{1}{\theta}\right)^{1-\frac{1}{\nu}}$$

the mean of this distribution is given by $E[\theta] = \frac{1}{\nu+1}$. Moreover, the skewness $S(\nu)$ of $f(\theta)$ is given by

$$S(\nu) = \frac{2(\nu - 1)\sqrt{1 + 2\nu}}{1 + 3\nu}$$

and it is positive and increasing for $\nu \geq 1$.

We assume that good projects are scarce, this means $\nu > 1$. It translates into right-skewness of the probability distribution of drastic innovations, as suggested by the empirical research in this area. For instance, Silverberg and Verspagen (2007) use patent data to study the skewness of the patent quality distribution proxied by citations. They find that both the distribution of citations and the return to patents are highly skewed, and that the tail index is roughly constant over time.[12] The fraction of high-type improvements when enacting a set $M \in (0, 1]$ of projects is given by

$$\tilde{\mu}^H = \frac{1}{M}\int_0^1 prob(e \in M) \times \theta(e)\, de$$

[12] Other firm related variables with *fat tails* are widely documented in the literature. For instance, Moskowitz and Vissing-Jorgensen (2002) find large skewness on entrepreneurial returns. Axtell (2001) shows that the size distribution of US firms closely mimics Zipf distribution, where the probability of a firm having more than n employees is inversely proportional to n. Scherer (1998) uses German patent data to show the skewness of the distribution of profits and technological innovation.

Random selection implies that for all e, $prob(e \in M) = M$. We denote by $\underline{\tilde{\mu}}^H$ the proportion of high type project on the entering cohort under random selection. Then $\underline{\tilde{\mu}}^H$ equals the unconditional probability of observing a drastic innovation:

$$\underline{\tilde{\mu}}^H = \int_0^1 e^\nu de = \int_0^1 \theta f(\theta) d\theta = \frac{1}{\nu + 1}$$

Finally, the higher ν is, the lower the proportion of high type innovations among the randomly enacted cohort. This formalizes one of the main intuitions of the model, that projects are heterogeneous and good ideas are scarce.

1.3.5 The Representative Financial Intermediary

The second key novelty of this model is the introduction of a non-trivial financial system that screens and selects the most promising projects.[13] The representative financial intermediary has access to a unit mass of projects every period. It collects deposits from households, selects in which projects to invest according to their expected value, and pays back to the household the profits generated by these projects.[14] This set up implicitly assumes that all entrants are in need of external financing as enacting any project requires investment by the intermediary.[15] Note that, if $V^H_{j,t} > V^L_{j,t}$ for any product line j, the financial intermediary strictly prefers to enact projects with higher e. In particular, if e were observable, a financial intermediary willing to finance M projects would enact only the projects with $e \in [1 - M, 1]$. However, e is unobservable. Nevertheless, the financial intermediary has access to a costless, yet imperfect, screening technology that delivers a

[13] The closest reference of a financial intermediary performing this function in an endogenous growth model is King and Levine (1993b). Nevertheless, lacking a link between *ex ante* and *ex post* heterogeneity, the focus of their model is only in the effect of the mass of entrants.

[14] Alternatively, we can assume that the representative household owns the projects but does not have access to any screening technology. Hence it sells the projects to the representative financial intermediary at the expected profits net of financing costs, and the financial intermediary earns no profits.

[15] Nofsinger and Wang (2011) use data from 27 countries, to document that 45% of start-ups use funds from financial institutions and government programs. Categories for 2003: self saving and income (39.97%), close family members (12.79%), work colleague (7.7%), employer (14.18%), banks and financial institutions (33.92%), and government programs (11.02%).

stochastic signal $\tilde{e}$ defined by:

$$\tilde{e}_t = \begin{cases} \tilde{e}_t = e_t & \text{with probability } \rho \\ \tilde{e}_t \sim U\left[0,1\right] & \text{with probability } 1-\rho \end{cases}$$

Note that $\rho \in [0,1]$ characterizes the accuracy of the screening with $\rho = 1$ implying the perfect screening case. Levine (2005) suggests that one characteristic of financial development is the *improvement in the production of ex ante information about possible investments*. In this sense, the accuracy of the financial selection technology ρ is a reflection of the financial development of an economy. There is also empirical evidence of financial selection, for instance, Gonzalez and James (2007) document that firms with previous banking relationships perform significantly better after going public than firms without such relationships.[16] Define $V_t^d = E_j\left[V_{j,t}^d\right]$ to be the expected value of successfully enacting a project with step size d. Proposition 2 shows that when the expected return of a drastic innovation is higher than the one of generating an incremental innovation, the optimal strategy is to set a cut-off for the signal. The proof is provided in Appendix A.2.

Proposition 2. *If $V_t^H > V_t^L$, the optimal strategy for a financial intermediary financing M_t projects at time t is to set a cut-off $\bar{e}_t = 1 - M_t$, and to enact projects only with signal $\tilde{e}_t \geq \bar{e}_t$.*

When the financial intermediary optimally uses this technology to select a mass $M_t = 1 - \bar{e}_t$ of projects, the proportion $\tilde{\mu}_t^H(\bar{e}_t)$ of high type projects in the successfully enacted λM_t mass is given by

$$\begin{aligned} \tilde{\mu}^H(\bar{e}_t) &= \frac{1}{\lambda M_t}\int_0^1 \lambda \times prob(\tilde{e}_t \geq \bar{e}_t | e_t) \times \theta\left(e_t\right) de_t \\ &= \frac{1}{1-\bar{e}_t}\left[\int_0^{\bar{e}_t} \left(1-\rho\right)\left(1-\bar{e}_t\right) e_t^{\nu} de_t + \int_{\bar{e}_t}^1 \left\{\left(1-\rho\right)\left(1-\bar{e}_t\right)+\rho\right\} e_t^{\nu} de_t\right] \\ &= \frac{1}{\nu+1}\left[1-\rho+\frac{\rho}{1-\bar{e}_t}\left(1-\bar{e}_t^{1+\nu}\right)\right]. \end{aligned} \tag{1.11}$$

[16] Keys et al. (2010) document that the lower screening intensity in the sub-prime crisis generated between 10% and 25% more defaults.

Note that for any cut-off $\bar{e}$, the composition increases with the level of financial technology ρ and decreases with the scarcity of high type projects ν. Moreover, in terms of the resulting composition, financial selection performs at least as well as the random selection of projects. We summarize these properties in Proposition 3.[17]

Proposition 3. *The proportion of high type entrants $\tilde{\mu}^H$ exhibits the following features:*

1. *$\tilde{\mu}^H(\bar{e}_t)$ is increasing in $\bar{e}_t$. Moreover, $\tilde{\mu}^H(\bar{e}_t)$ is increasing in ρ and decreasing in ν for every $\bar{e}_t$.*

2. *$\tilde{\mu}^H(\bar{e}_t) \geq \underline{\tilde{\mu}}^H$ with $\tilde{\mu}^H(\bar{e}_t) = \underline{\tilde{\mu}}^H$ if $\rho = 0$ or $\bar{e}_t = 0$.*

3. *$\tilde{\mu}^H(\bar{e}_t) = \frac{1-\bar{e}_t^{\nu+1}}{(\nu+1)(1-\bar{e}_t)}$ if $\rho = 1$ and $\lim_{\bar{e}_t \to 1} \tilde{\mu}^H(\bar{e}_t) = \frac{1+\nu\rho}{\nu+1} \leq 1$*

In this set up, the financial intermediary collects deposits D_t from the representative household in order to enact a mass $M_t = \frac{D_t}{w_t \kappa}$ of projects every period. Proposition 3 implies that the financial intermediary will always use its screening device.[18] Then, given $\{V_t^H, V_t^L, r_t, w_t\}$ the financial intermediary chooses $\{\bar{e}_t, D_t\}$ in order to solve

$$\max_{\{D_t, \bar{e}_t\}} \quad \left\{ \frac{\lambda D_t}{w_t \kappa} \left[\tilde{\mu}^H(\bar{e}_t) V_t^H + (1 - \tilde{\mu}^H(\bar{e}_t)) V_t^L \right] - D_t(1 + r_t) \right.$$
$$\left. -\xi_1 \left(1 - \bar{e}_t - \frac{D_t}{w_t \kappa} \right) - \xi_2 \left(\frac{D_t}{w_t \kappa} - 1 \right) + \frac{\xi_3}{w_t \kappa} D_t \right\} \tag{1.12}$$

where $\{\xi_1, \xi_2, \xi_3\}$ are Lagrange multipliers that control for the range of $\bar{e}$, and the equality of the households' deposits to the demand of funds by the intermediary. Note that the term that multiplies the brackets in the first line is the mass of projects that are enacted and turn out to be successful. The bracketed term is the expected return of the portfolio with composition $\tilde{\mu}^H(\bar{e})$. The intermediary needs to pay back D_t plus the interest. As the objective function is strictly concave, the first order conditions are sufficient for optimality. As Proposition 3 states, a financial intermediary with $\rho > 0$ faces a trade-off between

[17] Proof is trivial and therefore omitted.

[18] When a fixed cost is included the partial solution exhibits a kink. In general equilibrium there is a region where the equilibrium implies not screening, another region where it always implies screening, and a third region characterized by non-existence. A well behaved variable cost does not alter the results significantly.

mass and composition of the enacted pool. Now, we examine the optimal decisions of the intermediary. First order conditions regarding $\{D_t, \bar{e}_t\}$, respectively, yield

$$\begin{aligned}
\frac{\lambda}{w_t\kappa}\left[\tilde{\mu}^H(\bar{e}_t)V_t^H + (1-\tilde{\mu}^H(\bar{e}_t))V_t^L\right] - (1+r_t) + \frac{\xi_1}{w_t\kappa} - \frac{\xi_2}{w_t\kappa} + \frac{\xi_3}{w_t\kappa} &= 0 \\
\frac{\lambda D_t}{w_t\kappa}\left(\frac{V_t^H - V_t^L}{\nu+1}\right)\left[\frac{\rho}{1-\bar{e}_t}\left(\frac{1-\bar{e}_t^{\nu+1}}{1-\bar{e}_t} - (\nu+1)\bar{e}_t^{\nu}\right)\right] + \xi_1 &= 0.
\end{aligned}$$

Note that if $\rho > 0$ then $\xi_1 < 0$ which in turn implies a positive wedge between the marginal revenue the intermediary generates and the marginal payment it needs to make to households. Therefore, the screening technology allows the intermediary to make positive profits. Furthermore, the unique interior solution ($\xi_2 = \xi_3 = 0$) is characterized by

$$\rho\bar{e}_t^{\nu} = \frac{\frac{w_t\kappa}{\lambda}(1+r_t) - V_t^L}{(V_t^H - V_t^L)} - \frac{1-\rho}{(\nu+1)} \tag{1.13}$$

The uniqueness crucially depends on ρ being larger than zero. Otherwise, there are no profits and the intermediary is indifferent when enacting any mass of projects.

This partial equilibrium result is quite intuitive. In fact, the cut-off is increasing in the enacting cost κ, the interest rate, the wages, and the scarcity of good projects ν. The cut-off is decreasing in the precision of screening technology ρ and in the value of the projects which means that, in these cases, the intermediary is willing to enact more projects.

1.3.6 Equilibrium

Having introduced the basic components of the model, we can examine its equilibrium and balanced growth path (BGP). First, we characterize the analytical relationships posed by the equilibrium conditions, then we narrow down our analysis further to state the existence and uniqueness of a BGP, and characterize it analytically.

Definition 1 (Equilibrium)**.** *A competitive equilibrium for this economy consists of quantities* $\left\{D_t,\ \left\{x_{t,j}^S\right\}_{j\in[0,1]},\ \left\{x_{t,j}^D\right\}_{j\in[0,1]},\ c_t,\ y_t,\ a_{t+1},\ \left\{l_{j,t}^d\right\}_{j\in[0,1]},\ \bar{e}_t\right\}_{t=0}^{\infty}$*, policy parameters*

$\{\tau, T_t\}_{t=0}^{\infty}$, *values* $\left\{\left\{V_{j,t}^{H}\right\}_{j\in[0,1]}, \left\{V_{j,t}^{L}\right\}_{j\in[0,1]}\right\}_{t=0}^{\infty}$, *prices* $\left\{w_t\,,\, r_{t+1}\,,\, \{p_{j,t}\}_{j\in[0,1]}\right\}_{t=0}^{\infty}$, *financial intermediary profits* $\{\Pi_t\}_{t=0}^{\infty}$, *intermediate good producer's profits* $\left\{\pi_{t,j}^{d}\right\}_{j\in[0,1]\,,\, t=0}^{t=\infty}$, *entrants and incumbents compositions* $\{\tilde{\mu}_t\,,\, \mu_t\}_{t=0}^{\infty}$ *and initial conditions* $\left\{a_0\,, \{q_{0,j}\}_{j\in[0,1]}\,, \mu_0^H\right\}$ *such that:*

1. *Given* $\{w_t\,,\, r_{t+1},\, T_t,\, \Pi_t\}_{t=0}^{\infty}$, *household chooses* $\{c_t\,,\, a_{t+1}\}$ *to solve* (1.1) *subject to* (1.2) *and* (1.3).

2. *Given* $\{p_{j,t}\}$, *final good producer chooses* $\left\{\left\{x_{t,j}^{D}\right\}_{j\in[0,1]}\right\}$ *to solve* (1.5) *every* t.

3. *Given* $\{w_t\}$, *and* $\{q_{j,t-1}\}$ *intermediate producer of good* j *with type* d *sets* $p_{j,t}$ *according to* (1.9), *and earns profits* $\pi_{t,j}^{d}$, *for every* t *that she remains the leader in product line* j.

4. *Given* $\left\{V_t^H\,,\, V_t^L\,,\, r_t\,,\, w_t\right\}$, *financial intermediary chooses* $\{D_t,\, \bar{e}_t\}$ *to solve* (1.12) *every* t.

5. *Labor, asset, final and intermediate good markets clear:*

$$\int_0^1 l_{j,t}^{d}\, dj + (1-\bar{e}_t)\kappa = L \tag{1.14}$$

$$a_t = D_t = (1-\bar{e}_t)w_t\kappa \tag{1.15}$$

$$x_{j,t}^{S} = x_{j,t}^{D} \quad \Rightarrow \quad l_{j,t}q_{j,t} = \frac{y_t}{p_{j,t}} \tag{1.16}$$

$$c_t = y_t = e^{\int_0^1 \ln x_{j,t} dj} \tag{1.17}$$

6. $V_{j,t}^{d}$ *evolves accordingly to* (1.10), $q_{j,t}$ *evolves accordingly to* (1.8), *and government budget is balanced every period.*

7. *The entrant's composition* $\tilde{\mu}_t$ *is determined by* (1.11) *and the composition of the product line* μ_t *evolves according to:*

$$\mu_{t+1}^{H} = \mu_t^{H} + \lambda(1-\bar{e}_{t+1})\left(\tilde{\mu}_{t+1}^{H} - \mu_t^{H}\right). \tag{1.18}$$

An important feature of this class of models is that profits, values, and labor across intermediate goods are independent of the efficiency level accumulated in product line j up to time t. As a result, the particular product line j does not matter for the determination of these values; the size of the last innovation is a sufficient statistic for them. This is summarized in Proposition 4, the derivation is in Appendix A.3.

Proposition 4. *Equilibrium:*

1. $\forall j \in [0,1]$ *and* $\forall D \in \{L, H\}$ *we have:*

$$\pi^d_{j,t} = \pi^d_t \quad ; \quad l^d_{j,t} = l^d_t \quad ; \quad V^d_{j,t} = V^d_t$$

2. *If* $\sigma^H > \sigma^L$*:*

$$\pi^H_t > \pi^L_t \quad ; \quad l^H_t < l^L_t \quad ; \quad V^H_t > V^L_t$$

Proposition 4 shows that in equilibrium we have $V^H_t > V^L_t$ and hence the financial intermediary uses a cut-off strategy when selecting projects.[19] The system of equations that characterizes the equilibrium is in Appendix A.4.

Definition 2 (BGP). *Define* $Q_t = \exp\left\{\int_0^1 \ln q_{j,t}\right\} dj$ *as the average efficiency level. The economy is in a Balanced Growth Path at time* T *if it is in such an equilibrium that,* $\forall t > T$*, the endogenous aggregate variables* $\{C_t, Q_t, Y_t, a_{t+1}\}$ *grow at a constant rate, and the threshold* $\bar{e}_t$ *is constant.*

Lemma 1 states the existence and uniqueness of a BGP for this economy. The proof is provided in Appendix A.5.

Lemma 1. *Existence and Uniqueness:*

[19] Note that more efficient leaders needs less labor to serve the demand of their variety. For concreteness, imagine a type H leader with a follower of productivity level $\tilde{q}$. This leader will charge the same price as a type L leader who is also followed by someone with efficiency $\tilde{q}$. This implies that both are selling the same quantity, nevertheless, the more efficient leader needs less labor to produce that quantity, and hence earns more profits.

$\frac{\kappa}{L} \in [a, b]$, where $\{a, b\}$ are constants that depend on the model parameters, is a sufficient condition for the existence and uniqueness of an interior BGP for this economy.

1.3.7 Mass and Composition Effect

As derived in Appendix A.5, the long-run growth of this economy is characterized by the following expression:

$$1 + g(\bar{e}) = \left[(1 + \sigma^H)^{\mu^H(\bar{e})}(1 + \sigma^L)^{1-\mu^H(\bar{e})}\right]^{\lambda(1-\bar{e})} \tag{1.19}$$

The economic intuition of equation (1.19) is clear: the long-run growth of this economy is the geometric mean of the efficiency improvement weighted by the composition of the entrants and scaled by the mass of entrants. The trade-off between mass and composition is manifested in this term. Lower credit standard (low $\bar{e}$) implies a larger pool of entrants that increases the exponent of this term, but also decreases the base through the indirect effect on composition $\mu(\bar{e})$. The interaction of these two margins determines the long-run growth $g(\bar{e})$. Nevertheless, $\bar{e}$ is an endogenous variable, so we should also clarify the optimization problem that determines this variable.

To understand the source of the trade-off it is useful to think about two alternative cases the intermediary could face when investing in projects: An economy with no accuracy ($\rho = 0$) where project initialization is random, and a model with no heterogeneity ($\sigma^H = \sigma^L$) where selection is useless. These two alternatives have in common that the expected step size of the marginal enacted project is constant with respect to the total enacted mass, destroying the trade-off between the enacted mass and its composition.[20] But, the full model is characterized by the decreasing expected step size of the marginal entrants with respect to the total entry, this tension introduces a trade-off between mass and composition

[20]In both cases, the financial intermediary has no profits. Nevertheless this is not the source of the composition effect, if we impose a zero expected profit condition, as long as $\rho > 0$ and $\sigma^H > \sigma^L$, all the results carry on.

into the model. Since this is a general equilibrium model, the economic impact of this trade-off should be assessed by studying the long-run comparative statics of the model. Proposition 5 shows the general equilibrium comparative statics to changes in the enacting cost κ, the patience coefficient β, and the corporate tax rate τ.[21]

Proposition 5. *General Equilibrium Comparative Statics:*

1. *An economy with higher enacting cost κ has higher lending standards, less entry but better composition. Long-run growth decreases with κ:*

$$\frac{\partial \bar{e}}{\partial \kappa} \geq 0 \qquad ; \qquad \frac{\partial g(\bar{e})}{\partial \kappa} \leq 0 \qquad ; \qquad \frac{\partial \mu^H(\bar{e})}{\partial \kappa} \geq 0$$

2. *An economy with lower patience coefficient β has higher lending standards, less entry but better composition. Long-run growth increases with β:*

$$\frac{\partial \bar{e}}{\partial \beta} \leq 0 \qquad ; \qquad \frac{\partial g(\bar{e})}{\partial \beta} \geq 0 \qquad ; \qquad \frac{\partial \mu^H(\bar{e})}{\partial \beta} \leq 0$$

3. *An economy with higher corporate tax rate τ has higher lending standards, less entry but better composition. Long-run growth increases with τ:*

$$\frac{\partial \bar{e}}{\partial \tau} \geq 0 \qquad ; \qquad \frac{\partial g(\bar{e})}{\partial \tau} \leq 0 \qquad ; \qquad \frac{\partial \mu^H(\bar{e})}{\partial \tau} \geq 0$$

Proposition 5 shows first that economies with higher enacting cost (κ) enact in equilibrium less projects and hence, exert a tighter selection. Note that those economies are characterized by a lower rate of long-run growth but a higher composition on their product line. Second, economies with a higher patience coefficient (β) save more they are able to enact more projects. Although those economies grow more in the long-run, their average composition is lower. Finally, economies with higher corporate taxes (τ) have lower entry

[21] We select these parameters for the intuitive relationship to the main mechanism of the model, other results are available upon request. The proof is provided in Appendix A.6.

rates and lower long-run growth, but higher composition. All these cases share an important result: the mass effect generated by the underlying parametric change dominates the composition effect. Nevertheless, the composition effect introduces non-linearities on the relationship between credit availability and growth. In fact, in the alternative models that lack either selection or heterogeneity any marginal amount allocated to project enaction has a constant contribution to growth. Therefore, the relationship between entry (or total credit) and growth is linear. The model presented here breaks that linearity introducing a non-trivial relationship between entry and growth shaped by the interaction between heterogeneity, scarcity, and financial selection that characterizes the economy. In fact, the strength of the selection margin that determines the magnitude of the trade-off between mass and composition rest on the accuracy of the screening technology of the financial intermediary. Before concluding this section, we study the relatively more complex effect of a better screening technology (higher ρ).

Intuitively, better selection technology can be used to avoid enacting bad projects or to aim for more high-type projects. On the one hand, we can expect economies characterized by a high entry rates to increase their lending standards (higher $\bar{e}$) in response to an increase in the accuracy of their financial system. In fact, for those economies the marginal project enacted is more likely to be of low type, so the marginal benefit of improving the overall quality of the pool by reducing its size outweighs the potential benefit of increasing its mass. On the other hand, economies that are currently enacting less projects, should be willing to relax the selection standards and aim for a larger entry, since the marginal entrant has a high probability of becoming a type H leader. Proposition 6 gives analytical support to this intuition.[22]

Proposition 6. *Financial Development:*

1. *Let $\bar{s} > \underline{s}$ be two constants that are determined by the model parameters. For any economy with an equilibrium level of selection $\bar{e} \geq \bar{s}$ a marginal increase in the accuracy*

[22]The proof is provided in Appendix A.6.

of the screening technology ρ will result in a less selective equilibrium.

$$\bar{e} \geq \bar{s} \Rightarrow \frac{\partial \bar{e}}{\partial \rho} < 0.$$

2. *For any economy with an equilibrium level of selection $\bar{e} \leq \underline{s}$ a marginal increase in the accuracy of the screening technology ρ will result in a more selective equilibrium.*

$$\bar{e} \leq \underline{s} \Rightarrow \frac{\partial \bar{e}}{\partial \rho} > 0.$$

Proposition 6 suggests that the effects of financial development are non-monotonic. In particular, the level of domestic savings shapes the marginal response of entry to changes in the accuracy of the financial system.[23] This non-monotonic relationship between domestic savings and financial development challenges the most widely used proxy for economic development in the empirical literature. In fact, most of the cross country empirical research that relates financial development and economic growth proxies the first by the credit to output ratio. If we emphasize the screening role of the financial system, this strategy is only valid for economies with low entry rates. Moreover, the ambiguous relationship between financial development and firm entry carries on to the effect in growth. For example, if an increase in ρ triggers a reduction in the entry, the final effect on growth will depend on the relative strength of the two margins: a smaller cohort *versus* a higher proportion of drastic improvements.

To sum up, this section introduced a long-run endogenous growth model that features project heterogeneity and financial selection. In this economy good ideas are scarce and the ability of the financial intermediary to select the most promising ones is limited. This induces a trade-off between mass and composition as the larger the entrant cohort is, the lower the fraction of drastic innovations in the economy. The growth rate of this economy is endogenously determined and results from the interaction between mass and composition

[23] Recall that equation 1.15 imply a one to one mapping between entry and savings in equilibrium.

effect described above.

1.4 Mass and Composition: Two Quantitative Illustrations

In this section we perform a quantitative exploration of the model to illustrate the relevance of the composition effect introduced in this chapter. After proposing a reasonable parametrization of the model, we revisit two classical development problems.

First, we study the effects of corporate taxation on firm entry and economic growth. The empirical research points to an almost insignificant negative effect on long run growth but a strong and significant negative effect on firm entry. As the trade-off between mass and composition effect implies that the marginal entrant's contribution to growth is decreasing in the size of a cohort, the model can successfully account for both facts.

Second, we study the impact of financial development in economic growth. In the baseline parametrization, financial development reduces entry but increases growth due to a better allocation of resources. In particular, more financially developed economies tight their lending standards, experiencing gains from the composition margin that outweigh the losses on the mass margin. This generates a negative relationship between the level of financial development and the size of the entrant cohort. Alternative parametrizations with lower entry rates can generate a positive relationship between mass and financial development. Interestingly, the marginal gain from reallocation is increasing in the level of financial development. Moreover, in line with the empirical literature, financial development influence growth mostly by improving the allocation of resources.

1.4.1 Parametrization of the Model

We focus the baseline parametrization in high income economies, and then in each experiment we study deviations from this set-up. We proceed this way due to the availability of empirical literature on mark-up, and manufacturing productivity for more developed economies. Table 1 shows the baseline parametrization for the quantitative experiments of this section.

κ	λ	σ^L	σ^H	β	ν	ρ	γ	τ	L
0.12	0.25	0.095	0.45	0.95	5	0.9	2	0.3	1

Table 1: Parameter Values

Given the normalization of the labor force to 1 the value of κ implies that 12% of the labor force is enough to enact all the projects in the economy. The value of λ implies that one out of every four projects are able to generate a successful innovation in some product line. When the innovation is drastic the increase in the productivity of labor is 45% while an incremental innovation just generates a 9.5% increase in productivity. Given the scarcity parameter ν, the underlying heterogeneity of the projects is such that one out of every six projects is expected to generate a drastic innovation, this implies a highly skewed distribution for the probability of generating a drastic innovation.[24] The value of ρ suggests that 90% of the projects are successfully screened by the financial intermediary. In line with the average statutory corporate tax for high income economies presented by Djankov et al. (2010), we set τ to 30%. Finally, the intertemporal elasticity of substitution is set to 0.5 and the patience coefficient β to 0.95.

Table 2 presents a summary of the long-run implications of the model under the baseline parametrization.

$\bar{e}$	μ^H	$\lambda(1-\bar{e})$	g	r	$\frac{\kappa w}{Y}$	$\kappa(1-\bar{e})$	$Av.(\sigma)$	$Sd.(\sigma)$	$Sk.(\pi)$
0.599	0.373	0.100	0.012	0.095	0.105	0.048	0.228	0.172	0.524

Table 2: Output of the Model

The resulting cut-off value implies that 40% of the projects are enacted, given the level of financial development the resulting composition on the intermediate good sector is more

[24]The implied skewness using Proposition 1 is 1.66, in general, any value larger than one is considered high.

than two times higher than the one under random selection. The entry rate of 10% is in line with the international firm level evidence for developed countries.[25] The growth rate is also consistent with the average labor productivity growth of the European Union and the United States reported by Ark et al. (2008).[26] Fracassi et al. (2012) report an average interest rate for start up loans in the United States 11.5% slightly higher than the one generated by this set of parameters.[27] According to the *Doing Business* project, the average entry cost in 2012 resulting from fees and legal procedures among the OECD countries was 4.5% of the average per capita income. Moreover, the average minimum capital requirement to start a business was 13.3% for those countries, also in 2012, so the entry cost generated by the model of 10.5% of the average income is in line with the data. Fairlie (2012) states that in 2011, according to the Kauffman index of Entrepreneurial Activity, 0.32% of adults in the United States were engaged in business creation every month. This implies that almost 4% of the adult population was engaged in entrepreneurship every year which is comparable to the 5% generated by the parametrized model. The average markup generated by the model is also consistent with the estimates of Christopoulou and Vermeulen (2012). They document an average markup of 28% for the manufacturing and construction sector in the United States between $1981-2004$ and a corresponding value of 18% for the Euro area. The standard deviation of the markup is roughly half of the one estimated by Dobbelaere and Mairesse (2005) for the French economy between $1978-2001$.[28] Finally, the resulting skewness of the profit distribution is roughly consistent with the values reported by Scherer et al. (2000).[29] The first quantitative experiment studies the effects of corporate taxation in both entry and growth rates.

[25] According to the International Finance Corporation's micro small and medium-size enterprises database the Euro area has an average entry rate of 8.9% between $2000-2007$ while United States has a 12.9% average entry rate between $2003-2005$.

[26] They report an average of 1.5% for the European Union between $1995-2005$ and 2.3% for United States over the same period.

[27] They use the complete set of start-up loan applications received by Accion Texas between $2006-2011$. This number is consistent with the 11.3% reported by Petersen and Rajan (1994) from the National Survey of Small Business Finance also in the US for the years 1988 and 1989.

[28] Their weighted markup average estimation (33%) more than doubles the one estimated for France by Christopoulou and Vermeulen (2012).

[29] Note that financial selection implies that not all the underlying skewness is passed to the composition of the intermediate producers.

1.4.2 Corporate Taxation, Firm Entry, and Growth

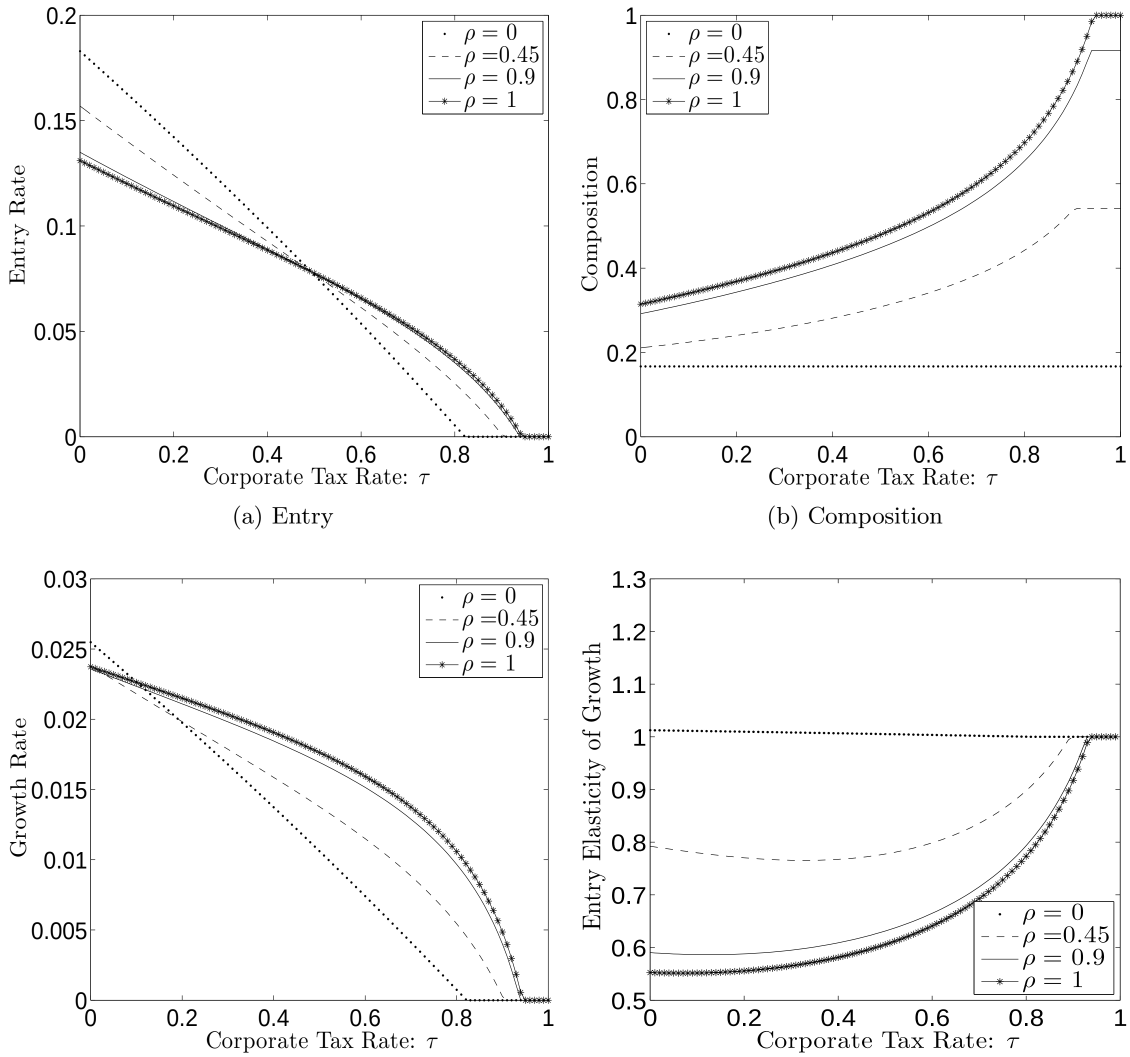
The empirical literature indicates a weak negative relationship between corporate taxes and long-run growth rates, whereas the effect on firm entry is found to be negative and sizeable. On the one hand, a cross sectional study with 85 countries performed by Djankov et al. (2010) suggests that decreasing the average tax rate from 29% to 19% would increase the average entry rate from 8% to 9.4%. Moreover, Da Rin et al. (2011) explore a firm level panel data for 17 European countries, and find a non-linear relationship between corporate taxes and entry rates with high responses in the relevant corporate tax range. On the other hand, the empirical growth literature finds only a slightly negative effect of corporate taxation on growth. To compare the magnitude of this relationship to the former stated regularity on entry rates we can take the estimation of Gemmell et al. (2011), where a 10 percentage points corporate tax reduction could increase long-run growth by at most 0.3 percentage points.[30] In summary, the research in corporate taxation suggests a fragile negative effect on growth and an economically significant negative effect on entry.[31]

Figure 2 shows the long-run responses of entry, composition, and growth in the model to changes in corporate taxation for the baseline parametrization ($\rho = 0.9$) and three other values of ρ. Figure 2d displays the entry elasticity of growth defined as the ratio of the percentage change in growth to the percentage change in entry generated by a one percentage point increase in taxation. In particular, an elasticity smaller than one in absolute value implies that marginal increases in taxation have larger absolute marginal effects on entry than in growth. In other words, growth responds to taxation less than entry does. In line with Proposition 5, increases in marginal taxation reduce both entry and growth, but

[30] Easterly and Rebelo (1993) study this relationship using a panel of 125 countries spanning over 1970 – 1988 and find that there is no robust effect of taxes on growth. Widmalm (2001), and Angelopoulos et al. (2007) establish a similar result for the OECD countries. Moreover, Levine and Renelt (1992) argue that the negative relationship documented in the literature is not robust to slight changes on the specifications of the econometric model.

[31] For concreteness, Appendix A.7 uses cross country data to illustrate that higher taxes are significantly and strongly correlated with lower entry, but the negative correlation with growth rate is extremely weak.

improve the composition of the economy.[32]



(a) Entry

(b) Composition

(c) Growth

(d) Elasticity

Figure 2: The Effect of Corporate Taxation on Growth and Entry

We first focus the analysis on the responses of the model when ρ is at its benchmark level. As Figures 2a and 2c show, the response of long-run entry and growth to changes in taxation are both highly non-linear, yet the growth rate exhibits the strongest non-linearity. Moreover, the responses of both, entry and growth are in line with the magnitudes suggested by the empirical literature discussed above. In fact, a tax cut of 10 percentage

[32]Recall that this result holds only for interior solutions. In fact, after a corner solution is met, entry and growth are both zero and do not react to extra taxation.

points from the baseline parametrization of 30% increases growth from 1.98% to 2.11% while the increase in entry from 10% to 12.5% is also in line with the empirical studies. This asymmetry in the response to taxation is summarized in Figure 2d: For a wide range of tax rates, the percentage decline in the growth rate caused by a one percentage point increase in taxation is only 60% of the corresponding decline in the entry rate. The reason behind this difference is the strength of the composition effect. As seen in Figure 2b the decrease in entry induced by higher corporate taxation implies tighter lending standards and hence a higher composition. In fact, financial selection implies that the contribution of the marginal entrant to growth is decreasing in entry. Therefore, the initial reductions in entry triggered by higher corporate taxation do not impose an important cost in terms of growth to this economy. Only when the level of taxation reaches extremely high levels, the sacrificed entrants pose a sizeable challenge to the long-run growth of the economy.

In a related article, Jaimovich and Rebelo (2012) use a similar mechanism to generate extremely non-linear responses of long-run growth to taxation. Their model combines the product line expansion framework of Romer (1990) with the heterogeneous ability framework of Lucas (1978). In a nutshell, entrepreneurs are heterogeneous in their ability to create firms, and more skilled entrepreneurs have a higher rate of success when enacting a project.[33] As the distribution of ability is highly skewed, relatively few entrepreneurs explain most of the entry rate of the economy. Hence, increases in taxation discourages only marginal entrepreneurs, and both the entry and the growth rates respond mildly for a wide range of taxes. In their model there is no *ex post* heterogeneity, all the active incumbents are identical, and hence the average *per firm* contribution to growth is the same for every cohort, regardless of its size.[34] In other words, even though their model features selection, the only engine of growth is the volume of the entrant cohort: the mass effect.

[33] In the context of our model, the heterogeneity is not in σ but in λ. Nevertheless, as the frameworks are completely different, this comparison need to be taken cautiously. In fact, Romer (1990) engine of growth is not the Schumpeterian creative destruction of Aghion and Howitt (1992), but an expansion in the number of intermediate varieties without replacement.

[34] They focus on self selection instead of financial selection, we believe that both mechanisms are present in the data and reinforce each other.

The absence of a composition channel implies that their model exhibits, by construction, an elasticity equal to one for any level of taxation, so it cannot generate any asymmetry between the responses of entry and growth.[35] Hence, the composition margin is fundamental when modelling this asymmetry.

Returning to Figure 2, to illustrate the key role of financial selection in determining the strength of the composition effect, we compare the baseline parametrization with three others that only differ in the value of ρ. The dotted line represents a model with no financial selection ($\rho = 0$) where project enaction is random, and in line with Proposition 3, composition is constant, and the responses of growth and entry to taxation are linear. Moreover, as shown in Figure 2d, there is no asymmetry between the two responses. The other two parametrizations exhibit intermediate levels of financial development. Figure 2a shows that for a wide range of corporate tax rates the parametrizations with lower levels of financial development exhibit higher entry rates. Nevertheless, as seen in Figure 2c, these economies are not able to capitalize the larger entry into higher economic growth. This is a consequence of the potential strength of the composition effect, where economies with less entry can grow at a faster pace only due to a higher proportion of drastic innovation. In fact, as shown in Figure 2b, the higher the corporate tax rate, the bigger the compositional advantage of the more developed economies. Moreover, for extremely high tax rates, a more developed economy can have larger and better cohorts than a less developed one, dominating the later not only in composition but also in mass. Finally, note that more financially developed economies exhibit extremely convex responses in growth, accentuating the asymmetry between the sensitivity of growth and entry to corporate taxation. This is clear in Figure 2d, where more financially developed economies have systematically lower entry elasticities to growth. Given the relevance of the financial development parameter ρ,

[35] Jaimovich and Rebelo (2012) do not study the effects on entry. When interpreting their results we use the same definition as in Romer (1990) for an entrant. Nevertheless, if an entrant is defined as one entrepreneur regardless of the number of product lines that she owns, then that model also generates this asymmetry between entry and growth. In this case, the composition should refer to the average size of an entrant in terms of the number of product line per entrepreneur. Yet, still the only engine of growth is the increase in the number of product lines, and hence, a mass perspective.

we explore quantitatively its influence in entry and growth in the next experiment.

1.4.3 Financial Development, Resource Allocation and Output Growth

To close the quantitative section we explore the interactions between financial development, resource allocation and output growth. In particular, we emphasize the relevance of Proposition 6 when studying the empirical relationship between financial development and economic growth. To illustrate this we present our results under three parametrizations that differ only in the fixed cost of project enaction (κ). Note that in Proposition 6, κ does not enter in $\bar{s}$ or $\underline{s}$, and it affects $\bar{e}$ monotonically. Hence, different values for κ are a natural choice to illustrate the non monotonicity introduced by changes in financial development (ρ) for economies with different entry rates. In particular, economies with high κ, which are characterized by a higher $\bar{e}$ and a lower entry rate, are likely to increase entry when ρ increases, but the opposite is expected from economies with low κ.

Size Measures and Financial Development

Figure 3 shows the long-run responses of entry, growth, composition, and the ratio of entry and composition effects to changes in the accuracy of the screening technology. To calculate the last component, we start by taking the natural logarithm of equation (1.19):

$$g_{t+1} \approx \ln(1+g_{t+1}) = \lambda(1-\bar{e}_t)\left(\mu_t^H \ln\left(\frac{1+\sigma^H}{1+\sigma^L}\right) + \ln\left(1+\sigma^L\right)\right)$$

Taking natural logarithm again we have:

$$\ln(g_{t+1}) \approx \ln(\lambda(1-\bar{e}_t)) + \ln\left(\mu_t^H \ln\left(\frac{1+\sigma^H}{1+\sigma^L}\right) + \ln\left(1+\sigma^L\right)\right)$$

Then, the change in this expression as a response to one percentage point shift in ρ yields approximately

$$\Delta\%_{\rho}\, g \approx \Delta_{\rho}\%\, mass + \Delta_{\rho}\%\, composition$$

Now we can define the relative measure of entry and composition effects at each level of ρ:

$$\eta_{\rho} = \frac{|\Delta_{\rho}\%\, mass|}{|\Delta_{\rho}\%\, composition|}.$$

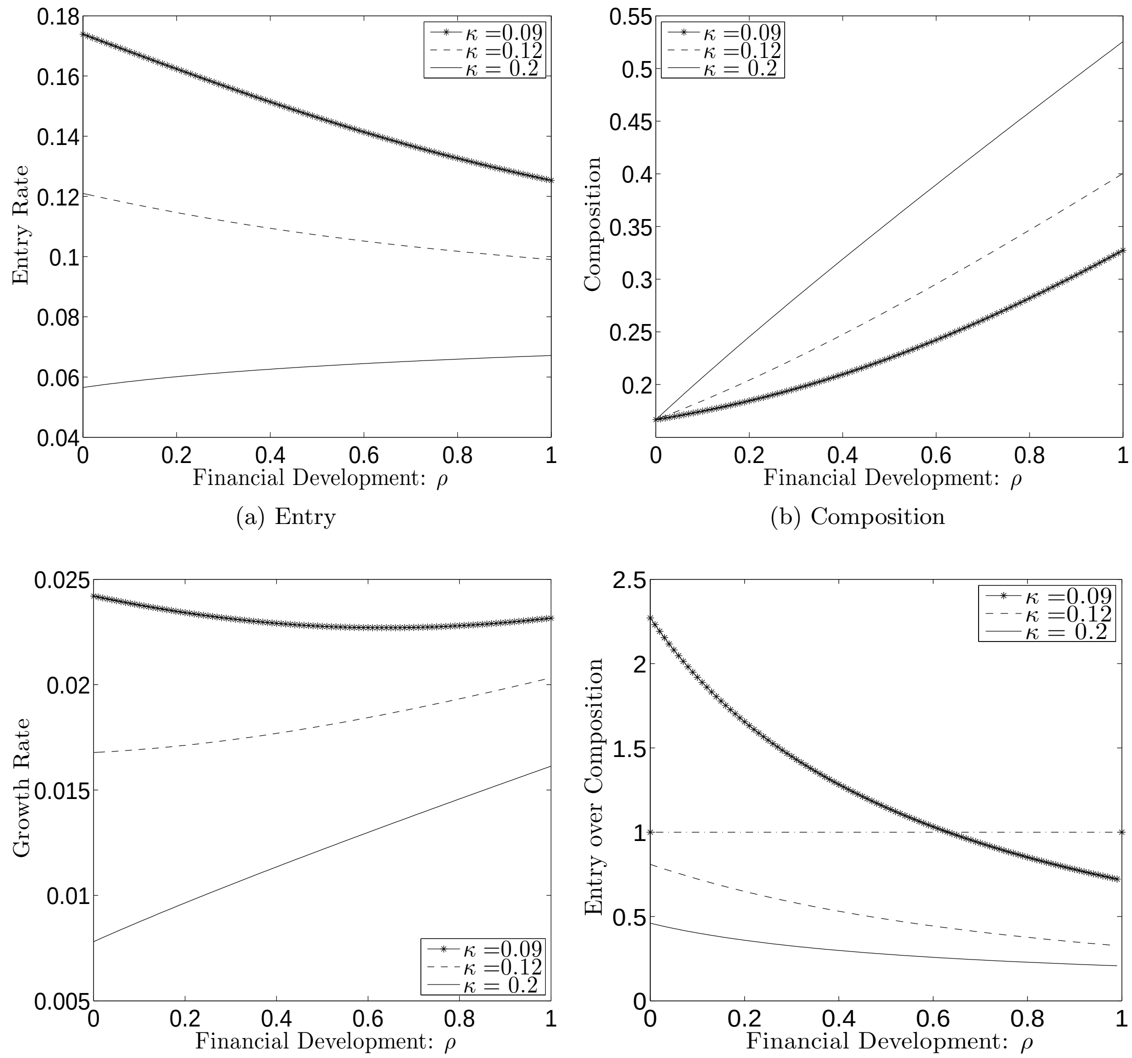
Note that, $\eta_{\rho} > 1$ implies that mass effects accounts for most of the percentage change in growth due to a marginal change in ρ, and $\eta_{\rho} < 1$ reflects the dominance of the composition effect.

In line with Proposition 6, Figure 3a shows that at high levels of entry (dashed and asterisk lines) entry rate decreases with financial development, while for the highest value of κ (solid line) the entry rate increases in ρ. As shown in equation 1.15, the entry rate $\lambda(1 - \bar{e})$ and the level of domestic savings $(1 - \bar{e})\kappa w$ are always positively related. As a result, the non-monotonicity between the entry rate and financial development implies that the relationship between domestic savings and financial development is not monotonic as well. Therefore, size based measures such as domestic credit over output do not necessary reflect the cross-country differences in the accuracy of the financial systems.

Resource Allocation and Financial Development

Note first that in Figure 3, under the baseline parametrization, mass and composition effects act in opposite directions: a higher level of financial development reduces the mass but improves the composition of the entrant cohort.[36] Note that as $\eta_{\rho} < 1$ for all the domain, the composition effect dominates the mass effect for this parametrization, and thus growth

[36] Two forces explain the rise in composition: a direct one due to the increase in ρ, and an indirect one due to the reduction in entry.



(a) Entry

(b) Composition

(c) Growth

(d) Relative Strength

Figure 3: The Effect of Financial Development on Growth and Entry

is increasing in ρ in Figure 3c. This suggests that under the baseline parametrization, the main source of growth is the reallocation of resources, and not an increase in the volume of resources allocated. In contrast, for low levels of κ (asterisk line) $\eta_\rho > 1$ in the low ρ region, the mass effect dominates, and output growth might even decrease with ρ.[37]

Figure 3d also shows that the relevance of the composition effect is always rising with

[37]Bose and Cothren (1996) find a similar result in the context of optimal contracting in an externality-driven growth model. Imposing a zero profit condition on the financial intermediary can eliminate this feature of our model.

ρ for every value of κ. This pattern can be explained using Figures 3a and 3b. While the proportion of high type leaders rises at increasing rates in Figure 3b, the changes in entry take place at decreasing rates for any κ. Moreover, for high levels of ρ, $\eta_\rho < 1$ at any value of κ. Hence, an increase in ρ in more financially developed economies translates into higher gains in growth mainly through the composition channel. In other words, more financially developed economies do not necessarily allocate more resources in order to grow, but they are more efficient in allocating them.

It is also interesting to note that for any given κ more financially developed economies experience larger improvements in growth due to a marginal increase in ρ than less developed economies do.[38] In fact, the effect of financial development on economic growth is highly non-linear: countries that are financially challenged benefit less from financial development than financially developed countries.

Related Empirical Work

Before reviewing some of the related empirical literature it is useful to recall the three main messages delivered by Figure 3: *i*) entry and financial development exhibit a non-monotonic relationship, *ii*) the main channel through which financial development affects economic growth is the better allocation of resources, rather than the allocation of more resources, and *iii*) the effect of financial development on economic growth is highly non-linear, more developed countries benefit more from marginal increases in their ability to select promising projects.

On the empirical side, the seminal contribution of Rajan and Zingales (1998) examine a cross country cross industry sample and find that industries with higher financial dependency grow faster in countries with more developed financial markets. Note that, in the context of the model presented in this chapter, industries more in need of the finan-

[38]Note that at higher levels of ρ the difference in growth rates for different entry costs κ decreases. In accordance with Asturias et al. (2012), this suggests that financial development helps to overcome entry barriers, and that the importance of ρ in terms of economic growth is greater when κ is higher.

cial system should be subject to more screening, and hence, grow more in more financially developed countries. Nevertheless, this analogy is accurate only if the empirical proxy for financial development is a good measure of the screening accuracy ρ. Rajan and Zingales (1998), as most of the literature, use a size measure in order to proxy for financial development, in particular, they use the total size of the stock market and the measure of domestic credit. But, as seen in Proposition 6, the amount of resources available in the credit market is not always positively related with the accuracy of the financial system.

Rioja and Valev (2004) explicitly mention this issue when using a 74 countries panel data to study if the effect of financial development in growth is monotonic across levels of financial development. In fact, they use three proxies for financial development, two of them centered on the size dimension (private credit and liquid liabilities) and a third measure that tries to proxy for the ability of an economy to perform a more accurate selection (the ratio of commercial bank assets over central bank assets).[39] For the two size measures they find that the effects of financial development are stronger for countries with an intermediate level of financial development than for countries with high levels. Moreover, the effect on countries with very low levels of financial development is insignificant. Nevertheless, when using the third measure, they also find a significant economic effect for lower levels of financial development. All their specifications point to strong non-linearities in both the relationship between volume of credit and economic growth, and the relationship between screening intensity and economic growth. These observations are in line with the non-linearities displayed under different parametrizations in Figure (3).

In another related empirical study, Wurgler (2000) studies the efficiency of the allocation of resources for different economies. His main contribution is the development of an elasticity based index that measures the ability of an economy to increase its investment

[39]The empirical work of King and Levine (1993b) and King and Levine (1993a) states these and other proxies for financial development. They suggest that the higher this ratio is, the stronger the screening in the economy, since commercial bank tend to exert a more thorough selection. For each of their measures they find a strong relationship between economic growth and financial development, moreover, they use case studies of financial reforms to validate them.

in growing industries, and decrease it in the ones that are shrinking. He finds no significant relationship between the volume of capital allocated in manufacturing and his proxy for financial development. Therefore, in line with Figure 3d, financially more developed economies grow faster mainly because of a better allocation of resources. He also finds that his measure of efficient capital allocation is strongly and positively related with the idiosyncratic (firm level) information available in the stock prices, a measure of the information available in the economy.[40]. Finally, Galindo et al. (2007) use a different approach to study the relationship between finance and the allocation of resources.[41] They use firm level panel data for 12 developing countries to build a measure of the efficiency in the allocation of resources, and then they use the chronology of financial reforms in Laeven (2003) for those countries. They find that episodes of financial liberalization are linked to better allocation of resources, but not necessarily to a larger mobilization of resources, this is again consistent with Figure 3d.

In sum, this section presented a quantitative examination of the strength and relevance of the composition effect. The first experiment showed that the composition effect can overturn the mass effect and allow an economy to grow faster even when enacting less projects. We also explained how the composition effect can rationalize the empirical relationship between corporate taxation, firm entry, and economic growth. The second illustration replicated the empirically observed non-linear relationship between financial development, allocation and reallocation of resources. This experiment also exemplifies the risks associated with the use of volume based proxies for financial development.

[40]The lower price *synchronicity* on the stock market, measured as in Morck et al. (2000), the higher the idiosyncratic information contained on the stock. He also finds that reallocation is more efficient when state ownership declines, and minority stockholder rights are strong

[41]They also review the cross country and firm level literature on the relationship between financial liberalization and growth. They argue that the positive effect on growth is well established, while a clear effect on the amount of resources allocated has not been found.

1.5 Skewness: A Proxy for Financial Selection

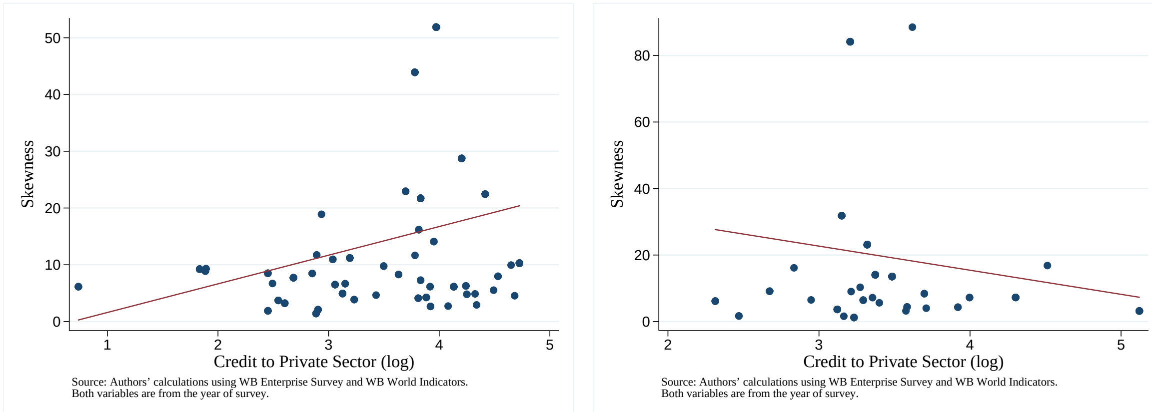
This chapter suggests that size-based measures are not appropriated proxies to assess the accuracy of the financial development in an economy when allocating resources to their best uses. In this section, we propose a micro-based measure that can potentially capture the selective function of the financial system. We also show that in line with the prediction of the model, size based measures and the proposed proxy behave non-monotonically.

The model implies that economies characterized by high accuracy (ρ) are successful at selecting projects ranked above the intended threshold ($e \geq \bar{e}$). Thus, among the enacted projects there are only few that with extremely low probability will generate a high cost reduction. This implies that the left tail of the realized ratio of value added to cost (profitability) among entrants is thin. Therefore, more financially developed economies should be characterized by low skewness in the profitability distribution of their incumbents.[42] Data to generate this variable are obtained from Private Enterprise Survey conducted by the WorldBank. This is an annual survey of about 135,000 firms in 135 countries that focuses on the financial and private sectors. Cost is defined as sales minus electricity, raw materials, and labor expenses. Value added is sales minus cost. Each observation of skewness is weighted by the firm weights specified by the survey. For the relevance of using weights, see Garcia-Santana and Ramos (2013).

According to Proposition 6 for low entry rates more financial development (lower skewness) should be associated with higher resources to firm entry, whereas the opposite should hold for countries characterized by high entry rates. We build our size based proxy to take into account the different entry costs across countries. In particular, we divide domestic credit by the average entry cost faced by firms, it reflects the total numbers of firms that could be created if all the credit is used to finance start-ups. We call this variable *Credit to the Private Sector*. Following our theoretical result we divide the sample of countries into

[42] The underlying assumption is that countries of interest have similar levels of ex-ante skewness across the potential projects.

two groups: below and above median entry, and we evaluate the relationship of the two measures.



(a) Above median entry

(b) Below median entry

Figure 4: Financial Development and Private Credit

Figure 4 shows the results.[43] Our finding confirms the theoretical argument. Financial development and private credit have indeed a non-monotonic relationship, and the direction of it is governed by the level of entry rate, as suggested by our model. This again shows why a researcher should be cautious when proxying the level of financial soundness of an economy with measures that only reflect the size of funds available to firms. Such proxies capture only one side of the impact of the financial development on economic growth, yet miss another one: the selective role in allocating resources. Hence, variables that capture the selective margin of the financial system should complement the empirical analysis of financial development. As a first candidate, we propose the skewness of the ratio of value added to cost observed in the economy.

1.6 Conclusion

In this chapter we introduced project heterogeneity and financial selection in an analytically tractable way to the classical endogenous growth framework of Aghion and Howitt

[43] Figure 22 in Appendix A.8 presents a version after removing the outliers. Results remain the same.

(1992). A financial intermediary, with access to an imperfect screening device, selects *ex ante* heterogeneous projects characterized by an idiosyncratic probability of generating a drastic innovation. Following implementation of the projects, the model also delivers an *ex post* heterogeneity, where two types of incumbents have different cost advantages over their followers, and hence, earn more profits. The model has a unique interior balanced growth path shaped by the Schumpeterian creative destruction generated by new firms. The impact of creative destruction in this economy results from the interaction between the mass and the composition of the entrant cohort. The relative strength of each margin crucially depends on the underlying scarcity of drastic ideas relatively to the accuracy of the selection technology in the economy.

Two quantitative experiments illustrate the importance of including heterogeneity and financial selection into the endogenous growth framework. First, since the marginal entrant has a decreasing contribution to economic growth, changes in the entry rate are not linearly mapped into the economic growth rate of the economy. Hence, this framework can accommodate the strong negative relationship between entry rates and corporate taxation without delivering a counterfactually strong negative effect of corporate taxation on economic growth.

The second experiment addresses the widely-debated link between financial development and economic growth. Two main lessons arise from this experiment. First, size-based measures miss the selective role of financial system and therefore are not good proxies for financial development. Hence, variables that capture the selection aspect should complement empirical work that aim to assess the level of financial development. As a first step, we suggest the skewness of the ratio of value added to cost across firms. The idea is that as financial selection improves less extremely unproductive firms operate in the market, reducing the *bad* tail of the value added to cost distribution. Second, the effect of financial development in economic growth is extremely non-linear. In particular, for a country with a high degree of financial development, a marginal increase in that financial development leads to a greater increase in growth, relative to the change in firm entry.

The next chapter extends this framework to study the growth effect of a credit crunch. A stochastic version of this model is well suited for economic analysis even outside the balanced growth path. Moreover, when using firm level data from Chile and the financial crisis triggered by the Russian sovereign default of 1998 as a natural experiment to test the model, we observe a strong compositional component; in fact, cohorts born under tighter credit conditions perform significantly better than cohorts arising under laxer credit standards. We believe that this framework can be enriched and brought quantitatively to data in order to perform policy analysis. For instance, changes in corporate taxation, entry barriers or financial liberalization can be evaluated, even accounting for the economic transition between the two balanced growth paths.

Chapter 2

Fewer but Better: Sudden Stops, Firm Entry, and Financial Selection

This chapter is co-authored with Sînâ T. Ateş.

Abstract

In this chapter, we build an endogenous technical change model into a stochastic small open economy framework to study the aggregated productivity cost of a sudden stop. In this economy, productivity growth is determined by successful implementation of business ideas, yet the quality of ideas is heterogeneous and good ideas are scarce. A representative financial intermediary screens and selects the most promising ideas, which gives rise to a trade-off between mass (quantity) and composition (quality) in the entrant cohort. Chilean firm-level data from the sudden stop triggered by the Russian sovereign default in 1998 confirms the main mechanism of the model, as firms born during the credit shortage are *fewer, but better*. A calibrated version of the economy shows the importance of accounting for heterogeneity and selection, as otherwise the permanent loss of output generated by the forgone entry after a 100 basis point increment in the interest rate is overestimated by 45%.

2.1 Introduction

In August 1998, the Russian sovereign default triggered a violent sudden stop in the developing world.[1] Interest rate spreads for the seven biggest Latin American economies tripled in the weeks after this crisis, decreasing the availability of external funding by 40% between 1998 and 2002.[2] Most of the economic analysis of these crises of interest rate spreads is centered on the short-run detrimental effects that they imposed on the real economy. Nevertheless, cross-country empirical studies have documented persistent output losses associated with large economic downturns, due to permanent losses in total factor productivity.[3] Because firm entry is an important driver of productivity growth, and because start-ups are in need of external funding, distortions in firm entry are likely to cause part of this long-run cost.[4]

Evaluating the cost of forgone entry is not an easy task. On the one hand, behind every firm lies an entrepreneur's idea, and ideas are not born alike. In fact, drastic innovations are a scarce resource.[5] On the other hand, because the financial system does not allocate funding randomly, not every idea has the same chance of being granted an opportunity.[6] Not surprisingly, when resources are scarce, banks adopt higher lending standards, and fund only the most promising projects.[7] Therefore, the better the financial system is at picking the most promising start-ups, the higher will be the average contribution of this smaller cohort. The main novelty of this study is the recognition that the scarcity of good ideas and

[1]A sudden stop in capital flows is a large and abrupt decrease in capital inflows, characterized by jumps in sovereign spreads and quick reversals of current accounts deficits.

[2]These numbers are from Calvo and Talvi (2005).

[3]See, for instance, Cerra and Saxena (2008), Blyde et al. (2010), and Queraltó (2013).

[4]The importance of the entry margin is discussed by Bartelsman et al. (2009), and Nofsinger and Wang (2011) document how start-ups are in need of external funding; see Section 2.2 for details. Moreover, Klapper and Love (2011) use a cross-country panel of 91 countries to document a 25% decrease in business formation during the Great Recession of $2008-2009$.

[5]For the heterogeneity and scarcity of ideas, see Scherer (1998), and Silverberg and Verspagen (2007), among others.

[6]The masterful survey on financial development and growth by Levine (2005) discusses the allocative function of the financial system.

[7]For example: Asea and Blomberg (1998), Holmstrom and Tirole (1997), Schmidt and Nehls (2003), Tornell et al. (2004), Ikhide (2003), Agénor et al. (2004), and Chan-Lau and Chen (2002).

the presence of financial selection induces a trade-off between the size of the entrant cohort and the average contribution of each firm within that cohort to aggregate productivity. Consistent with this intuition, we show empirically that firms born during a sudden stop are *fewer, but better*. Failure to consider this trade-off would imply that discarded projects are just as productive as actual entrants, magnifying the productivity cost of a crisis, and potentially misleading public policy. Thus, the ability of the financial system to allocate resources between heterogeneous projects needs to be taken into account when facing the main question of this chapter: what is the productivity cost of the forgone entry during a sudden stop?

An innovative model is then needed to answer this question, specifically one that allows us to separate and quantify the effects of the size and the quality of the entrant cohort on the long-run productivity loss. Three ingredients are fundamental to building an appropriate model: (i) generating a sudden stop requires a small open economy subject to stochastic interest rate fluctuations; (ii) creating a connection between these short-run episodes and the long-run level of productivity implies that growth has to be endogenous; and, (iii) a meaningful selection margin requires a financial intermediary that allocates resources among heterogeneous projects. The next paragraph digs deeper into the structure of this model.

In a nutshell, aggregate productivity in this economy evolves following a Schumpeterian concept of growth, where new firms (entrants) replace established firms (incumbents). In particular, because new intermediate goods producers are more productive than incumbents, Bertrand monopolistic competition implies that the newcomer sets a price that forces the old incumbent to exit. In order to study the role of financial selection in firm entry and productivity accumulation during a sudden stop, three main innovations are added to this traditional endogenous growth framework. The first variation introduces *ex-ante* and *ex-post* heterogeneity in productivity improvements. A representative financial intermediary owns business plans that can generate either a drastic or a marginal productivity improvement in the production technology of an intermediate variety. Every project is characterized by its idiosyncratic probability distribution over those two outcomes. Hence, projects are *ex-post* heterogeneous in terms of the productivity advantage that they enjoy after entering an industry, and they are also *ex-ante* heterogeneous with respect to their idiosyncratic probability of generating a drastic innovation. This ingredient allows us to model the underlying scarcity of the economy, where only a few ideas are highly likely to give birth to outstanding incumbents. The second addition adds an imperfect screening device to the model. The financial intermediary cannot unveil the *ex-ante* heterogeneity of its projects but it can observe noisy signals of their potential. The optimal allocation of funding follows a cut-off rule based on the signal. This ingredient introduces a linkage between the size of the entrant cohort and the average efficiency gain generated by its members. In fact, periods of laxer credit standards (low cut-off) are characterized by a larger cohort and lower average efficiency gains. The strength of this link and its implications for entry and productivity are determined by the accuracy of the screening device of the financial system. The third modification incorporates elements from the stochastic small open economy literature. This feature introduces economic dynamics into an otherwise deterministic model. Note that, since the financial intermediary borrows at the stochastic interest rate to finance start-ups, interest rate shocks trigger entry and productivity dynamics that are absent in a traditional open economy framework. The model has a unique non-stochastic interior balanced growth path that allows for quantitative solutions of the stochastic dynamic equilibrium. In the model economy, a mass/composition trade-off (that is, a quantity/quality trade-off) arises at the cohort level: periods of high interest rates are characterized by high credit standards that give rise to smaller cohorts with higher expected average productivity.

The empirical section of this chapter studies the Chilean sudden stop to validate the trade-off between mass and composition at the core of the model. We focus on Chile for three reasons: (i) it is a small open economy; (ii) we have access to plant level data for Chilean manufacturing firms, which allows us to directly study entrant cohorts; and, (iii) -as argued by Calvo et al. (2006)- the sudden stop after the Russian sovereign default is mainly exogenous to the Chilean economy. We show that firm entry in Chile from 1996 to 2007 decreased by 40% during the sudden stop, even at the three digit industry level. However, firms born in crisis are not just fewer, they are also better. In fact, the econometric analysis in Section 2.4 shows that cohorts born in crisis are 14.4% more profitable than cohorts born in normal times.

In the quantitative section of the chapter, we calibrate the model to the Chilean economy between 1996 and 2007. We then use the Chilean sudden stop to assess the performance of the model, fitting the real interest rate faced by the country during this episode. Although the model is stylized, with its single shock it is able to approximate the non-targeted behavior of the macro aggregates during the crisis. For example, the model can explain 80% of the decrease in hours, consumption, and firm values. Moreover, entry rate falls by 25% in the model during the crisis, and the average profitability for those cohorts increases by 7%. Hence, this parsimonious model can account for roughly 65% of the decrease in entry and more than 45% of the increase in profitability of entrants documented in the empirical section. After validating the model, we introduce two modified economies in order to assess the role of heterogeneity and selection in shaping the effect of a sudden stop: a model with exogenous growth, and a model with endogenous growth but no heterogeneity. We use those alternative economies to highlight the role of firm entry and financial selection when the economy is hit by a shock that increases the interest rate by 100 basis points.

Three important features arise from the comparisons of these models. First, acknowledging the endogeneity of technological progress amplifies the short-run effects of a crisis. For instance, the baseline model amplifies the effects of a sudden stop in output by 15%, compared to the model with exogenous growth. Second, including heterogeneity among intermediate goods producers triggers compositional dynamics that increase the short-run persistence of these episodes. Third, distortions in the entry margin trigger permanent losses in output in the models with endogenous technological change. The composition margin dramatically shapes the long-run cost of these short-run crises. In fact, the model with no heterogeneity generates a permanent loss in output of 0.8%, while, in the baseline model, the long-run permanent loss in output is 0.55%. Thus, if we ignore the existence of heterogeneity and selection and judge the forgone entry using successful start-ups as the measure, then the cost of the forgone entry is overestimated by 45%. This is a large economic magnitude that can bias public policy during a crisis toward entry subsidies or indiscriminate government lending.

The structure of the chapter is as follows. The next section (Section 2.2) revisits both the empirical literature that motivates the main mechanism of this study and the theoretical literature to which our model contributes. Section 2.3 introduces our model and characterizes the existence and uniqueness of an interior balanced growth path. Section 2.4 presents the analysis of the Chilean economy as a natural experiment for the model, exploring at the macro and micro level the consequences of the sudden stop for the Chilean economy. Section 2.5 presents the calibration of the model and the quantification of the long-run cost of a sudden stop. Finally, Section 2.6 concludes the chapter and suggests avenues for future research.

2.2 The Mechanism and the Literature

Increasing attention has been driven to the lack of recovery from large economic downturns. For instance, Cerra and Saxena (2008) document highly persistent output losses associated with a variety of economic crises. In their main specification, less than one percentage point of the deepest loss in output is regained after a decade. In this sense, the neoclassical *catch-up* intuition, where stationary fluctuations have no long-run effects on output, would be just a *myth*. Queraltó (2013) uses the same methodology to show that financial crises have long-lasting effects on labor productivity. Blyde et al. (2010) focus their analysis on measured total factor productivity (TFP).[8] They document large and persistent TFP losses associated with output collapses characterized by negative interest rate shocks.

[8]They measure TFP using a Solow residual approach.

Therefore, they suggest that a long-run loss of productivity triggered by those episodes could explain the *myth of economic recovery*. In this chapter, we explore how financial crises generate long run costs by disrupting the process of firm creation.

In the Schumpeterian concept of long-run growth, firm entry is a powerful engine of productivity gains as more efficient entrants replace less productive incumbents. The importance of this margin is confirmed by the empirical literature. Bartelsman et al. (2009) perform a cross-country firm level productivity decomposition that suggests that the entry margin accounts for 20% to 50% of labor productivity growth for the 15 countries in their sample. Then, if a sudden stop affects the entry of new firms, it could potentially reduce the productivity level of the economy. What can we infer about this link from the empirical literature?

On the one hand, cross-country entrepreneurial data points to external financing as an important source for start-up capital. For instance, Nofsinger and Wang (2011) document that, in their entrepreneurial dataset for 27 countries, 41% of start-up capital on average comes from external financing. Therefore, periods characterized by low availability of funds could dramatically reduce the size of the entrant cohort and dampen aggregate productivity. On the other hand, ideas are heterogeneous, and good projects are scarce. In fact, the empirical study by Silverberg and Verspagen (2007) shows a highly skewed distribution of citation of patents, and Scherer (1998) derives the same pattern from the distribution of profits related to innovation. Hence, ideas are not born equal, even before entering an industry; projects are heterogeneous, and success is scarce among them. Therefore, in order to assess the cost of difficult financial times, it is fundamental to understand which ideas are being discarded.

The fundamental question is then, how good is the financial system at selecting the most promising projects? In fact, if the financial system just randomly allocates credit, then promising projects are just as likely to be accepted as mediocre ones. Accordingly, in a financial crisis, many good projects would be dismissed and the productivity loss would be considerable. But the empirical literature suggests that the financial system is in fact quite able to assess the quality of different projects. In particular, Jayaratne and Strahan (1996) use the relaxation of bank branch restrictions in the United States to study the effects of competition on growth. Their main finding is that competition induced a tighter selection in lending instead of augmenting the availability of resources, so the increase in the average quality of entrants implied higher growth in the liberalized states. Dell'Ariccia et al. (2012) also provide evidence of financial selection. Using data from rejection rates during the sub-prime mortgage crisis, they find evidence of systematic changes in credit standards, even after controlling by the quality of the pool. Moreover, they point to a trade-off between the volume of credit granted and the average quality of those loans.[9] Therefore, the financial system has the ability to willingly affect the average quality of the projects that are financed.

In a nutshell, the main motivation of the economic mechanism that drives our model is drawn from recent empirical research. In fact, if projects are heterogeneous and good ideas are scarce, because loans for start-ups are not given randomly, the expected contribution of the forgone projects should be considerably lower than the average contribution of the entrant cohort. Therefore, the long-run cost of a financial crisis is strongly related to the ability of the financial system to select the most promising projects.

On theoretical grounds, we build an endogenous growth model, where *ex-ante* heterogeneous projects materialize in *ex-post* heterogeneous firms with a financial system that screens and selects the more promising projects. We nest this model in an open economy stochastic framework in order to study the effects that external shocks to the interest rate trigger on the mass and composition of the entrant cohort, and, thus, on the aggregate productivity of the economy. The latter implies that we can relate to at least two distinct strands of literature.

[9] Jiménez et al. (2014) show how banks react to changes in the cost of funding, adjusting the standards used for rejection; in particular, a lower overnight interest rate is associated with more loans to firms with higher *ex-post* probability of default.

Firstly, we embrace the Schumpeterian tradition of creative destruction in an endogenous growth model formalized by Grossman and Helpman (1991) and Aghion and Howitt (1992). In this tradition, we are closely related to a new generation of business cycle models where short-run stationary fluctuations can affect the process of creative destruction. For instance, Fatas (2000) documents a positive correlation between the persistence of business cycles and the average long run growth of an economy. His stochastic endogenous growth model with pro-cyclical productivity improvements generates this fact naturally. Barlevy (2004) shows how a stochastic version of Aghion and Howitt (1992) can increase the famous Lucas (1987) cost of business cycles by two orders of magnitude. Nuno (2011) combines the real business cycle framework of Kydland and Prescott (1982) with Aghion and Howitt (1992) to explain the pro-cyclical nature of research and development expenditure, and studies optimal research subsidies throughout the economic cycle.

This chapter makes at least two contributions to the existing literature. First, it formalizes the intuition that good ideas are scarce and that the financial system does not select projects randomly. Second, it includes a link between *ex-ante* and *ex-post* heterogeneity that allows a meaningful composition discussion. There have been diverse attempts to include *ex-ante* heterogeneity and selection in the three main frameworks of endogenous growth models. Examples include Bose and Cothren (1996) in the Romer (1986) tradition, Jaimovich and Rebelo (2012) in the Romer (1990) framework, and King and Levine (1993b) in the Schumpeterian tradition. Nevertheless, since there is no *ex-post heterogeneity* in those models, no compositional dynamics arise. Moreover, those models are fully deterministic, and hence cannot study the long-run cost of a financial crisis.

Secondly, it builds on the framework of Mendoza (1991) for real business cycles models in small open economies. In particular, we build on the models of Neumeyer and Perri (2005) and Uribe and Yue (2006) to include endogenous growth, heterogeneity, and financial selection.[10] A recent paper by Queraltó (2013) also includes an endogenous growth

[10] Aguiar and Gopinath (2007), document that developing small open economies exhibit substantial volatility in trend growth. This suggests that a model with a deterministic trend is not appropriate for those coun-

framework in a small open economy model. The endogenous growth model at the core of that paper is the framework that Comin and Gertler (2006) build around Romer (1990). Queraltó (2013) studies the long lasting productivity effects of a financial crisis; in particular, in his model an interest rate shock triggers a balance sheet channel, as in Gertler and Kiyotaki (2010), which harms the process of invention and implementation. Ergo, fewer firms enter the market and fewer ideas are developed for future use. The first effect amplifies the impact of the crisis, and the second effect delays the recovery. Another recent paper by Gornemann (2013) combines the endogenous default framework of Mendoza and Yue (2012) with the variety model of Romer (1990) to study how endogenous growth affects the decision of the sovereign to default. Because default increases the price of imported intermediate goods in his model, it decreases the expected profits of potential entrants, and hence, depresses productivity growth. Besides the Schumpeterian framework of our model and the focus on financial selection, we have two other differences with respect to those articles. First, there is no heterogeneity in either of them, so the only driver of growth is the mass of entrants, and therefore no compositional dynamics can arise. Second, we use firm level data to support our channel, calibrate the model, and assess its performance.

Finally, a related literature has focused on the short-run reallocation effects of recessions between incumbent firms. These articles point to three different effects. First, recessions facilitate the exit of less productive incumbents (*cleansing effect*). Second, these downturns destroy promising firms before they mature (*scarring effects*). Third, market frictions dampen the efficient allocation of the resources freed by the exiting firms (*sullying effect*).[11] This study differs in two aspects from that literature. Firstly, its main focus is on the contribution to aggregated productivity of the entry margin during financial crises. A recent empirical study by Hallward-Driemeier and Rijkers (2013) evaluates the different effects of recessions using firm level data from Indonesia during the Asian crisis of 1997. They do not

tries. Nelson and Plosser (1982) show that, even for the US, the hypothesis of a stochastic trend component cannot be rejected.

[11] See for instance Caballero and Hammour (1994), Caballero and Hammour (1996), Caballero and Hammour (2005), Barlevy (2002) and Ouyang (2009) among others.

find conclusive evidence of better reallocation among incumbents. Nevertheless, the data does show that during that crisis entrants were *fewer, but better*. In particular, the contribution to labor productivity of those smaller cohorts was significantly higher. Secondly, the aim of this chapter is to characterize the long-run effects of those short-run crises, a question that cannot be explored with models that do not account explicitly for the endogenous evolution of productivity. The next Section introduces a model that explicitly accounts for the link between short-run crises and long-run productivity.

2.3 Model

In this section, we introduce a tractable endogenous growth model with heterogeneity and financial selection, for a small open economy, subject to exogenous interest rate shocks. Aggregate productivity in this economy is modeled in the Grossman and Helpman (1991) and Aghion and Howitt (1992) tradition.[12] This means that we follow a Schumpeterian concept of growth, where new firms (entrants) replace established firms (incumbents). In particular, because new intermediate goods producers are more productive than incumbents, Bertrand monopolistic competition implies that the newcomer sets a price that forces the old incumbent to exit. In order to study the role of financial selection in firm entry and productivity during a sudden stop, three main innovations are added into this traditional endogenous growth framework.

The first variation introduces *ex-ante* and *ex-post* heterogeneity in productivity improvements. A representative financial intermediary owns business plans (projects or potential firms) that can generate either a drastic (H) or a marginal (L) productivity improvement (step size) in the technology for producing a particular variety of an intermediate good. Every project is characterized by its idiosyncratic probability distribution over those two outcomes. Hence, projects are *ex-post* heterogeneous in terms of the productivity ad-

[12] A detailed review of this literature can be found in Aghion et al. (2013).

vantage that they enjoy after entering the business ($\{H, L\}$), and they are also *ex-ante* heterogeneous with respect to the idiosyncratic probability of generating a drastic innovation ($P^H \in (0,1)$). This first ingredient allows us to model the underlying scarcity of the economy, where only few ideas are very likely to give birth to outstanding incumbents.

The second addition to the framework introduces an imperfect screening device to the model. The financial intermediary cannot unveil the *ex-ante* heterogeneity of its projects, but it can observe noisy signals of their potential. The optimal allocation of funding follows a cut-off rule based on the signal. This ingredient introduces a linkage between the size of the entrant cohort and the average efficiency gain generated by its members. In fact, periods of laxer credit standards (low cut-off) are characterized by larger cohort and lower average step sizes. The strength of this link and its implications for entry and productivity are determined by the accuracy of the screening device of the financial system.

Finally, the third modification follows the framework of Mendoza (1991) to introduce exogenous interest rate shocks into the model.[13] This feature introduces economic dynamics into an otherwise deterministic model. Note that, because the financial intermediary borrows at the stochastic interest rate to finance start-up businesses, interest rate shocks trigger entry and productivity dynamics that are absent in a traditional open economy framework. The next sub-section introduces the model, defines an equilibrium for this economy and proves the existence and uniqueness of an interior balanced growth path (BGP).

2.3.1 Final Good Producer

Time is discrete in this economy. We denote a history $(s_0, s_1, ..., s_t)$ by s^t, where s^t contains all the relevant past information that agents need in period t to make decisions. For instance, $Y(s^t)$ is the output at period t under history s^t, but, because capital used in production at time t is decided at $t-1$, we index it by s^{t-1}. There is a representative final

[13]The open economy part of the model follows closely Neumeyer and Perri (2005) and Uribe and Yue (2006) articles.

good producer that combines intermediate inputs

($\{X_j(s^t)\}_{j\in[0,1]}$), indexed by $j \in [0,1]$, with capital ($K(s^{t-1})$), to produce the only final good of this economy ($Y(s^t)$). The constant return to scale production function is given by:

$$\ln Y(s^t) = \alpha \int_0^1 \ln X_j(s^t)dj + (1-\alpha)\ln K(s^{t-1}). \tag{2.1}$$

Equation (2.1) is an extension of a standard Cobb-Douglas production function, where α determines the production share of intermediate varieties. Production is subject to a working capital constraint. In particular, the final good producer needs to hold a proportion $\eta > 0$ of the intermediate goods bill before production takes place. To do so, he borrows at the interest rate at the beginning of the period and pays back just after production takes place.[14] Uribe and Yue (2006) show that this constraint can be summarized as a wedge in the cost of the input. In particular, given input prices ($p_j(s^t)$), interest rate ($R(s^t)-1$), and utilization cost of capital ($r(s^t)$), the final good producer demands intermediate goods and capital in every period in order to solve:

$$\max_{\{X_j(s^t)\}_{j\in[0,1]},K(s^{t-1})} \left\{ Y(s^t) - \left(1 + \underbrace{\eta(R(s^t)-1)}_{\text{Cost wedge}}\right)\int_0^1 X_j(s^t)p_j(s^t)dj - K(s^{t-1})r(s^t) \right\} \tag{2.2}$$

where the final good price is used as the *numeraire*. An interior solution to (2.2) is characterized by the following set of first order conditions:

$$X_j(s^t) = \frac{\alpha Y(s^t)}{p_j(s^t)\left(1+\eta(R(s^t)-1)\right)} \tag{2.3}$$

$$K(s^{t-1}) = \frac{(1-\alpha)Y(s^t)}{r(s^t)}. \tag{2.4}$$

Both demands are unit elastic; in particular, a monopolist facing the demand in equation (2.3) would choose $p_j(s^t) \to \infty$ and hence $X_j(s^t) \to 0$. Only the existence of a potential

[14] This is a standard modeling assumption in the open economy literature. It is mostly used to amplify interest rate shocks using a labor channel. The main mechanism of the model does not need this feature; in fact, as Appendix B.6 shows, the long-run effect of this channel is negligible. We include it only to compare the baseline model with a standard open economy model with exogenous growth.

competitor can force the intermediate producer to set a finite price.

2.3.2 Intermediate Goods Sector: ***Ex-post*** Heterogeneity

There is a continuum of incumbents, each producing a differentiated intermediate good indexed by j. Labor ($L_j(s^t)$) is the only input used in intermediate production, using a technology with constant marginal productivity ($q_j(s^t)$).[15] Thus, the production of variety j is given by:

$$X_j(s^t) = L_j(s^t)q_j(s^t). \tag{2.5}$$

The efficiency of labor ($q_j(s^t)$) in the production of intermediate goods evolves with each technological improvement generated by a successful entrant. Entrants are heterogeneous in their capacity to improve the existing technology. Drastic innovations (type H) improve the efficiency level by a factor of $1+\sigma^H$, while marginal innovations (type L) generate improvements with a smaller factor $1+\sigma^L$, where $\sigma^H > \sigma^L > 0$.[16] Innovations in this economy come exclusively from newcomers.[17] Then, we define the indicator functions $I_j^d(s^{t-1}, s_t)$, taking the value 1 if product line j receives an entrant of type $d \in \{L, H\}$ under $s^t = (s^{t-1}, s_t)$, and 0 otherwise. We can summarize the evolution of the productivity of the most efficient firm in product line j as follows:

$$q_j(s^t) = \left[1 + I_j^H(s^{t-1}, s_t) \times \sigma^H + I_j^L(s^{t-1}, s_t) \times \sigma^L\right] \times q_j(s^{t-1}). \tag{2.6}$$

Hence, productivity in product line j remains unchanged in the next period if, and only if, no entry takes place in that product line; in that case, last period's incumbent continues to dominate the product line. In line with the endogenous growth literature, we assume

[15] This is the most common assumption in both the Romer (1990) and the Schumpeterian tradition of Grossman and Helpman (1991) and Aghion and Howitt (1992).

[16] We only allow for two types in order to summarize the composition of the product line with only one variable: the fraction of leaders with σ^H advantage. More types complicate the analysis and do not add new insights to the mechanism.

[17] A simplified version of Klette and Kortum (2004) could be accommodated to allow undirected innovations by incumbents without loss of tractability. But incumbents' dynamics are not the focus of this study.

Bertrand monopolistic competition in each product line. In order to understand how this framework allows us to abstract from the distribution of productivity along product lines, we solve the partial equilibrium problem of the intermediate good producer before continuing with the exposition of the model.

This monopolistic competition set-up implies that the competitor with the lowest marginal cost dominates the market by following a limit pricing rule, i.e., she sets her price ($p_j(s^t)$), equal to the marginal cost of the closest follower. We can denote the efficiency of the closest follower by $\tilde{q}_j(s^t)$. Then given wage ($W(s^t)$) the optimal price is set to:

$$p_j(s^t) = \frac{W(s^t)}{\tilde{q}_j(s^t)}. \tag{2.7}$$

Note that (2.6) implies that a leader with type d has productivity $q_j(s^t) = (1+\sigma^d) \times \tilde{q}_j(s^t)$. Then, using the demand for varieties of the final good producer from (2.3), we can find the following expression for the profits ($\Pi_j^d(s^t)$) of the leader in product line j with productivity advantage d:

$$\Pi_j^d(s^t) \quad = \quad X_j(s^t)\left(p_j(s^t) - \frac{W(s^t)}{q_j(s^t)}\right) = \frac{\alpha\sigma^d}{(1+\sigma^d)\,(1+\eta(R(s^t)-1))}Y(s^t). \tag{2.8}$$

Note that profits are independent of the product line, as the only relevant characteristic of product line j is the type of the current leader. Moreover, type H leaders enjoy higher profits than type L leaders in every period. Profits are subject to corporate taxation rate (τ). The value of the firm is determined by the present discounted value of its after-tax profits in the current period. Nevertheless, in the next period, the firm will continue to produce if, and only if, it is not replaced by a new leader. In fact, at time $t+1$, when a mass $M(s^t, s_{t+1})$ of projects is funded, a portion $0 < \lambda < 1$ of them will randomly enter the intermediate sector; at that time, every incumbent firm faces a time-variant survival probability of $1-\lambda M(s^t, s_{t+1})$. Finally, using the stochastic discount factor of the household ($m(s^t, s_{t+1})$), the expected discounted value $V^d(s^t)$ of owning any product line j at time t

for a type d leader can be defined recursively by:[18]

$$V^d(s^t) \quad = \quad (1-\tau)\Pi^d(s^t) + E\left[m(s^t, s_{t+1})\underbrace{\left(1-\lambda M(s^t, s_{t+1})\right)}_{\text{survival probability}} V^d(s^t, s_{t+1})|s^t\right]$$

where $E\left[\bullet|s^t\right]$ denotes the conditional expectation over every possible s_{t+1} event after history s^t. Note that *ex-post* firm heterogeneity can be summarized by $d \in \{L, H\}$, since every type d leader charges the same price, hires the same number of workers, and earns the same profits. Therefore, we do not need to keep track of the distribution of labor productivity across product lines; we can instead summarize the relevant information of the intermediate sector by the fraction of leaders with step size H, namely, the time-variant fraction $\mu(s^t) \in [0, 1]$.

2.3.3 Projects: *Ex-ante* Heterogeneity

There is a financial intermediary that owns a continuum of projects indexed by z and uniformly spread on the unit interval ($z \in [0, 1]$). The fixed cost of starting (enacting) a project is κ units of labor.[19] After a successful beginning, a project materializes into a new firm generating an undirected innovation. One of the key novelties in this model is the way heterogeneity and scarcity are introduced, and how the *ex-ante* heterogeneity in projects is related to the *ex-post* heterogeneity of incumbents. Projects are heterogeneous in their expected step size; every project has an unobservable idiosyncratic probability $P^H(z) = z^\nu$ ($\nu > 0$) of generating a drastic improvement in productivity characterized by a step size $\sigma^H > \sigma^L$. The higher the index z, the more likely it is that project z will generate a drastic (type-H) innovation, and, hence, the higher the expected increase in productivity. In this sense, z is more than an index; it is a ranking among projects based on their idiosyncratic and unobservable $P^H(z)$. Note that ν governs the scarcity of good ideas in this economy.

[18]See 2.3.5 for the characterization of $m(s^t, s_{t+1})$.

[19]As Klenow et al. (2013) show, cross country industry level data suggests that entry cost is mostly associated with labor. The main mechanism of the model would not change if the entry cost were instead denominated in final goods units.

In fact, the implied probability distribution of P^H is given by:

$$f(P^H) = \frac{1}{\nu}\left(\frac{1}{P^H}\right)^{1-\frac{1}{\nu}}.$$

The mean of this distribution reflects the expected proportion of type H entrants when projects are enacted randomly. In fact, for any $M(s^t) \in (0,1]$, random selection implies that, for all z, $prob(e \in M) = M$. Therefore, the fraction of high-type improvements ($\underline{\tilde{\mu}}$) when enacting a set of projects randomly is given by:

$$\underline{\tilde{\mu}} = \frac{1}{\lambda M}\int_0^1 \lambda \times prob(z \in M) \times P^H(z)\, dz = \int_0^1 P^H f(P^H) dP^H = \frac{1}{\nu+1}$$

As an example, if $\nu = 3$, the expected proportion of type H projects in the portfolio of the financial intermediary is 25%. Therefore, if a mass of $M(s^t)$ of projects is enacted randomly, a quarter of the $\lambda M(s^t)$ entrants generate a step size σ^H. Moreover, we can characterize the skewness of $f(P^H)$ as follows:

$$S(\nu) = \frac{2(\nu-1)\sqrt{1+2\nu}}{1+3\nu}$$

Note that the skewness is fully determined by ν, and it is positive and increasing for every $\nu > 1$. Intuitively, note that $\nu = 1$ implies a uniform distribution for $f(P^H)$; hence, $S(1) = 0$ because the distribution is symmetric. However, for $\nu > 1$, the skewness is strictly positive, indicating that the left tail concentrates most of the probability density. This means that only a few ideas have strong chances of generating drastic improvements in productivity. Thus, ν summarizes the underlying scarcity of *good* ideas in the economy.

2.3.4 The Representative Financial Intermediary: Selection

In this economy, projects are heterogeneous and good ideas are scarce. Therefore, as the ranking z is unobservable, project selection is not a trivial task. We thus introduce a screening device in order to study the effects of financial selection.

The representative financial intermediary has access to a unit mass of projects every period. It borrows funds and selects projects in which to invest according to the expected present value of the projects, and pays back the profits generated by its portfolio to the household every period.[20] Note that, because $V^H(s^t) > V^L(s^t)$, the financial intermediary strictly prefers to enact projects with higher z. In particular, if z were observable, a financial intermediary willing to finance $M(s^t)$ projects would enact only the projects with $z \in \left[1 - M(s^t), 1\right]$. However, z is unobservable. In order to introduce selection, we define a costless, yet imperfect, screening technology that delivers the following stochastic signal $\tilde{z}$ of the underlying ranking z:

$$\tilde{z} = \begin{cases} \tilde{z} = z & \text{with probability } \rho \\ \tilde{z} \sim U\left[0, 1\right] & \text{with probability } 1 - \rho. \end{cases}$$

The financial intermediary can observe the true ranking of the project with probability $\rho \in [0, 1]$; otherwise, the ranking of the signal is drawn uniformly from the unit interval. Intuitively, ρ characterizes the accuracy of the screening, with $\rho = 1$ implying the perfect screening case.[21]

Proposition 7. *The optimal strategy for a financial intermediary financing $M(s^t)$ projects at time t is to set a cut-off $\bar{z}(s^t) = 1 - M(s^t)$, and to enact projects only with signal $\tilde{z} \geq \bar{z}(s^t)$.*

Proposition 7 shows that the optimal strategy is to set a cut-off for the signal.[22] When the financial intermediary uses this technology optimally to select a mass $M(s^t) = 1 - \bar{z}(s^t)$

[20] Alternatively, we can assume that the representative household owns the projects but does not have access to any screening technology. Hence, it sells in equilibrium the projects to the representative financial intermediary at the expected profits net of financing costs, and the financial intermediary earns no profits. A similar story is used by Jovanovic and Rousseau (2009).

[21] We assume that the battery of questions and procedures that commercial banks use to discriminate among borrowers is sometimes truly informative about the potential of the projects, but *false positives* and *false negatives* also happen.

[22] As the expected value is strictly increasing in the signal, and the enacting cost is fixed, the cut-off strategy is optimal and unique. See the former chapter for details.

of projects, the proportion $\tilde{\mu}(\bar{z}(s^t))$ of high type projects in the successfully enacted $\lambda M(s^t)$ mass is given by:

$$\begin{aligned} \tilde{\mu}(\bar{z}(s^t)) &= \frac{1}{\lambda M(s^t)} \int_0^1 \lambda \times prob(\tilde{z} \geq \bar{z}(s^t)|z) \times P^H(z)\, dz \\ &= \underbrace{\frac{1}{\nu+1}}_{\underline{\tilde{\mu}}} \times \underbrace{\left[1-\rho+\rho\frac{1-\left(\bar{z}(s^t)\right)^{\nu+1}}{1-\bar{z}(s^t)}\right]}_{\geq 1} \end{aligned} \tag{2.9}$$

Note that for any cut-off $(\bar{z}(s^t))$, the composition of H-types $(\tilde{\mu}(\bar{z}(s^t)))$ increases with the level of accuracy (ρ) and decreases with the scarcity of high type projects (ν). Moreover, in terms of the resulting composition, financial selection performs at least as well as random selection does. Because screening is costless, the financial intermediary will always use its device to select projects. Then, the financial intermediary borrows exactly $W(s^t)M(s^t)\kappa$ in order to enact $M(s^t) = 1-\bar{z}(s^t)$ projects every period. In particular, given $\{V^H(s^t),\, V^L(s^t),\, R(s^t),\, W(s^t)\}$, the financial intermediary chooses $\bar{z}(s^t)$ in order to solve:

$$\begin{aligned} \max_{\bar{z}(s^t)} \quad & \Bigg\{ \underbrace{\lambda(1-\bar{z}(s^t))}_{\text{Cohort's mass}} \Bigg[\underbrace{\tilde{\mu}(\bar{z}(s^t))V^H(s^t) + (1-\tilde{\mu}(\bar{z}(s^t)))V^L(s^t)}_{\text{Cohort's expected value}} \Bigg] - \\ & \underbrace{(1-\bar{z}(s^t))R(s^t)W(s^t)\kappa}_{\text{Total cost of enaction}} \Bigg\}. \end{aligned} \tag{2.10}$$

The bracketed term is the expected return of the portfolio with composition $\tilde{\mu}\left(\bar{z}(s^t)\right)$. The intermediary needs to pay back the borrowed amount plus the interest. As the objective function is strictly concave, the first order conditions are sufficient for optimality.[23] As equation (2.9) shows, a financial intermediary with $\rho > 0$ faces a trade-off between mass and composition of the enacted pool: lower $\bar{z}_t(s^t)$ increases the mass of projects enacted, but it also decreases the average value of the entrant cohort. If an interior solution $(\bar{z}(s^t) \in (0,1))$

[23] The second derivative is given by $-\rho\nu(\nu+1)\left[V^H(s^t) - V^L(s^t)\right]\left(\bar{z}(s^t)\right)^{\nu-1} < 0$.

exists, it is unique and characterized by:

$$\bar{z}_t(s^t) = \left(\frac{\frac{W(s^t)\kappa}{\lambda} R(s^t) - \left[\frac{1}{1+\nu} V^H(s^t) + \frac{\nu}{1+\nu} V^L(s^t) \right]}{\rho(V^H(s^t) - V^L(s^t))} + \frac{1}{\nu+1} \right)^{\frac{1}{\nu}} \tag{2.11}$$

Note that, from a partial equilibrium perspective, for $\rho > 0$ the cut-off ($\bar{z}_t(s^t)$) increases with the interest rate. Nevertheless, from a general equilibrium perspective, the interest rate also affects the intermediary's choice of cut-off through wages and values.[24] Finally, using the mass ($\lambda(1 - \bar{z}(s^t))$ and composition ($\tilde{\mu}(s^t)$) of the entrant cohort, we derive the law of motion of the composition of incumbents in the intermediate sector ($\mu(s^t)$). In fact, as entry is undirected, the evolution of the composition among incumbents is given by:

$$\mu(s^t) = \mu(s^{t-1}) + \lambda \left[1 - \bar{z}(s^t)\right] \left[\tilde{\mu}(\bar{z}(s^t)) - \mu(s^{t-1})\right]. \tag{2.12}$$

Note that, given last period's composition, and the value of this period's cut-off, we can pin down this period's composition.

2.3.5 The Representative Household

There is a representative consumer in this economy, and it is modeled following the open economy literature that builds on Mendoza (1991). In particular, as in Neumeyer and Perri (2005) and Uribe and Yue (2006), we include both capital adjustment costs, and a bond holding cost. Capital adjustment cost are very popular in the business cycle literature, and they become especially important in an open economy set-up with an exogenous interest rate. Without them, moderate fluctuations in the interest rate can generate implausible variations in investment. Bond holding costs are even more important in this literature because a fundamental indeterminacy arises between consumption and bond holdings.[25]

[24] Random selection ($\rho = 0$) boils down to a zero profit condition with constant composition $\underline{\tilde{\mu}}$, with the intermediary either at a corner, or indifferent between any cut-off.

[25] In a nutshell, because the interest rate is completely inelastic with respect to the demand of bonds, consumption shows excessive smoothing and its level cannot be pinned down independently of the amount

Schmitt-Grohe and Uribe (2003) discuss several alternatives to solve this issue, and show that every method delivers the same quantitative results. From an economic perspective, bond holding costs can be thought to capture legal and bureaucratic issues related to levels of debt that differ from their usual long-run level. In particular, the household chooses state-contingent sequences of consumption $C(s^t)$, labor $L(s^t)$, bond holding $B(s^t)$, and investment $I(s^t)$, given sequences of interest rate $R(s^t)$, wages $W(s^t)$, capital rental rates $r(s^t)$, and initial bond and capital positions, in order to solve:

$$\max_{\{B(s^t),C(s^t),L(s^t),I(s^t)\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t E\left[u(C(s^t), L(s^t))|s_0\right] \tag{2.13}$$

subject to:

$$\begin{aligned} C(s^t) &\leq W(s^t)L(s^t) + r(s^t)K(s^{t-1}) + B(s^{t-1})R(s^{t-1}) + T(s^t) - \\ &\quad I(s^t) - B(s^t) - \psi(B(s^t), Y(s^t)) \qquad (2.14) \\ I(s^t) &= K(s^t) - (1-\delta)K(s^{t-1}) + \Phi(K(s^{t-1}), K(s^t))). \qquad (2.15) \end{aligned}$$

where $E[\bullet|s_0]$ is the expectation over history s^t, conditional on the information at $t = 0$; $0 < \beta < 1$ is the constant discount factor; investment is subject to convex adjustment costs $\Phi(\bullet)$; and bond holdings are subject to the convex cost function $\Psi(\bullet)$. The household also receives the profits of the financial intermediary $\Pi(s^t)$, as well as the revenue generated by corporate taxation $T(s^t)$, which the government levies on intermediate firms. As shown in the sequences of budget constraints defined by equation (2.14), the price of consumption is set to unity since we use the final good as the *numeraire*. The program also requires the usual transversality conditions, and a *no-Ponzi-game* condition on bonds holdings.

Following Neumeyer and Perri (2005), we modify Greenwood et al. (1988) preferences (GHH) to allow for a balanced growth path equilibrium. However, in our set-up, because

of bond holdings. This becomes critical in a dynamic setting as the Lagrange multiplier associated with the bond holding decision exhibits a unit root. Then, in the absence of bond holding costs, when a shock hits the economy, the level of debt never returns to its stationary value.

aggregate labor productivity ($A(s^t)$) grows at an endogenous rate, the scaling is time-variant.[26] We also take from them the functional forms for Ψ and Φ:

$$u(C(s^t), L(s^t)) = \frac{1}{1-\gamma}\left(C(s^t) - \Theta_l A(s^t)\left(L(s^t)\right)^{\chi}\right)^{1-\gamma} \tag{2.16}$$

$$\Psi(B(s^t)) = \frac{\psi}{2}Y(s^t)\left(\frac{B(s^t)}{Y(s^t)} - \bar{b}\right)^2 \tag{2.17}$$

$$\Phi(K(s^{t-1}), K(s^t)) = \frac{\phi}{2}K(s^{t-1})\left[\frac{K(s^t)}{K(s^{t-1})} - (1+g_{bgp})\right]^2. \tag{2.18}$$

where $\Theta_l > 0$ is the labor weight, $\chi > 1$ determines the Frisch elasticity of labor $\left(\frac{1}{\chi-1}\right)$, γ is the utility curvature, and $\phi > 0$ and $\psi > 0$ determine the convex cost functions. Note that, as $\bar{b}$ is the long-run household debt-output ratio, and g_{bgp} the long-run growth of the economy, the household pays neither adjustment nor bond holding costs along the balanced growth path. In order to characterize the interior first order conditions of this problem, we define the stochastic discount factor of the household ($m(s^t, s_{t+1})$) as:

$$m(s^t, s_{t+1}) = \beta\frac{\frac{\partial u(C(s^{t+1}), L(s^{t+1}))}{\partial C(s^{t+1})}}{\frac{\partial u(C(s^t), L(s^t))}{\partial C(s^t)}}$$

where

$$\frac{\partial u(C(s^t), L(s^t))}{\partial C(s^t)} = \left(C(s^t) - \Theta_l A(s^t)\left(L(s^t)\right)^{\chi}\right)^{-\gamma}.$$

[26]The usual economic intuition used to justify the scaling of labor dis-utility by labor productivity is that the opportunity cost of labor consists mostly of home production, and non-market labor productivity might grow at the same rate as market labor productivity. Benhabib et al. (1991) study how home production shapes participation in the formal labor market, and how that intuition can be modeled by the preferences used in this model.

Then, the interior first order conditions can be stated as:

$$B(s^t): \quad 1+\psi\left(\frac{B(s^t)}{Y(s^t)}-\bar{b}\right) = E\left[m(s^t,s_{t+1})|s^t\right]R(s^t) \tag{2.19}$$

$$K(s^t): \quad E\left[m(s^t,s_{t+1})\frac{r(s^t,s_{t+1})+(1-\delta)-\frac{\phi}{2}\left([1+g_{bgp}]^2-\left[\frac{K(s^t,s_{t+1})}{K(s^t)}\right]^2\right)}{1+\phi\left[\frac{K(s^t)}{K(s^{t-1})}-(1+g_{bgp})\right]}|s^t\right] = 1 \tag{2.20}$$

$$L(s^t): \quad W(s^t)=\Theta_l A(s^t)\chi\left(L(s^t)\right)^{\chi-1} \quad \Rightarrow \quad L(s^t)=\left(\frac{W(s^t)}{\Theta_l A(s^t)\chi}\right)^{\frac{1}{\chi-1}}. \tag{2.21}$$

Note that as equation (2.21) shows, if in the long-run, wage and aggregate productivity grow at the same rate, then labor supply is constant. Therefore, these preferences can support a balanced growth path. Moreover, labor supply is independent of household consumption due to the lack of income effect on the labor decision; therefore, the efficiency adjusted wage $\left(\frac{W(s^t)}{A(s^t)}\right)$ is always positively correlated with the labor supply.

2.3.6 Interest Rate Process and Open Economy Aggregates

In this small open economy, the interest rate is completely exogenous, and we use the following AR(1) process to model it:[27]

$$\ln\left(\frac{R(s^t)}{\bar{R}}\right)=\rho_r\ln\left(\frac{R(s^{t-1})}{\bar{R}}\right)+\sigma_e\epsilon_t \quad \text{where} \quad \epsilon_t \overset{iid}{\sim} N(0,1). \tag{2.22}$$

Because only the final good can be traded in this model, we can easily define net exports as the difference between production and all its uses (i.e., consumption, investment, and the

[27]Neumeyer and Perri (2005) use two uncorrelated autoregressive processes: one for the spread and one for the international interest rate. Uribe and Yue (2006) use a VAR to estimate the determinants of the domestic interest rate, and then feed it into their model. Both procedures do alter the qualitative behavior of the model.

bond holding cost):[28]

$$NX(s^t) \quad = \quad Y(s^t) - C(s^t) - I(s^t) - \Psi(B(s^t)). \tag{2.23}$$

We can also define the foreign debt of the country as the sum of the debt of the household, the debt that the final good producer incurs in holding working capital, and the debt that the financial intermediary holds in order to enact projects every period.[29]

$$D(s^t) \quad = \quad B(s^{t-1}) \underbrace{-\eta \frac{\alpha Y(s^t)}{1+\eta(R(s^t)-1)} - (1-\bar{z}(s^t))\kappa W(s^t)}_{\text{Working Capital and Project Enaction}}. \tag{2.24}$$

2.3.7 Total Factor Productivity and Growth

In the remainder of this section, we derive the expression for the total factor productivity (TFP) in this economy; we then define an equilibrium for the stationary version of the economy; and finally we state the existence and uniqueness of an interior balanced growth path for the model.

We can re-write the production function from equation (2.1) using equation (2.5), recognizing that intermediate labor depends only on the step size of the incumbent.

$$Y(s^t) = \underbrace{\left(A(s^t)\right)^{\alpha}}_{\text{TFP}} \left[\left(L^H(s^t)\right)^{\mu(s^t)} \left(L^L(s^t)\right)^{1-\mu(s^t)}\right]^{\alpha} \left(K(s^{t-1})\right)^{1-\alpha} \tag{2.25}$$

where $A(s^t)$ is defined as:

$$\ln(A(s^t)) \equiv \int_0^1 \ln q_j(s^t) dj.$$

[28] Intermediate goods can be thought of as specialized labor, and hence as non-tradable goods.

[29] Usually in this literature, a country as an aggregate can only borrow at the domestic interest rate, because the rest of the world is not subject to the same spread. Thus, an important point that must hold along the equilibrium path is that the country should always be a net borrower ($D(s^t) < 0$), so that private savings should not be enough to fund the domestic sector.

The TFP in this economy is endogenous and we can characterize it using the evolution of firm level labor productivity in equation (2.6), together with the entry rate of the economy. In particular, the following expression for TFP growth explicitly accounts for both mass and composition of the entrant cohort:

$$
\begin{aligned}
\ln\left(\frac{A(s^t)}{A(s^{t-1})}\right) &= \int_0^1 \ln\left(\frac{\left(1+I_j^H(s^{t-1},s_t)\sigma^H + I_j^L(s^{t-1},s_t)\sigma^L\right) q_j(s^{t-1})}{q_j(s^{t-1})}\right) dj \\
&= \int_0^1 \ln\left(1+I_j^H(s^{t-1},s_t)\sigma^H + I_j^L(s^{t-1},s_t)\sigma^L\right) dj \\
&= \lambda(1-\bar{z}(s^t))\left[\tilde{\mu}(s^t)\ln\left(1+\sigma^H\right) + (1-\tilde{\mu}(s^t))\ln\left(1+\sigma^L\right)\right].
\end{aligned}
$$

We get the following intuitive expression that characterizes TFP growth:

$$
1+a(s^{t-1},s_t) = \frac{A(s^{t-1},s_t)}{A(s^{t-1})} = \left[\left(1+\sigma^H\right)^{\tilde{\mu}(s^t)}\left(1+\sigma^L\right)^{1-\tilde{\mu}(s^t)}\right]^{\lambda(1-\bar{z}(s^t))}.
$$

Note that TFP growth boils down to a scaled geometric weighted average of the step sizes, where the weights are given by the fraction of each type in the entrant cohort (composition) and the scale is given by the size of the cohort (mass). This highlights once again the interplay between mass and composition effects in the determination of the productivity growth of this economy.

2.3.8 Stationary System and Definitions

In order to render the model stationary, we define the following convention: any lower case variable represents the TFP scaled version of its upper case counterpart; for instance, the stationary transformation of output is given by $y(s^t) = \frac{Y(s^t)}{A(s^t)}$. This transformation is performed for consumption, bond holdings, capital, wages, intermediate goods production, investment, and output.[30] With this transformation, we define a stationary competitive equilibrium for this economy:

[30] Appendix B.1 justifies this normalization, derives the normalized system that characterizes the model, and provides a proof for the Lemma 2.

Definition 3. *A competitive equilibrium for this small open economy, given an initial efficiency level $q_j(0)$ for every product line, an initial fraction of type H incumbents, and initial levels of bond holding and capital for the household is given by:*

1. *Household optimally chooses* $\{c(s^t), b(s^t), k(s^t), L(s^t)\}$ *given prices to solve* (2.13) *subject to* (2.14) *and* (2.15).

2. *Final good producer optimally chooses* $\left\{\{x_j(s^t)\}_{j\in[0,1]}, k(s^{t-1})\right\}$ *given prices to solve* (2.2).

3. *Intermediate good producers optimally choose* $\{p_j(s^t), L_j(s^t)\}_{j\in[0,1]}$ *given wages and their type following the pricing rule in* (2.7).

4. *Financial intermediary optimally chooses* $\{\bar{z}(s^t)\}$ *given values and prices in order to maximize* (2.10).

5. *Government budget is balanced in every period.*

6. *Labor, asset, capital, and final and intermediate good markets clear in every history, and product line (if applicable):*[31]

$$L(s^t) = \tilde{\mu}(s^t)L^H(s^t) + (1-\tilde{\mu}(s^t))L^L(s^t) + \kappa(1-\bar{z}(s^t)) \tag{2.26}$$

$$d(s^t) = b(s^{t-1}) - \eta\frac{\alpha y(s^t)}{1+\eta(R(s^t)-1)} - (1-\bar{z}(s^t))\kappa w(s^t) \tag{2.27}$$

$$nx(s^t) = y(s^t) - c(s^t) - i(s^t) - \psi(b(s^t)-\bar{b})^2 \tag{2.28}$$

$$\tag{2.29}$$

7. $\{v_j(s^t), q_j(s^t)\}_{j\in[0,1]}$ *and* $\mu(s^t)$ *evolve according to* (2.6), (2.9), *and* (2.12).

8. *Transversality, no-Ponzi-game, and non-negativity conditions are met.*

[31] Intermediate good market clearing implies that the demand of the final good producer is equal to the supply of the intermediate good producer, and capital market clearing implies that the demand of the final good producer is satisfied by the household capital holdings.

We can also define a balanced growth path (BGP) for this economy as follows:

Definition 4. *A BGP is a non-stochastic ($\sigma_e = 0$) equilibrium where $\left\{\bar{z}(s^t)\right\}$ is constant, and consumption, bond holdings, capital, wages, intermediate goods production, investment, net exports, and output grow at a constant rate.*

Appendix B.1 derives the BGP for this economy and shows that, as the long-run growth is determined by the growth rate of productivity, every normalized endogenous variable is constant. Moreover, that section also proves the following proposition:

Lemma 2. *There is a well-defined parameter space where this economy has a unique interior BGP ($\bar{z} \in [0,1]$).*

Proposition 2 is fundamental for the quantitative analysis in Section 2.5. In fact, it allows us to use a perturbation method to solve the stochastic system that characterizes this economy, centered on its unique BGP. Before exploring the quantitative implications of the model, Section 2.4 uses plant level data from the Chilean sudden stop of 1998 to provide empirical evidence of the mass-composition trade-off at the heart of the model.

2.4 Empirical Analysis

This section explores Chilean macroeconomic and microeconomic data to assess empirically the main mechanism of the model, i.e., the existence of a mass-composition trade-off on the entry margin. We focus the analysis in Chile mainly for three reasons. First, it is a small open economy with detailed macroeconomic data. Second, the violent sudden stop triggered by the Russian default provides the perfect natural experiment to test our mechanism. Third, we have access to detailed plant level panel data that can be used to directly study firm entry. We start presenting the basic macroeconomic picture of the sudden stop, then we introduce our firm level data set, and finally, we show that firms born in crisis are not just *fewer*, they are also *better*.

2.4.1 The Chilean Sudden Stop

In August 1998, the Russian government declared a moratorium on its debt obligations to foreign creditors. This default triggered a sudden and radical increase in the interest rates faced by emerging markets.[32] Latin America was not an exception. Calvo and Talvi (2005) present a detailed analysis of the impact of the Russian default on the seven biggest economies of the region.[33] One of the most successful economies of the region, Chile, also suffered the consequences of the Russian default.[34]

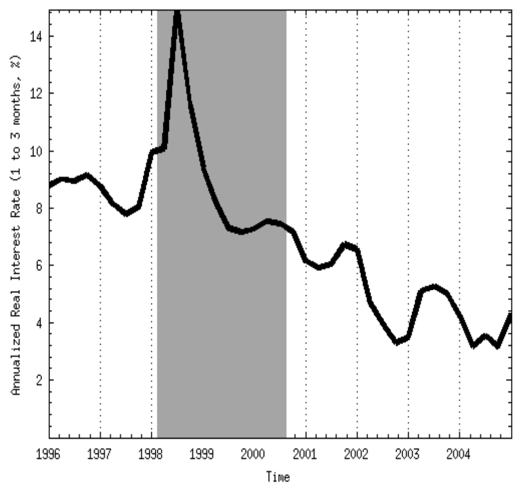


Figure 5: The Chilean Sudden Stop

Figure 5 shows the evolution of the annualized real lending interest rate between 1996 and 2005, where the grey area spanning the period between 1998:II and 2000:III highlights the crisis period. The real interest rate peaked in 1998:III, increasing by 5 percentage points

[32]For a detailed time-line of the Russian default, see Chiodo and Owyang (2002). Calvo and Mendoza (2000) propose a model where the de-leveraging of international financial intermediaries can cause extreme movements in the prices of bonds in countries that seem unrelated to the country where the original phenomenon started.

[33]The LAC-7 group is composed by: Argentina, Brazil, Chile Colombia, Mexico, Peru, and Venezuela. Calvo and Talvi (2005) also perform a thorough empirical analysis for Argentina and Chile.

[34]Chile has the largest GDP per capita in Latin America (46^{th} of the world in 2012, according to World Bank Data WDI database). Its economic freedom score is 79, (the 7^{th} freest country in the world in the 2013 Index of Economic Freedom), and its trade-weighted average tariff rate is 4 percent. See Table 22 in Appendix B.3 for more details. The main two sources of the macroeconomic data in this section are the IFS database and the Chilean Central Bank. See Appendix B.3 for a description of the macroeconomic data used in this section.

in a quarter. The interest rate spread, as reported by Calvo and Talvi (2005), increased from 120 basis points before the crisis to 390 basis points in October 1998, triggering a 47% decrease in cumulative external financial flows between 1998 and 2002. Figure 6 explores some of the macroeconomic consequences of this *imported crisis*.[35]

(a) Real Investment (↓ 30%)

(b) Total Hours (↓ 6%)

(c) Real GDP (↓ 5%)

(d) Household Consumption (↓ 5%)

Figure 6: Macroeconomic Impact of the Crisis.

Figure 6a shows a drop of more than 30% in real investment over just one quarter. In that same period, Figure 6b points to a drop of more than 6% in hours worked. Figures

[35]The macroeconomic aggregates of Figure 6 are in real terms and in logarithms.

6c and 6d show that both output and consumption decreased by 5% and took more than a year to return to the pre-crisis level. These macroeconomic consequences of a sudden stop in emerging markets have been widely studied, but the effects of firm entry dynamics triggered by these episodes have been considerably less explored. From a Schumpeterian point of view, those changes in entry can potentially be harmful even in the long-run, when the well-studied short-run effects are no more. In this section, while presenting empirical support for the composition effect, we aim to contribute to the empirical research on the microeconomic consequences of a sudden stop.

2.4.2 Mass and Composition During a Sudden Stop

There was no change in the domestic fundamentals of Chile that could have caused or predicted an increase in the interest rate as sudden and substantial as the one observed in the data. In fact, the average annualized real GDP growth of Chile between 1990:IV and 1997:IV was 8.6%, its fiscal policy was steady and responsible, and the monetary policy of its autonomous Central Bank was not expansionary. Moreover, as argued by Calvo et al. (2006), the generalized and synchronized nature of the increase in spreads charged in emerging markets also points to an exogenous and common origin for this episode. Thus, taking the Russian crisis as an exogenous shock, unrelated to Chilean fundamentals, and completely unforeseen by firms and authorities, we can use it to perform a natural experiment in order to test the main intuition of the model: cohorts born during the sudden stop window should be smaller but more profitable.

Chile's National Institute of Statistics (INE) performs a manufacturing census (ENIA) every year, collecting plant level data from every unit with more than ten employees.[36] The survey contains yearly plant information on sales, costs, value added, number of workers, energy consumption, and other variables. For the empirical analysis in this section, we use

[36]Most of the firms in the survey are single plants. In the recent literature, Alvarez and Lopez (2008) use this data to study the determinants of entry into and exit from, international markets. Alvarez and Vergara (2010) also use ENIA to assess the importance of economic reforms in entry dynamics.

the information in the surveys between 1995 and 2007 to build a panel.[37] We take the first appearance in the data as the entry year and the last appearance as the exit date.[38] We also restrict our attention to 20 of the 29 industries, since some of them lack variation in entry and exit dynamics. For example, the tobacco industry is characterized by only $1-2$ plants, and we observe a positive entry in only two years. We also build a measure to capture the profitability ($P_{i,t}$) of each plant every year:

$$P_{i,t} = \frac{Revenue_{i,t} - Cost_{i,t}}{Revenue_{i,t}}.$$

After cleaning the data and checking for consistency, our restricted sample contains 3675 plants with an average of 4.9 observations per plant.[39] The sub-sample is representative, as it has 90% of the total number of workers, and 95% of the total observations in the data.

We first calculate entry rates at year t at the industry level for each cohort, dividing the number of new plants in year t by the average of the total plants in years t and $t-1$. Table 21 in Appendix (B.2) presents two year average entry rates for every industry in the sample. Figure 7 plots two-year average entry rates by industry for the two-years preceding the crisis and the first two years of the sudden stop. Every industry below the 45^o line decreased its two-year entry rate during the crisis.

For all industries but two (355 and 369), the average entry rate in $1998-99$ is lower than in $1996-97$. Moreover, Table 21 shows that, for practically every industry, entry rates remain low until $2002-03$. The average percentage change in the entry rate is -39% between $1996-97$ and $1998-99$. Accordingly, entry dropped dramatically, at the industry level during the Chilean sudden stop.

[37]We restrict attention to this period because the questionnaire and the identification number of each firm are practically invariant.

[38]Note that a small firm might appear in the panel after passing the threshold of ten employees, and it should not be counted as an entry. The results are robust if we eliminate all the plants that appear the first time with less than fifteen workers, which reduces the likelihood of this phenomenon.

[39]Appendix (B.2) shows the details of the data construction. For example, we eliminate observations with negative energy consumption and we restrict $P_{i,t}$ to be between -150% and 150%.

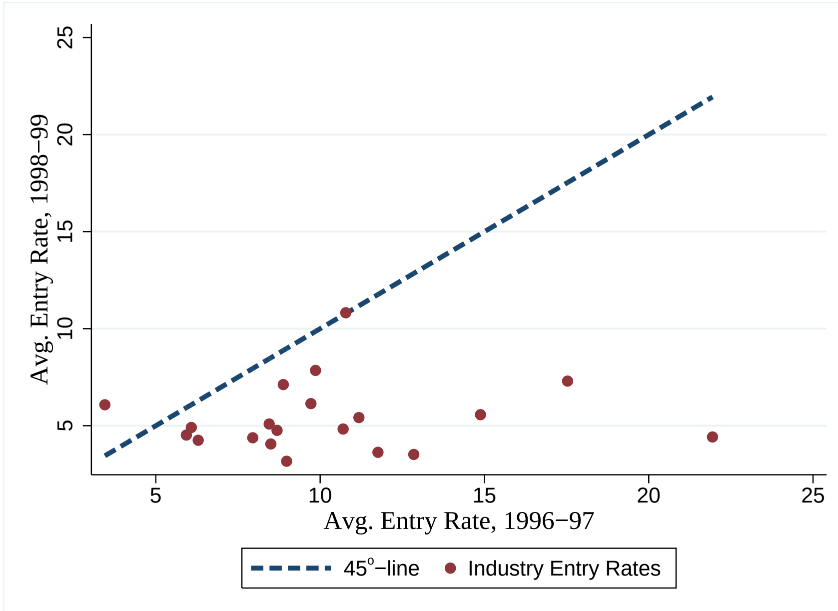


Figure 7: Mass (quantity)

Although it is clear that *fewer* firms are born during crisis, we still have to see whether they are *better*. In this sense, we want to show that firms born during the sudden stop are intrinsically more profitable. In particular, we would like to estimate the following equation:

$$P_{i,t} = \alpha + \beta_1 X^1_{i,t} + \beta_2 X^2_{i,t} + \gamma_1 Z^1_i + \gamma_2 Z^2_i + \mu_i + u_{i,t} \tag{2.30}$$

where $X^1_{i,t}$ represents exogenous time-varying variables (e.g., vacancy index of the economy), $X^2_{i,t}$ refers to endogenous time-variant variables (e.g., number of workers), Z^1_i correspond to exogenous time-invariant variables (e.g., region of the country), and Z^2_i are endogenous time-invariant variables (e.g., workers in the entry year). Note that variables with a superscript 2 are endogenous in the sense that they are likely to be correlated with the unobserved fixed effect μ_i. The main challenge of this panel estimation is that the variable of interest, *being born in crisis*, is not only time-invariant, but also endogenous. On the one hand, coefficients on time-invariant variables can be consistently and efficiently estimated by random effects regression, but the estimation is not consistent when the variable is also endogenous. On the other hand, fixed effects panel regression can consistently estimate every coefficient associated with the time-variant variables, but it cannot identify the coefficients of the time-invariant variables.

In this situation, the Hausman and Taylor (1981) procedure delivers consistent and efficient estimators for every coefficient in equation (2.30). The method can be summarized as a four-step procedure. First, a fixed effects regression delivers consistent estimators $\hat{\beta}_1$ and $\hat{\beta}_2$ that are used to retrieve estimators $\hat{u}_{i,t}$ and $\hat{\sigma}_u$. The second step is an instrumental variables (IV) regression with $\hat{u}_{i,t}$ as dependent variable, Z^1 and Z^2 as independent variables, and Z^1 and X^1 as instruments; this delivers a consistent estimator for $\tilde{\sigma}$ (the dispersion of the residual). Third, an estimator for the variance of the unobserved fixed effect component can be built as $\hat{\sigma}^2_\mu = \tilde{\sigma}^2 - \frac{\hat{\sigma}^2_u}{T}$, in order to form the usual generalized least squares (GLS) correction. Finally, the GLS correction is used to transform the original equation and estimate all the coefficients simultaneously in equation (2.30) using an IV procedure where the instruments are given by Z^1, the mean of X^1 and the deviations from the mean of X^1 and X^2. After every estimation we perform the Sargan-Hansen test to assess the validity of the instrumental variables procedure.[40]

Table **??** presents the results for three different specifications. In all three regressions the dependent variable is $P_{i,t}$. The only difference is the coefficient of interest. In the first regression we use a single dummy to determine whether the cohorts born in $1998 - 2000$ perform better than every other cohort. In the second regression, we use two dummies in order to allow a differential effect for cohorts *pre* and *post* crisis. The third specification studies the effect of the three-digit industry entry rate at the moment of entry. This means that it is a continuous variable common to every firm in the same industry born in the same year and is also time-invariant. Note that all the coefficients of interest are associated with time-invariant endogenous variables, because better firms (with higher unobserved fixed effect μ_i) are expected to enter in years of crisis. In the case of the third specification, when

[40]Intuitively, we can think that this procedure aims to remove the endogenous component from the original regression in order to meet the main assumption of random effects. More details on this method can be found in Wooldridge (2010), Chapter 11. STATA software has built-in routines for both procedures. The null hypothesis is that the instruments are valid, so the higher the p-value, the better.

fewer firms enter, we expect them to be *better*.

	Profitability	Profitability	Profitability
Crisis dummy	0.070**		
	(0.023)		
in Crisis		0.070***	
		(0.021)	
after Crisis		0.008	
		(0.014)	
avg. Entry_{j,t_0}			−0.547**
			(0.225)
$\log(\text{electricity}_{i,t})$	−0.006***	−0.006***	−0.006***
	(0.002)	(0.002)	(0.002)
$\log(\text{worker}_{i,t})$	0.015***	0.015***	0.015***
	(0.004)	(0.004)	(0.004)
$\log(\text{age}_{i,t})$	0.008**	0.010**	0.014***
	(0.003)	(0.004)	(0.004)
$\log(\text{worker}_{i,t_0})$	0.178***	0.166***	0.114***
	(0.050)	(0.051)	(0.039)
$\log(\text{manufacture}_t)$	−0.034	−0.033	−0.039
	(0.028)	(0.028)	(0.028)
unemployment_t	−0.235*	−0.237*	−0.221*
	(0.130)	(0.132)	(0.128)
$\log(\text{ppi}_t)$	−0.172***	−0.173***	−0.175***
	(0.035)	(0.035)	(0.034)
$\log(\text{labor cost}_t)$	0.521***	0.498***	0.451***
	(0.140)	(0.147)	(0.142)
Industry control	Yes	Yes	Yes
Region control	Yes	Yes	Yes
Observations	18190	18190	18190
Sargan-Hansen (p)	0.7777	0.665	0.052

[1] Source: WorldBank for Panel (a), own calculations using ENIA for Panel (b).

[2] Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[3] Endogenous time-varying independent variables are electricity expense, age, number of workers. Endogenous constant independent variables are initial number of workers, average entry, region and industry controls.

Table 3: Hausman and Taylor Estimation

We use as time-variant exogenous variables ($X^1_{i,t}$) four macroeconomic aggregates: an index of manufacturing production, the unemployment rate, an index of wholesale producer prices, and an index of the cost of labor.[41] The estimated values are practically unchanged in the three specifications.[42] There are three endogenous time-variant variables ($X^2_{i,t}$), the age of the plant, its electricity consumption, and the number of workers. All three variables are associated with significant and stable coefficients. The signs suggest that older and bigger firms are more profitable. The negative correlation associated with electricity consumption could be rationalized as an efficiency proxy. We use five geographic regions and two digit industry controls as time-invariant exogenous variables (Z^1_i). Finally, besides the coefficients of interest, we include the initial size of the plant, specified as the natural logarithm of the plant's initial number of workers, among the time-invariant endogenous variables (Z^2_i); this coefficient is significant, stable and positive, as suggested by the empirical literature.

Back to our main question: are those *fewer* firms born in crisis *better*? The first specification shows that firms born in crisis are significantly more profitable than firms born in normal times. In fact, after correcting for initial size, macroeconomic conditions, and post-entry decisions, firms born during the sudden stop have, on average, a profitability index 7% higher; relative to the mean of $P_{i,t}$, they are 14.4% more profitable. As the second specification shows, this result is robust when allowing for differential effects; in fact, *pre* and *post* crisis firms are not statically different, but firms born in crisis still have a profitability index 7% higher than firms born in normal times. The third specification is more general in the sense that it aims to directly unveil a mass-composition trade-off at the entry level. Although the Sargan-Hansen test is barely above 5%, the coefficient suggests that firms born in smaller cohorts have a permanently positive effect in their profitability measure. In particular, every extra percentage point in entry decreases the profitability of the firm by

[41] Because this method relies on $X^1_{i,t}$ to build instruments, and because they are all aggregated variables, we cannot include year dummies, which are perfectly correlated with our instruments.

[42] Although not significant, the negative sign of the first control seems to point to a competition effect. The other macro controls also have reasonable signs as bad business years have high unemployment and good business years have high wages, and as the producer price index might be pointing to slightly counter-cyclical mark-ups.

0.55%.[43]

One caveat can be added to the preceding result as it might be related to *post* entry selection. In fact, if firms born during crisis are more likely to die early, then, after that initial selection, those cohorts would seem more profitable. Appendix B.4 estimates a proportional hazard model in order to evaluate that concern. The main empirical question in that section is whether firms born during the crisis window are more likely to exit. The answer is not only negative, but, if anything, firms born during crisis have lower hazard rates in each of their first six years of life.[44] A second concern with the analysis might be due to the nature of selection. In fact, one might think that those cohorts are better just because of self-selection: when the interest rate is high, only good firms apply for credit. Although it is likely that some self-selection arises during these episodes, the hypothesis of complete self-selection is at odds with the real world. In fact, this argument implies that every firm that applies for credit is granted a loan. This is clearly not true in the data. For instance, according to Eurostat firm level data for 20 countries (showing access to finance for small and medium-sized enterprises in the European Union), 28% of firms applied for loans in 2007 (before the 2009 crisis), with a success rate of 84%. In 2010, although more firms were applying for loans (31%), the success rate decreased to only 65%.

Finally, as a robustness check, we estimate equation 2.30, comparing each cohort against all the others. This means that we estimate the equation eleven times, one for each cohort c, using as the time invariant endogenous variable a dummy that takes a value of 1 only for the firms in cohort c.[45] Figure 8 plots the estimated profitability for each cohort when all the regressors are set to the sample mean; it also includes a two standard deviation confidence interval. The markers in some years indicate cohort dummies significant at 10%.

[43] Appendix B.5 shows that the results are robust when we evaluate firm performance by (real) value added per worker, VA/L, a measure of labor productivity.

[44] Kerr and Nanda (2009) find that start-ups born in the United States before the banking deregulation period have higher survival probabilities than those born after that period. So, in that case also, tighter credit standards are related to stronger firms.

[45] We do eleven different regressions instead of one regression with ten dummies because, in order to perform the procedure correctly, we need at least as many time variant exogenous variables as there are time invariant endogenous variables.

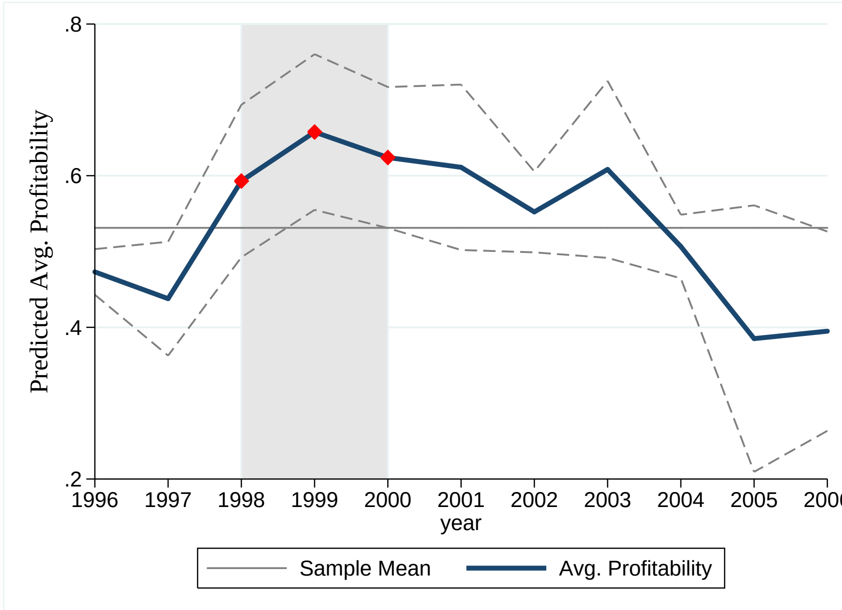


Figure 8: Composition (quality)

The message is robust to this more flexible estimation: only cohorts born in $1998-2000$ have positive and significant coefficients.[46] Note that cohort 1999 is significantly *better* than the average predicted profitability evaluated at the mean of the regressors. Moreover, the inverted U shape in Figure 8 completes the story of Table 21: as the mass effect gains strength, the composition effect weakens.[47]

Summarizing, the Chilean sudden stop had strong macroeconomic consequences: real output, real consumption, real investment and hours worked decreased drastically. At the firm level, the effect is relatively more complex. Cohorts born during the crisis, and in its aftermath, are 40% smaller; nevertheless, firms in those cohorts are at least 14% more profitable. Hence, taking the average quality of the entrant cohort as a reference to evaluate the forgone entry is extremely misleading, as the unborn firms are substantially *worse* than the observed ones. As these unborn firms are often the excuse for policy interventions, such as indiscriminate government credit, the correct assessment of the economic cost of that

[46] Cohort 2001 is significant at 10%, pointing to a longer crisis window, as in Calvo and Talvi (2005).

[47] Because the Sargan-Hansen p-value is low for some of the later years, we prefer the original specification to document the differences in profitability.

forgone entry is crucial. For this reason, we proceed to calibrate our model and assess the long-run cost imposed by a sudden stop.

2.5 Quantitative Exploration: The Role of Selection

This section presents a quantitative exploration of the model. First we calibrate the baseline model using Chilean data. To assess the performance of the calibrated model, we feed it with a smoothed series of the quarterly interest rate observed in the data. Although the model is stylized, with its single shock it is able to approximate the non-targeted behavior of the macro aggregates during the crisis. For instance, the model replicates the behavior of consumption, labor, investment, and the stock market. Moreover, the entry rate falls by 25% in the model during the crisis, and the average profitability for those cohorts increases by 7%. Hence, this parsimonious model can account for roughly 65% of the decrease in entry and more than 45% of the increase in profitability during the Chilean sudden stop. Then, in order to assess the role of heterogeneity and selection in shaping the effect of a sudden stop, we introduce two modified economies: a model with exogenous growth, and a model with endogenous growth but no heterogeneity. We use those alternative economies to highlight the role of firm entry and financial selection when the economy is hit by a shock that increases the interest rate by 100 basis points. For instance, including heterogeneity and selection amplifies the effects of a sudden stop in output by 15%, compared to the exogenous growth model, and also increases the persistence of the effects of the crisis. Moreover, in the baseline model, the shock generates a long-run permanent loss in output of 0.55%. The composition effect plays a considerable role in shaping the long-run cost of the crisis. In fact, the model with no heterogeneity generates a considerably higher permanent loss in output, amounting to 0.8%. Thus, even at the macro level, the existence of selection is fundamental when assessing the cost of the forgone entrants.

2.5.1 Calibration to the Chilean Economy

Externally Calibrated Parameters

The nineteen parameters of the model are calibrated to Chilean data on a quarterly basis. A first group of eight parameters is externally calibrated. The depreciation rate of capital (δ) is set at 8% annually, and the share of intermediate goods in the final good production (α) is set to 0.65, both numbers consistent with Bergoeing et al. (2002).[48] The corporate tax rate (τ) is set to 20%, in line with Chilean legislation; the long-run interest rate ($\bar{R}$) is set to the average quarterly real Chilean interest rate on loans performed by commercial banks between 1991:I and 2007:II, a value of 1.7% quarterly (6.5% per year); and the persistence of the interest rate process (ρ_r) is also set to its empirical value of 0.811. We follow Neumeyer and Perri (2005) and set the working capital requirement (η) to 1; this implies that the final good producer needs to keep as working capital 100% of the cost of intermediate goods. The capital adjustment cost (ϕ) is set to 8, a quite small number when compared to Neumeyer and Perri (2005). The bond adjustment cost (ψ) is set to $3 \cdot 10^{-4}$, a small number that renders the model stable. Table 4 presents the values for every externally calibrated parameter.

[48] Because intermediate goods are just a transformation of labor, we use the labor share in the final good production suggested in that paper for Chile.

Parameter	Symbol	Value	Source
Intermediate share	α	0.650	Bergoeing et al. (2002)
Depreciation	δ	1.95%	Bergoeing et al. (2002)
Profit tax	τ	20%	data
Interest rate	R	1.016	1991:I-2007:IV
Working capital	η	1	Neumeyer and Perri (2005)
Bond adjustment	ψ	$3 \cdot 10^{-4}$	low
Capital adjustment	ϕ	8	low
Persistence	ρ_ε	0.81	1991:I-2007:IV

Table 4: Externally Calibrated Parameters

Internally Calibrated Parameters

The remaining eleven parameters are internally calibrated to match some salient features of the Chilean economy. Although every moment is related to the whole set of parameters, we can point to some strong relationships between targets and parameters. The two step sizes of the model (σ^d) and the scarcity of drastic ideas (ν) are mostly related to the first two moments of the mark-up distribution and to the average growth rate of labor productivity in the economy. We set the first two targets to 0.4 and 0.17, following the empirical research on mark-up by Dobbelaere et al. (2013), for the Chilean manufacturing sector. The growth rate of real GDP is 1% per quarter; for the period $1996 - 2007$, we target two-thirds of that as the long-run growth rate per quarter in order to recognize that Chile might not be on its balanced growth path, and that there are sources of long-run growth other than entry. The success probability (λ) is highly related to the long-run entry rate of start-ups in the model; we set that target to the average entry of the pre-crisis years in our sample, 2.48% per quarter. The accuracy of the financial system (ρ) governs the proportion of firms in the entrant cohort that are below the threshold set by the financial intermediary. A proportion of the entrant cohort dies during the first year (as for every year in our data set); we use that percentage as a proxy for the firms that were able to enter, although their true type was below the threshold. We set the former target to 11.4%, the average of that proportion in the pre-crisis portion of the data. The average cost of starting a firm as a proportion of the gross national income is obtained from the *Doing Business Indicators* from *World Bank* database; it pins down the cost of enacting a project (κ). In the model, we set this target to 12.1% of 2003, the earliest year available. The dis-utility of labor (θ_l) and the parameter that determines the Frisch elasticity (χ) are pinned down by the labor share and the employment of the Chilean economy. We target a labor share of 52% and an employment of 44% of the available time. Both are in line with the data in Appendix B.3 and with Bergoeing et al. (2002). The discount factor (β) and the curvature of the utility function (γ) need to be consistent with the growth rate of the economy, the long-run debt-output ratio, and the consumption-output ratio. The first target was already set; the other two are set to their $1996 - 2007$ quarterly average, i.e., 73% for the consumption-output ratio and 1.78 for the long-run debt-output ratio (44.6% per year). Finally, the long-run household debt ($\bar{b}$) is internally determined, as no debt cost is paid along the balanced growth path, by assumption.[49]

Calibration Results

Considering the simplicity of this economy, the model is able to match the targets successfully. The main challenge of the model is to reconcile the spectacular growth of Chile during the period with the average entry and average mark-ups in the data. Because this is a long-run calibration, and some of the growth observed in Chile is likely to be transitional, an annualized productivity growth rate of 2.5% seems on the high end of economic intuition. Table 5 presents the performance of the model regarding the ten targets and Table 6 presents the calibration for the reminding parameter in the model.

[49] Equation (2.27) can be thought as an implicit target for $\bar{b}$.

Target	Model	Data	Source
Avg. mark-up	35%	40%	Dobbelaere et al. (2013)
Std. mark-up	22%	17%	Dobbelaere et al. (2013)
Entry_{1997}	2.21%	2.48%	1996 – 1997
Fast exit_{1997}	12%	11.4%	1996 – 97
long-run Growth	0.63%	0.66%	$\frac{2}{3}$ of 1996-2007
Debt/GDP	-167%	-178.4%	1996 – 2007
Consumption/GDP	72.4%	73%	1996 – 2007
Working hour	36.5%	44%	Microdatos, Bergoeing et al. (2002)
Labor share	55%	52%	Bergoeing et al. (2002)
Entry Cost	15.2%	12.1%	World Bank

Table 5: Targets: Model and Data

Parameter	Symbol	Value
Step sizes	(σ^L, σ^H)	$(19.4\%, 65.7\%)$
Success prob.	λ	5.2%
Scarcity	ν	4.97
Screening accuracy	ρ	79.1%
Enaction cost	κ	10.1%
Private debt	$\bar{b}$	97.8%
Utility curvature	γ	1.32
Labor disutility curv.	χ	1.28
Labor disutility level	θ_l	1.71
Discount rate	β	0.99

Table 6: Internally Calibrated Parameters

The calibrated step sizes point to a significant heterogeneity in mark-ups in the Chilean economy; specifically, drastic ideas are three times more productive that incremental ones. These values are in line with the empirical studies of Navarro and Soto (2006) and Dobbelaere et al. (2013) for the Chilean manufacturing sector.[50] The success probability is in line with the success in adoption in Queraltó (2013). Considering that this is a quarterly calibration, it is consistent with the annual range used in the endogenous growth literature. The scarcity of good ideas implies that, under random selection, one out of six ideas generates a high step size. This corresponds to an *ex-ante* skewness of 1.66, and, given the screening accuracy of 80%, translates into an *ex-post* skewness in profitability of 0.7, in line with the fat tails documented by Silverberg and Verspagen (2007) and Scherer (1998). In our dataset, the skewness of this measure in 2007, for cohorts born between $2002-2007$, ranges from 0.05 to 0.28, with an average of 0.16.[51] The fixed cost of enacting a project is 10% of the real wage; this implies that 11% of working hours are used in enacting the project. This second non-targeted moment is in line with the data from the first entrepreneurship survey for Chile (*Encuesta de Microemprendimiento*), where 13% of the Chilean workforce declared themselves to be entrepreneurs in 2011. The preference parameters are in the usual range for a quarterly calibrated real business cycle model. Note that the private debt to GDP ratio corresponds to 24.5% annually, which is a reasonable value for developing countries. In term of non-targeted macro moments, the model generates an investment-output ratio of 25.6%, consistent with the data of Table 22 in Appendix B.3, and slightly above the 23% average in the period $1996-2007$. The capital-output ratio in the model is 2.5 in annual terms, above the average 2.0 in the period $1996-2007$. Table 7 summarizes the former non-targeted moments.

[50] Dobbelaere et al. (2013) mark-up estimation by industry ranges from 20% to 70%.

[51] Because the model has only two type of incumbents, this measure reflects only the relative weights of the types.

Moment	Model	Data
Skewness of Profitability	0.7	0.16
% of L as entrepreneurs	11%	13%
Investment-output ratio	25.6%	23%
capital-output ratio	2.5	2

Table 7: Non-Targeted Moments

Before exploring the role of financial selection during sudden-stops through the lens of this model, we evaluate the quantitative performance of this economy when compared with the Chilean episode described in Section 2.4.

2.5.2 Validation of the Model: The Chilean Sudden Stop

In this section, we test the quantitative behavior of the model when compared to the macroeconomic aggregates during the Chilean sudden stop. In particular, we feed the model with a smoothed version of the quarter real interest rate, and we compare several non-targeted time series between 1998:I and 2002:I. In particular, we transform the interest rate of Figure 5 using the following function:

$$R_t = 0.5R_{t-1} + 0.5R_{t-2}$$

We chose to use this smoothed series for two reasons. First, decisions like investment or labor are not taken every quarter; thus, instead of introducing a time to adjust friction, as in Uribe and Yue (2006), or a delay in the pass-through between the external shocks and the domestic variables, as in Neumeyer and Perri (2005), we decided to smooth the effect of the financial crisis. The second reason has to do with the empirical analysis in Section 2.4. Because our firm level data is annual, at every observation we have entrants that were subject to the interest rate of different quarters; hence, a two quarter backward-looking moving average seems to be a parsimonious alternative. Note that, as the model has only one shock, it can perfectly replicate only one time series, in this case, the smoothed quarterly interest rate. Figure 9 shows the logarithmic series for the baseline model and the actual data between 1998:I and 2002:I, for total hours, real investment, the Chilean stock index (IPSA) in real terms, and real consumption.[52] Note that the long-run calibration previously introduced did not target any of the information in these time series.

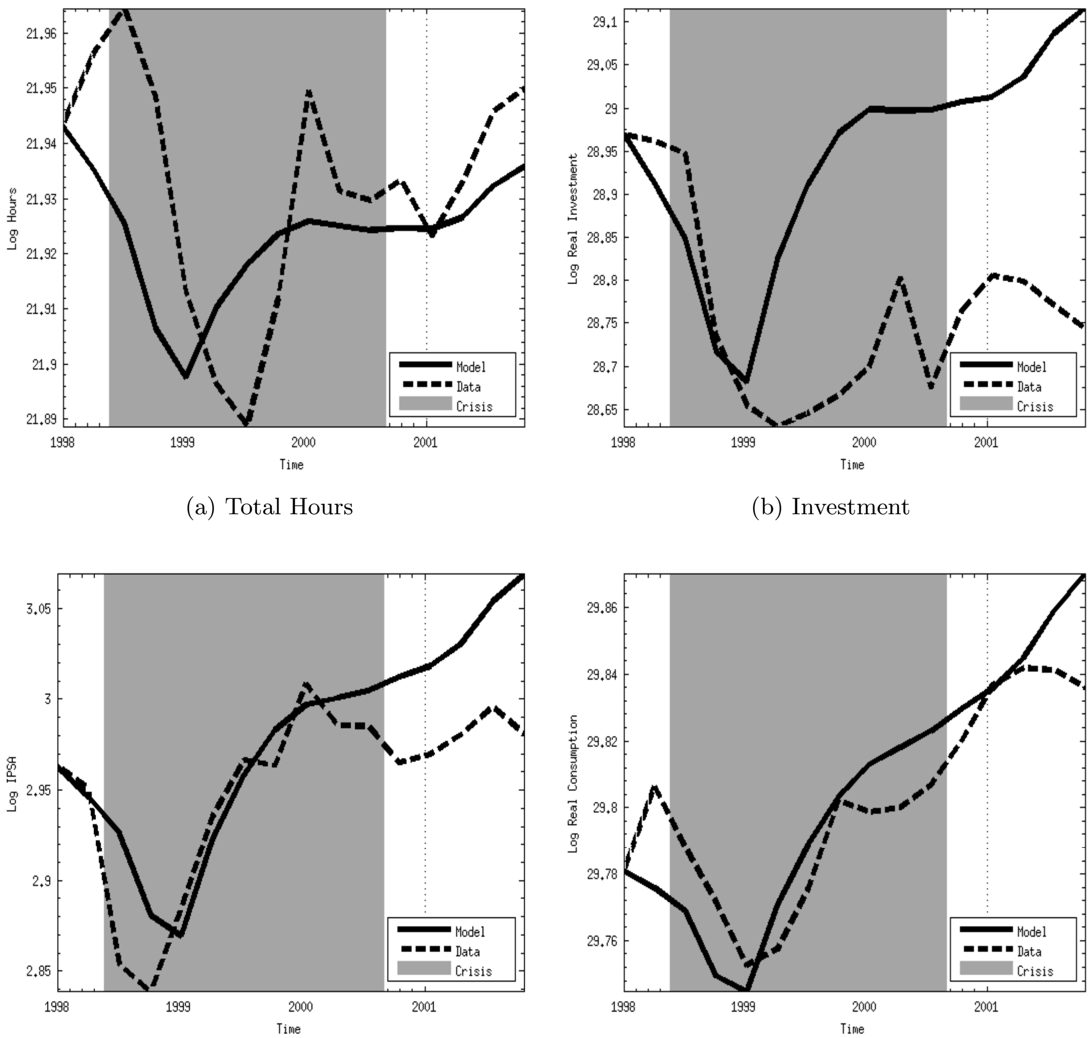
We set the state variables of the model to be at their balanced growth path level in 1998:I and adjust the initial logarithmic scale such that model and data coincide at that quarter. Define the depth of the crisis as the difference between the initial point of the series and the lowest point reached during the episode. Despite its simplicity, and the fact that none of these moments are targeted, the ability of the model to replicate this measure is impressive. The model can account for around 80% of the decrease in hours, investment, and the stock index. It slightly overshoots the effect on consumption. Table 8 summarizes these results.

Series	Model	Data
Hours	4%	5%
Investment	30%	37%
IPSA	11%	14%
Consumption	6%	4%

Table 8: Depth of the Crisis

The economic recovery predicted by the model, other than some slight timing issues, matches the data extremely well for labor, the stock index, and consumption. However, the model predicts a much stronger recovery for investment. Including another source of stochasticity in the model, for instance, a shock to the labor supply or a demand shock,

[52]The corresponding series for the IPSA is the average value of an intermediate good producer.



(a) Total Hours

(b) Investment

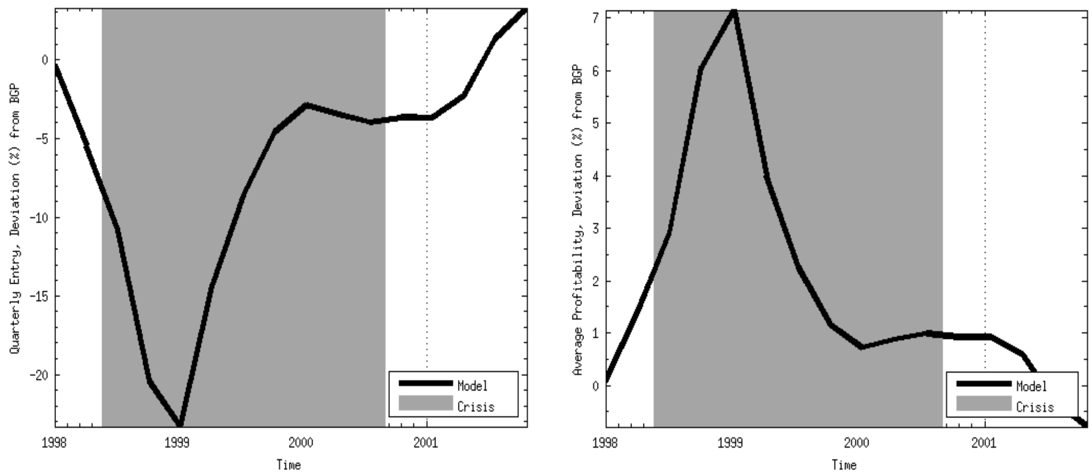
(c) Stock Index

(d) Consumption

Figure 9: Model and Data.

would of course increase the fitting of the model. Moreover, standard frictions in labor and investment can improve the timing of the model. Because it is easy to enrich this framework, it is more interesting to see how far a single stochastic component in a simple environment can go in explaining the effects of a sudden stop.

Finally, we use the empirical results of Section 2.4 to assess the ability of the model to capture the mass-composition trade-off at the heart of this chapter. Figure 10 shows the implied path for quarterly entry and the average profitability of the entrant cohort, expressed as percentage deviations from their balanced growth path level.



(a) Entry (mass) (b) Average cohort profitability (composition)

Figure 10: Mass, and Composition.

As Figure 10a shows, the change in the interest rate can account for roughly a 25% decrease in the entry rate. This is almost 65% of the average decrease observed at the industry level on Table 21. Figure 10b shows the increase in the average profitability of the entrant cohort. Cohorts born in the worst part of the crisis are 7% more profitable than an average cohort. Therefore, the model can explain around 45% of the increase in profitability. The biggest challenge of the model is once again to generate enough persistence in both entry and profitability.

To summarize, this highly stylized model performs surprisingly well when compared to non-targeted macroeconomic time series. In particular, it can explain around 80% of the decrease in labor, investment, and the stock market. Moreover, it can also explain 65% of the decrease in entry, and 45% of the increase in profitability documented in Section 2.4. Having provided evidence to support the quantitative behavior of the model, we finally focus our attention on quantifying the role of financial selection in shaping the long-run cost of a sudden stop.

2.5.3 Long-Run Loss, Amplification, and Persistence

In this section, we study the long-run cost imposed by a sudden stop on an economy where heterogeneous entrants subject to financial selection contribute to the process of productivity accumulation. To highlight the relevance of endogenous growth and financial selection when analysing these episodes, we introduce two modified versions of the baseline model. The first version (*Exo*) is a model with exogenous growth, and no financial intermediation. In particular, *Exo* has no entry on its intermediate product line; it experiences a constant growth rate equal to the balanced growth path of the *Baseline*. We can think of *Exo* as Neumeyer and Perri (2005) with intermediate goods, and a constant mixture of H and L incumbents equal to the BGP level of the *Baseline*. The second version (*NoHet*) is a model with no heterogeneity and with endogenous growth. In this model, there is neither *ex-ante* nor *ex-post* heterogeneity, since every entrant has the same step size. This unique step size is set in order that *NoHet* exhibits the same long-run growth as the baseline. Finally, *Exo* and *NoHet* share every common parameter with the *Baseline* model. Before conducting a quantitative exploration of the models, note that growing variables, such as output or investment, are normalized by A_t in all the models. Denoting percentage deviations of a variable P from its last period value by a hat ($\hat{P}_t = \frac{P_t - P_{t-1}}{P_{t-1}}$), we can use output to approximate the following relationship:

$$y_t = \frac{Y_t}{A_t} \Rightarrow \hat{Y}_t \approx \hat{y}_t + \hat{A}_t \tag{2.31}$$

Along the non-shocked path, because y_t is constant there, we get $\hat{Y}_t = \hat{A}_t = a_{ss}$. Hence, for scaled variables, we define the percentage deviation at time t between the non-shocked economy and the one subject to the shock as $\tilde{x}_t^Y$:

$$\tilde{x}_t^Y \approx \sum_{i=1}^{i=t} \left\{ \hat{y}_i + \hat{A}_i \right\} - t * a_{ss} \tag{2.32}$$

The main difference between *Exo* and the other two models is that, because growth is exogenous, $\hat{A}_t = a_{ss}$, and then $\tilde{x}_t^Y = \sum_{i=1}^{i=t} \hat{y}_i$. Because y_t is stationary, this term converges to zero when time goes to infinity. This illustrates why there is no long-run cost of a sudden stop for a model with exogenous growth. But a model with endogenous growth has a long-run cost (LRC), in any normalized variable, approximately equal to:

$$LRC \approx \lim_{t \to \infty} \left\{ t * a_{ss} - \sum_{i=1}^{i=t} \left\{ \hat{A}_i \right\} \right\} \tag{2.33}$$

Note that, as $\hat{A}_t$ converges to a_{ss}, this long-run cost is finite. Moreover, as is clear from equation (2.32), this long-run cost arises only for variables that exhibit long-run growth. Therefore, the analysis of a sudden stop in a model with endogenous growth needs to consider the long-run impact that comes through this TFP-driven loss. Moreover, the long-run effect is the same for every growing variable. Also note that, because *NoHet* and *Baseline* have the same long run growth, the path of $\hat{A}_i$ fully determines their relative long-run cost. We turn now to the quantitative response of the models to a 100 basis point increase on the interest rate R. Figures 11 to 14 show the responses of the model to this shock. The units on the y-axis are the percentage deviation from a counter-factual non-shocked path, as defined in equation (2.32).

Figure 11a displays a one-time 100 basis point increase in the interest rate for the three economies. This washes away with an autocorrelation of 0.81. Figure 11b shows the response of firm entry in the two models that feature this margin. The decrease in entry is more than two times larger in impact for *NoHet* when compared to the baseline model. The main reason behind this difference lies on the compositional dynamics displayed in Figure 11c. In fact, the proportion of high type entrants in the enacted cohort in *NoHet* is constant, while the baseline economy is able to adjust this fraction. In particular, the entrant cohort contains on impact an extra 15% of high type leaders. The last panel of Figure 11 shows the change in productivity growth generated by the disruption in the entry margin. Note that *NoHet* exhibits a large decrease in productivity growth on impact of more

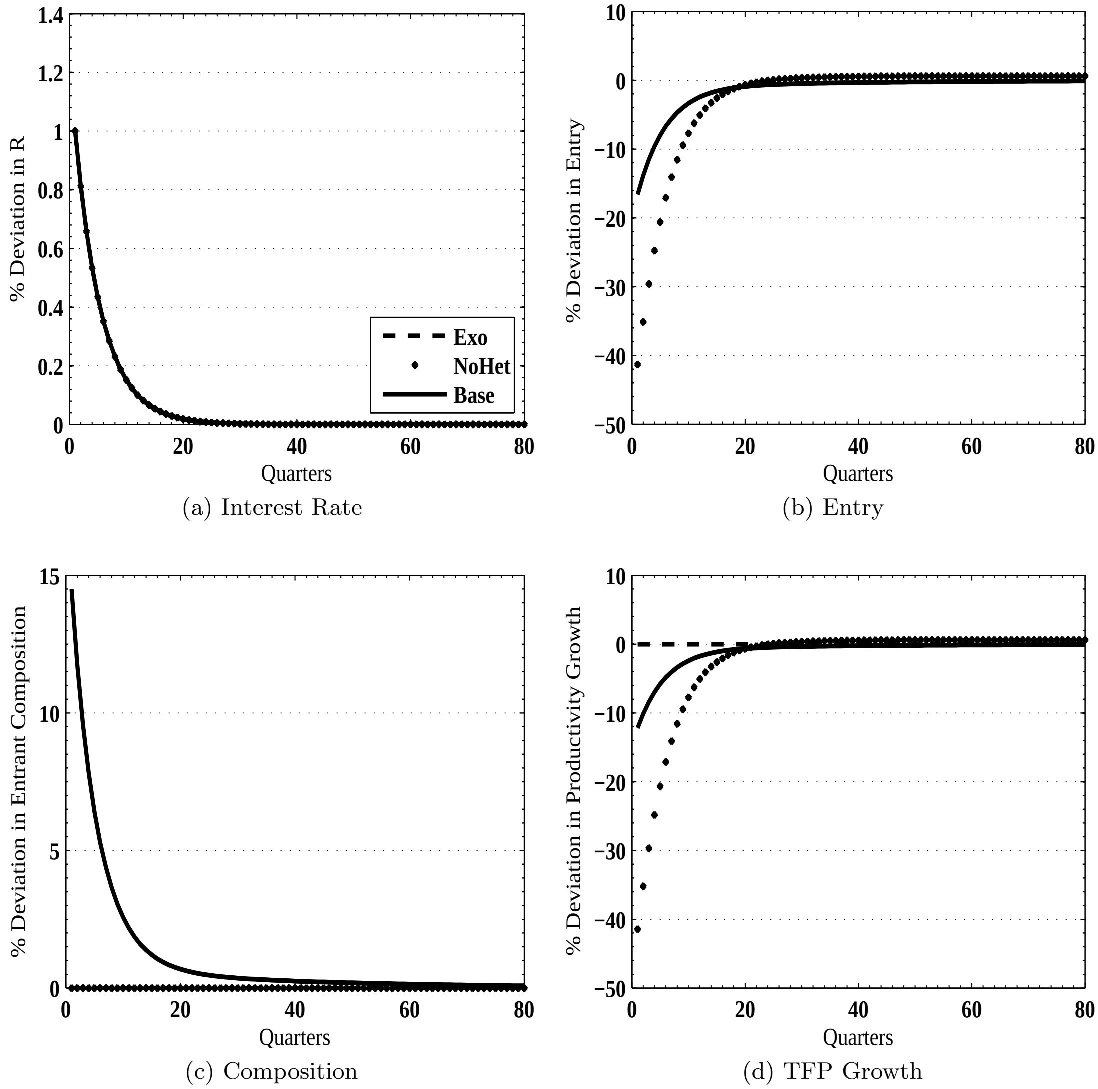
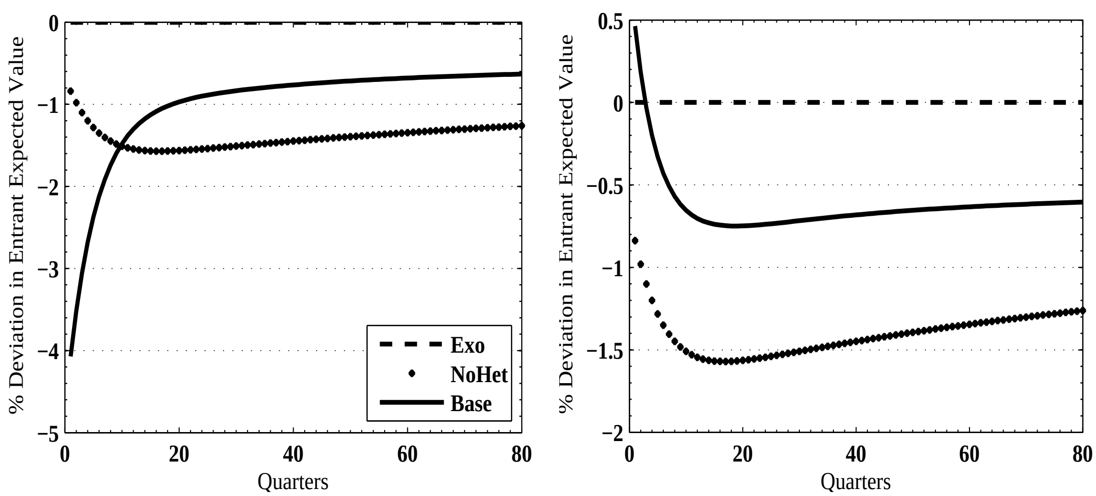


Figure 11: 100 basis point increase in interest rate.

than 40%, while the decrease in the baseline model is less than 15%. The reason behind this difference is seen in Figures 11b and 11c; in fact, when the shock hits the economy, the only margin of adjustment for *NoHet* is the mass of the entrant cohort. Because there is only one step size, the contribution of the forgone entrants to growth is the same as the contribution of the actual entrants. But the compositional margin of the baseline model implies that, on average, the contribution to productivity of the forgone entrants is lower than the contribution of the selected projects; hence, the productivity cost is smaller. Figure

11d can also be used to illustrate the long-run effect of a sudden stop in the three models; we can calculate *LRC* for each model as the area between their productivity path and the zero change path of *Exo*. In this particular case, the long-run cost is 0.8% for *NoHet* and 0.55% for the baseline. Therefore, the model with no heterogeneity generates a long-run cost 45% larger. Hence, taking into account heterogeneity and selection is critical when assessing the economic cost of a sudden stop. Figure 12 sheds more light on the role of financial selection.



(a) Expected Entrant Value Random Selection (b) Expected Entrant Value

Figure 12: The Impact of Selection.

In order to understand the value of selection for the financial intermediary, Figure 12a displays the deviations of the average expected revenue per entrant under random selection: $\underline{\tilde{\mu}}V^H(s^t)+(1-\underline{\tilde{\mu}})V^L(s^t)$. Note that, for the baseline model, the average value of a randomly enacted project drops 3% more on impact than for *NoHet*. In this sense, the decrease in values for the baseline model is more violent than for the model without selection. An important part of this difference comes from the sharp drop in entry exhibited by *NoHet*. In fact, lower entry implies higher survival probabilities, and hence more valuable product lines. Going back to Figure 12a, the higher return of a randomly enacted project in *NoHet* in comparison to the baseline implies that, if the financial intermediary in the baseline model had no access to selection, she would enact even fewer projects.[53]

Figure 12b shows how this relationship is reversed when we take into account the change in the composition of the entrant cohort in the baseline model. In fact, financial selection allows the financial intermediary to increase the average value of each member of the entrant cohort and counteract most of the decrease in the value of product lines. The difference in the average value of an entrant displayed in the second panel of Figure 12 illustrates why the financial intermediary decreases project enactment twice as much in *NoHet*.

Having characterized the source and magnitude of the long-run cost, we focus our attention in the behavior of output. Figure 13a shows the response of output for the three models. Moreover, following equation (2.25), we can distinguish the following three components:

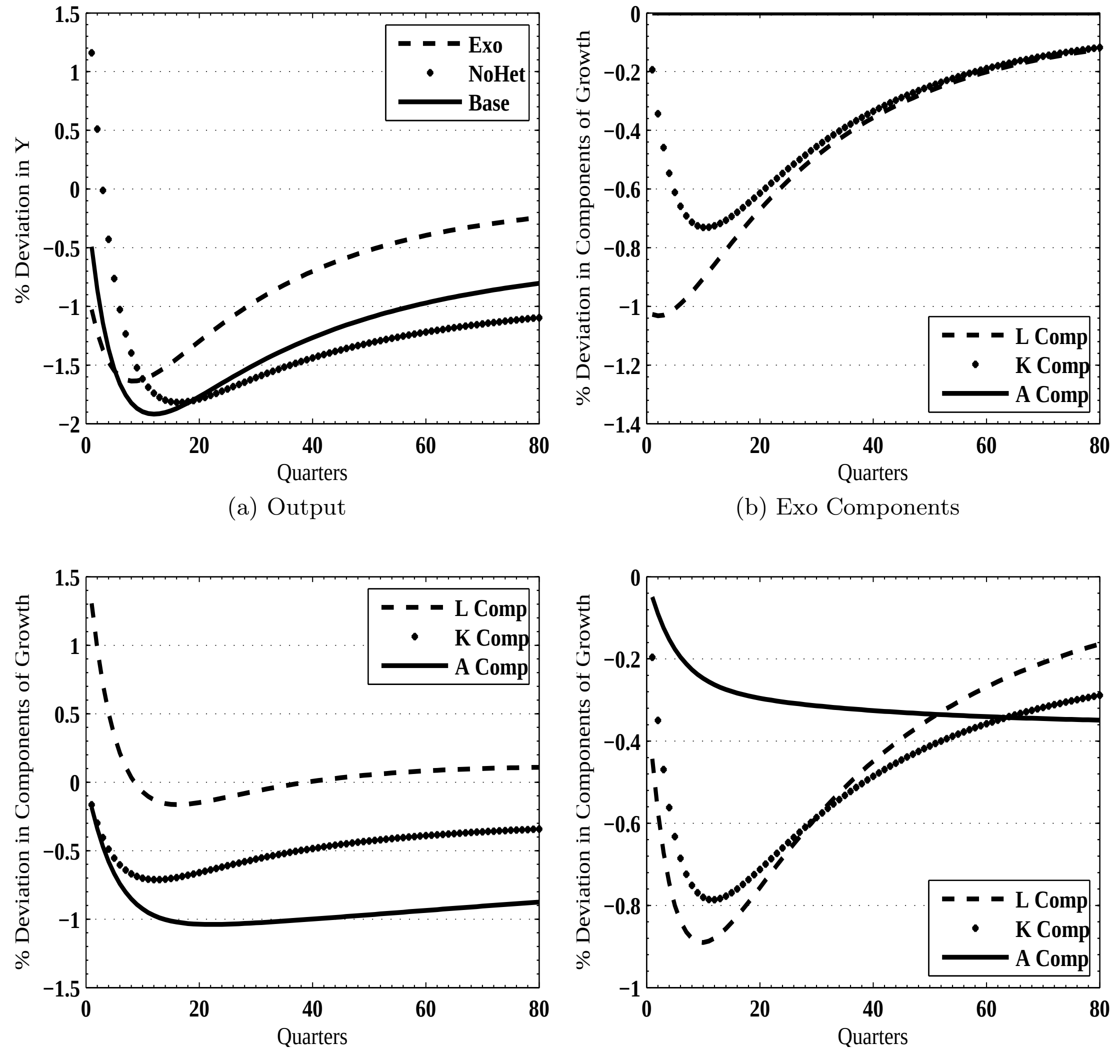
$$Y(s^t) = \underbrace{\left(A(s^t)\right)^{\alpha}}_{\text{A Component}} \underbrace{\left[\left(L^H(s^t)\right)^{\mu(s^t)} \left(L^L(s^t)\right)^{1-\mu(s^t)}\right]^{\alpha}}_{\text{L Component}} \underbrace{\left(K(s^{t-1})\right)^{1-\alpha}}_{\text{K Component}} \tag{2.34}$$

Figures 13b, 13c, and 13d display the evolution of those three components for each model.

The most striking fact in Figure 13a is the positive response of output for *NoHet* on impact. This counter-factual response is explained by the evolution of labor in relation to intermediate good production. In fact, the radical decrease in entry in *NoHet* releases much more labor than the decrease that is absorbed by the contraction in labor supply, ergo the use of labor in the intermediate good production rises in the short-run, generating an increase in production. This means that, from the point of view of the intermediate good producers, the drop in their costs due to the decrease in wages is more powerful than the drop in their benefit due to the decrease in the demand for intermediate goods triggered by the working capital constraint.[54] Note that the L component in Figure 13c increases

[53] Note that the analysis from the cost side does not reverse this partial equilibrium intuition; as seen in Figure 14d, the marginal cost of enacting a project decreases more for *NoHet*.

[54] Neumeyer and Perri (2005) document, for $\eta = 0$, a counter-factual positive correlation between output and spreads.



(a) Output

(b) Exo Components

(c) NoHet Components

(d) Baseline Components

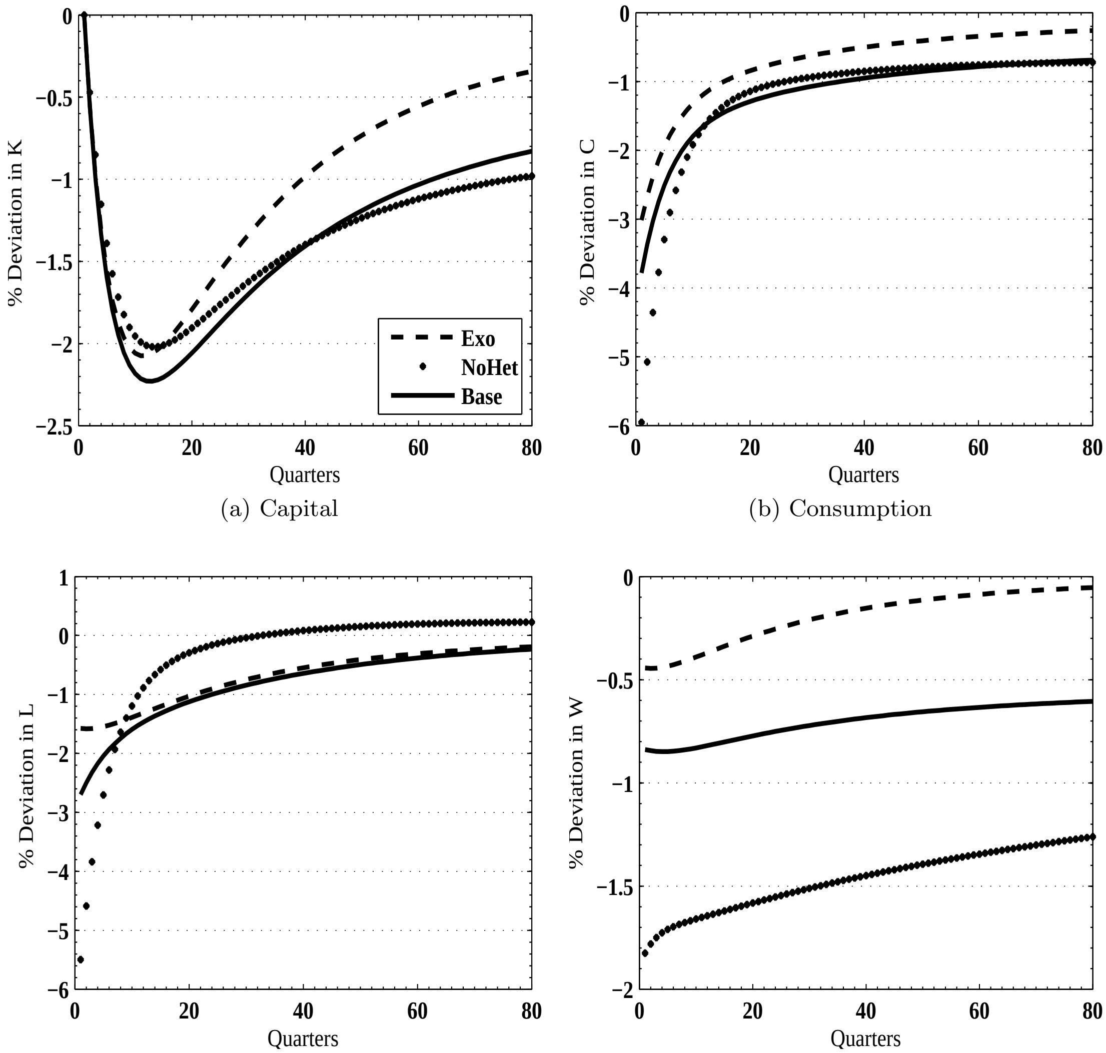
Figure 13: The Sources of Output.

by more than 1%, reversing, in the short-run, the decrease in the other two components. Nevertheless, as labor is a stationary variable, it returns in the long-run to its balanced growth path level. On the contrary, the K and A components feature a long-run loss that drives the shocked path of output to be permanently 0.8% lower. Less striking, but equally interesting, is the amplification and persistence of the baseline model when compared to *Exo*. In fact, besides the long-run cost in output, the baseline model exhibits an amplitude roughly 15% larger, as well as more persistent, as can be seen from the delay in the lower point of the path in Figure 13a. Comparing the sources of output in both models, we can identify the drivers of both effects. First, the amplification is driven by the extra drop in the K component; this is, in turn, due to the decrease in the return of capital triggered by the reduction in aggregated productivity.[55] Second, the persistence is due to the hump shape of the L component. This shape is driven by the compositional dynamics in the intermediate product line. In fact, the slow convergence of $\mu(s^t)$ delays the return of the L component to its long-run value. To complete the macroeconomic picture triggered by this episode, Figure 14 presents the deviations of capital, consumption, total hours, and wages for the three models.

First note that capital, wages, and consumption are subject to the same long-run cost as output. In this sense, those variables close the gap with the un-shocked path in the long-run only for *Exo*. For *NoHet* and the baseline model, they remain permanently lower; the difference stabilizes at 0.8% for the first, and 0.55% for the second. Second, Figure 14c shows the response of total hours in the three models. On impact, the model with exogenous growth has the lower decrease in labor (-1.5%), while the baseline model almost doubles the effect, and the model with no heterogeneity shows an even larger decrease (-5.5%). The main reason behind this amplification is the decrease in labor productivity in the models with endogenous growth; this amplifies the decrease in real wages and so, given GHH preferences, this unambiguously reduces the labor supply of the household. As this is a stationary variable, there is no long-run cost, and employment goes back to its un-shocked path for the three models.

Summarizing, models with endogenous growth exhibit a long-run cost of a sudden stop in every growing variable, but failing to account for heterogeneity and selection induces a considerable overestimation of this cost. The experiment also showed that the baseline model generates persistence and amplification of interest rate shocks, while the model with

[55]Note that *NoHet* exhibits a lower decrease in the K component, although the loss in TFP is higher. The reason lies once again in the rise of the L component in *NoHet*, as the complementarity between inputs increases the marginal productivity of capital.



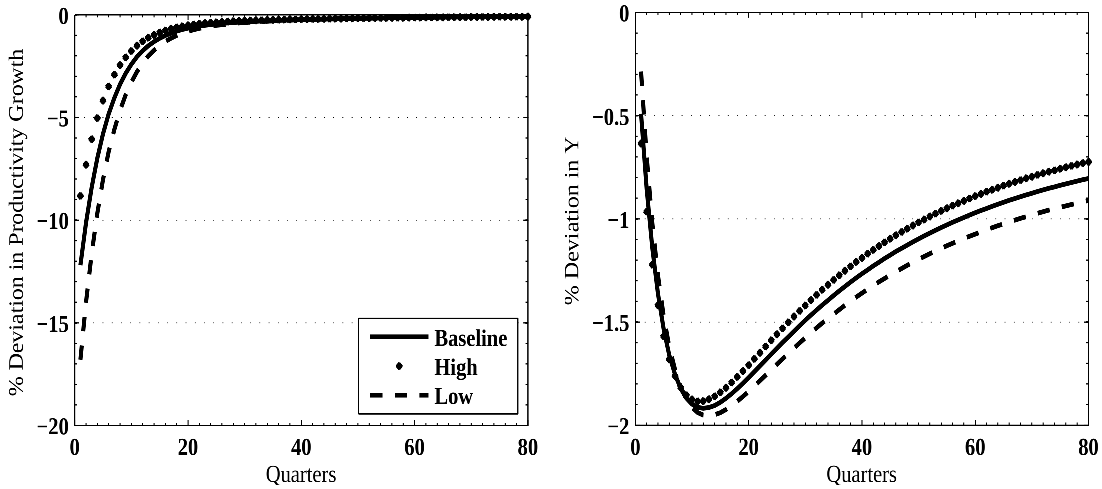
(a) Capital (b) Consumption

(c) Total Hours (d) Wages

Figure 14: Macroeconomic Aggregates.

no heterogeneity can deliver counter-factual predictions. Finally, it is interesting to explore the accuracy of the response of the financial system in both the long-run cost of a crisis and its short-run effects. Figure 15 compares the deviation of productivity and output of the baseline calibration with two alternative parametrizations: one with perfect selection ($\rho = 1$), and one with lower accuracy ($\rho = 0.6$).

In line with economic intuition, Figure 15a shows that the long-run cost of a sudden stop decreases with the accuracy of the financial system. In fact, the better the selection,



(a) TFP Growth

(b) Output

Figure 15: Financial Development.

the stronger the composition effect, and, hence, the less detrimental the decrease in entry. Moreover, Figure 15b shows that economies with better selection technology endure the crisis better, as output not only drops less, but also recovers faster. In a nutshell, economies with higher selection technology have a lower long-run cost and a faster recovery from a sudden stop. A recent country report by IMF (2012) compares the effects of the 2008 global financial crisis on Brazil and Chile. They show that the latter country has a faster and less costly recovery from the crisis. Figure 15 suggests that part of this might be due to the development of the Chilean financial system.

2.6 Conclusion

In this chapter, we revisited the effects of a sudden stop, introducing a new element into consideration: the effect of the crisis on firm entry. With that aim, we presented an open economy endogenous growth model subject to interest rate shocks. The engine of growth in this economy is the creative destruction induced by new entrants. But, as potential entrants are heterogeneous, and promising ones are scarce, financial selection introduces a trade-off between the mass (quantity) and the composition (quality) of the entrants. In particular, an interest rate shock increases credit standards, giving rise to a smaller cohort with higher productivity during the crisis. We use the Chilean sudden stop to test the main intuition of the model. In fact, although *fewer* firms are born during the crisis, they are *better*.

While the model is highly stylized, it is able to convey some interesting insights about the role of firm entry during a financial crisis. For instance, in the quantitative section, we explored the long-run cost of a sudden stop driven by the changes in TFP growth. An increase of 100 basis points in the interest rate has a permanent effect on output, investment and consumption of -0.55% with respect to the un-shocked path. Not accounting for heterogeneity and selection overstates the cost of the crisis by 45%. As governments often use the forgone entry as an excuse for massive credit subsidies, a correct assessment of that cost is critical. Moreover, this model provides a framework to analyze the costs and benefits of those policies. A second interesting point from the quantitative analysis is the role of the financial system in an interest rate crisis. In fact, more developed financial systems are able to take better advantage of the trade-off between mass and composition, reducing both the short-run and long-run impact of a financial crisis. In this sense, financial reforms that increase the ability of the financial system to better allocate resources, such as the reforms empirically studied by Jayaratne and Strahan (1996) and Galindo et al. (2007), are not only desirable from a balanced growth path perspective, but also as a buffer against large crises. This chapter provides a framework for the design and evaluation of such policies.

Future research along these lines could include in the model rich dynamics of incumbent behavior, in order to understand how a financial crisis affects both the investment and exit decisions of incumbents. This would include both a cleansing channel and a competition for funding between entrants and incumbents. This framework could study the debate between preventing exit and supporting entry during downturns. Another interesting avenue for future exploration is the role of banking competition in shaping the efficiency of selection. As we pointed out in the second section of the chapter, the empirical literature has suggested that banking deregulation and financial competition have improved credit allocation. Hence, the cost of banking collusion or rent-seeking behavior in long-run productivity growth could be addressed using this tractable framework. In summary, the scope of this model is far beyond sudden stop episodes, or the particular Chilean experience. In fact, the mass-composition trade-off at the core of this study can be triggered by any economic shock that disrupts the entry margin. The long-run economic cost of those fluctuations depends on the ability of the financial system to efficiently allocate scarce resources to the most promising projects.

Chapter 3

Capital-Based Corporate Tax Benefits: Endogenous Misallocation through Lobbying

This chapter is co-authored with Tanida Arayavechkit and Minchul Shin.

Abstract

The dominant issue of corporate lobbying in the U.S. is taxation. Firms that lobby are granted tax benefits and enjoy systematically lower effective tax rates than non-politically active firms, even after controlling by firm characteristics. Because most of these tax benefits are tied to capital holding, corporate lobbying could distort the allocation of capital in the economy. A heterogeneous firm dynamics model with endogenous lobbying decisions is presented to study the macroeconomic effects of capital-based tax benefits and their interaction with endogenous corporate lobbying behavior. The model is calibrated to U.S. firm-level data. The model suggests that the increase in corporate lobbying and the decrease in effective corporate tax rates between 1998-99 and 2010-11 are mostly due to the increase in the availability of political rents. Moreover, rent-seeking by firms explains more than 20% of the dispersion in the marginal product of capital, the main measure used in the literature to quantify the misallocation of capital.

3.1 Introduction

The current U.S. tax system taxes corporate income at a statutory rate of 35%, the highest rate among the Organization for Economic Co-operation and Development (OECD) nations.[1,2] The system, however, contains a number of deductions, exemptions, deferrals, and tax credits. The largest part of corporate tax benefits - also referred to as corporate tax expenditures - includes accelerated depreciation, the domestic production activities deduction, the deferral of income earned abroad, and credit for increasing research activities.[3] These benefits affect firms unequally. For instance, the largest tax deduction is associated with depreciation of capital, and one of the most important tax credits is the Research and Experimentation Tax Credit, heavily used by large and capital intensive companies. These tax provisions imply that the effective tax rate paid by U.S. corporations is highly heterogeneous and well below 35% on average.[4] Figure (16) illustrates the distribution of effective tax rates paid by U.S. corporations over the past decade. Effective tax rates vary significantly across firms, with the average fluctuating around 21.8%.

Nevertheless, the nature and extension of these tax benefits is not completely exogenous to the companies. In fact, some of those benefits are applicable to a very restrictive set of firms.[5] This leaves room for corporate pressure by lobbying activity. While tax benefits cannot be negotiated on a case-by-case basis with companies because they must be incorporated into a tax code, many companies successfully lobby for the creation of tax benefits

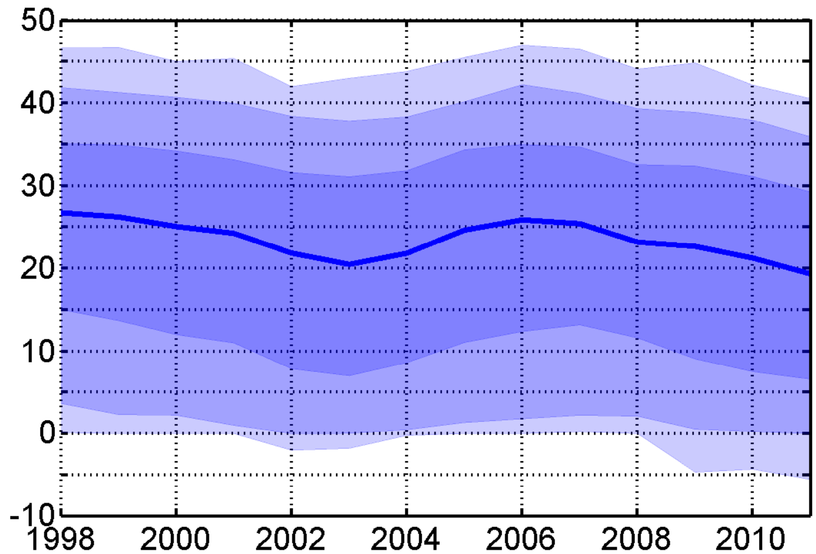
[1]According to the law, the tax starts at 15% for income below $50,000. It reaches 34% gradually for incomes between $335,000 and $10m, then it gradually increases to 35% for incomes above $18.33m.

[2]See Appendix C.1 for corporate income tax rates in OECD countries.

[3]Tax expenditures - special exemptions and exclusions, credits, deductions, deferrals, and preferential tax rates claimed by corporations - support federal policy goals to encourage certain types of behaviors and assist certain businesses but result in revenue forgone by the federal government. Source: U.S. Government Accountability Office.

[4]The effective tax rate for a corporation is the average rate at which its pre-tax profits are taxed. It is computed by dividing total tax expenses by the firm's earnings before taxes. In fact, the U.S. average effective tax rate is similar to the OECD weighted average, as reported in Gravelle and Marples (2014).

[5]For example, according to the Government Accountability Office (*GAO*, 2013), "in 2010 almost 12,000 organizations claimed the tax exemption for certain insurance companies owned by tax-exempt organizations ($200 million in corporate tax revenue losses in 2011) while 5 corporations claimed the credit for energy efficient appliances ($280 million in corporate tax revenue losses in 2011)."



Source: Authors' calculation. 5%, 10%, 25%, 50%, 75%, 90%, and 95% quantiles of effective tax rate among all firms over time.

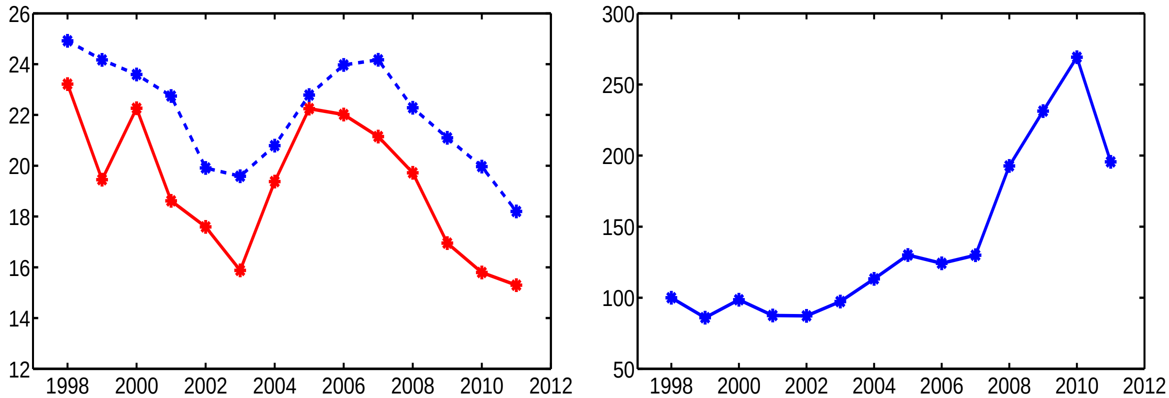
Figure 16: Effective Tax Rate Distribution

tailored to their profiles.[6] Not surprisingly, lobbying expenditures for taxation purposes are among the top two issues of corporate lobbying every single year in the U.S. The tax benefits of firms that lobby can be seen even in the raw data. As Figure (17a) shows, lobbying firms face consistently lower effective tax rates than non-lobbying firms[7], and this gap is particularly important when corporate lobbying expenditure for taxation, Figure (17b), increases sharply.

This chapter, thus, aims to study the macroeconomic effects of capital-based tax benefits and their interaction with endogenous corporate lobbying behavior. In particular, as this class of benefits distorts the marginal cost of capital differently across firms, it can potentially generate substantial capital misallocation in the economy. In a nutshell, if two firms face different costs of capital, the marginal productivity of capital between these firms will not be equalized, and, hence, a redistribution of the total existing capital from this

[6]Case studies and journal articles are full of examples. See, for instance, Kocieniewski (2011) for "GE's strategies let it avoid taxes altogether," and McIntyre et al. (2011) for "Corporate taxpayers and corporate tax dodgers."

[7]For the rest of the chapter, the terms "lobbying firm" and "non-lobbying firm" are used to describe a firm's lobbying status. For example, firm A is a lobbying firm in 2000 if it spent money on lobbying in 2000.



(a) Mean Effective Tax Rates of Lobbying (solid line) and Non-lobbying (dashed line) Firms

(b) Total Lobbying Expenditure on Tax Issues divided by Total Sales, normalized to 1998

Figure 17: Effective Tax Rates and Lobbying Expenditures

Source: Authors' calculation.

distorted situation could potentially increase output in the economy. Moreover, the presence of political rents tied to lobbying can substantially amplify the gaps in the marginal product of capital among firms and, therefore, exacerbate the misallocation in the economy.

To support the link between tax benefits and firms' political influence, which will be the central mechanism of interest, some empirical regularities on effective corporate taxation and lobbying behavior in the U.S. economy are documented. The lobbying data from the Center for Responsive Politics is matched with Compustat to obtain the firm characteristics that are necessary for calculating effective corporate tax rates.[8] We first document that taxation is the dominant issue for corporate lobbying, and that, although less than 12% of the sample lobbies every year, these firms account for more than 50% of the capital holding in the sample. Then, we document three empirical regularities that motivate our model: i) capital intensity is associated with lower effective tax rates; ii) lobbying firms are large and capital intensive; iii) lobbying firms, on average, have lower effective tax rates.

To identify the mechanisms that link tax benefits and firms' lobbying activities to resource misallocation, we develop a dynamic model of heterogeneous firms with endogenous

[8]The Center for Responsive Politics data set is available starting in 1998.

lobbying decisions. The framework is adapted from Hopenhayn (1992). In the model economy, firms use a decreasing returns to scale technology to transform capital and labor into output, and they face idiosyncratic productivity shocks. Firms decide on the level of inputs and on lobbying spending. In addition, there is a government, which grants tax benefits to firms as tax deductions associated with their capital holdings. A first component of these benefits is applied to all firms, while a second component can be influenced by lobbying activity, namely, a preferential tax treatment. However, because the government has limited resources for tax expenditures, the benefits are allocated sequentially, starting with the firms that value them the most. Hence, only a subset of the firms lobby in equilibrium.

In order to quantify the macroeconomic impact of tax benefits and corporate lobbying on capital allocation, we calibrate the model to the U.S. economy during 2010-11. The benchmark calibration is able to successfully match every targeted moment. We evaluate the model calibration using a set of non-targeted moments. The model is able to mimic closely the empirical distribution of the marginal product of capital, for both lobbying and non-lobbying firms. Moreover, it generates 70% of the persistence in lobbying status observed in the data, as well as the signs of all conditional correlations between lobbying activities and effective tax rates documented in the empirical section. The success of the model relies on the fact that highly productive firms with low capital that decide optimally not to participate in lobbying face a higher effective tax rate than low-productivity firms that over-accumulate capital in order to maximize their tax benefits from lobbying.

After validating the calibrated model, we conduct two counterfactual exercises. First, we examine whether an increase in the fraction of revenue losses from tax expenditures can explain the differences between 1998-99 and 2010-11. To this end, we compare the benchmark to a counterfactual calibration, where the only change is that the fraction of revenue losses from tax expenditures is set to 1998-99. In the model, the increase in the proportion of tax benefits generates a decrease in the effective tax rate of lobbying and non-lobbying firms, with lobbying firms experiencing a larger decrease. It also increases the fraction of lobbying firms and the amount of capital held by them. All these trends are present in the data. Moreover, the model captures fairly well the magnitudes of these changes. It generates 76% of the observed decrease in the average effective tax rate of the U.S. economy. The second exercise studies the effect of capital-based tax benefits and corporate lobbying on capital misallocation. To this end, we compare the benchmark model to two counterfactuals, one where tax benefits are tied to capital but lobbying does not generate additional rents, and the other where there are neither standard capital-based benefits nor rents to be extracted by lobbying. Because, in an undistorted world, the marginal product of capital should be equalized among firms, the dispersion of the marginal product of capital reflects an inefficiency in allocation of resources. The impact of corporate lobbying on misallocation is substantial. Firms' political activity accounts for at least 20% and up to 70% of the dispersion. The remaining fraction is due to the standard tax benefits that apply evenly across firms. Therefore, the calibrated model suggests that an increase in the fraction of tax expenditures can explain a decrease in effective tax rates and an increase in corporate lobbying at both the extensive and intensive margins. This, in turn, worsens capital misallocation in the economy.

The chapter is organized as follows. Section 3.2 summarizes some of the related literature on firms' political activity and corporate taxation. Section 3.3 presents our database and the main empirical findings of the chapter. A dynamic model of heterogeneous firms with endogenous lobbying decisions is introduced in Section 3.4. Section 3.5 presents the quantitative exercises, including the model calibration and quantitative experiment. Finally, Section 3.6 concludes the chapter.

3.2 Literature Review

This study contributes to two strands of literature: corporate lobbying and resource misallocation. Firm-level empirical work on corporate lobbying has been done in several dimensions. Igan et al. (2012) find that lobbying was associated with more risk-taking during 2000-07. Kerr et al. (2014) explore lobbying behavior toward immigration-specific issues and document the persistence in lobbying status. Several accounting and finance papers have explored the link between lobbying expenditure and tax benefits. Birnbaum and Murray (2010) provide evidence of the pressure exerted by lobbyists in the Tax Reform Act of 1986 in the United States in order to grant specific benefits and exemptions to their clients. Kang (2013) quantifies the effect of lobbying expenditures on policy enactment in the energy sector. Among others, Richter et al. (2009), Meade and Li (2012), Cooper et al. (2010), and Brown et al. (2013) find that political action by firms is positively correlated with firms' preferential treatment and profit. However, theoretical work is considerably less developed. The only area of study that is theoretically and empirically well developed is the literature on the influence of lobbying activity on trade policy by Grossman and Helpman (1994), Mitra (1999), Gawande and Bandyopadhyay (2000), Bombardini (2008), Bombardini and Trebbi (2012), and Kim (2012). Less attention has been drawn to tax lobbying, which accumulates more expenditure than trade issues for every single year in the data. Even so, little work has been done in looking at lobbying effort as an endogenously determined decision.

Recent literature emphasizes that input misallocation across firms is one of the main sources of aggregate total factor productivity (TFP) loss. Many factors are thought to be important sources of misallocation. Hopenhayn and Rogerson (1993) and Lagos (2006) and Guner et al. (2008) study the distortion created by taxes and government policy, which leads to resource misallocation and aggregate TFP loss. Another interesting factor is trade barriers as a source of misallocation, studied by Waugh (2010) and Epifani and Gancia

(2011). However, the most studied source of misallocation is credit market imperfections. Erosa (2001), Amaral and Quintin (2010), Buera et al. (2011), and Midrigan and Xu (2010) have all estimated the effects of credit market imperfections on TFP through various channels. However, one key issue in this literature is that productivity differentials usually disappear once the establishments can overcome credit market constraints through self-financing. Instead of focusing on the channel which creates misallocation, Restuccia and Rogerson (2008) exogenously introduce idiosyncratic tax rates and examine the conditions under which the misallocation caused by these generic distortions leads to larger effects on aggregate TFP. This chapter proposes a new source of misallocation which, to our knowledge, has not been explored. The distortion in our model is endogenously driven by capital-based tax benefits and firms' rent-seeking behavior, creating resource misallocation.

3.3 Data and Empirical Regularities

This section introduces the database used in this chapter. We first document that taxation is the dominant issue in corporate lobbying. Then we document an expansion in lobbying activities, at both the intensive and extensive margins, during the 1998-2011 period. Finally, we document the main empirical regularities that motivate our modelling strategy.

3.3.1 Data: Lobbying for Taxation

The empirical analysis relies on two sources of data. Lobbying behavior data is obtained from the Center for Responsive Politics (CRP). This data is available due to the Lobbying Disclosure Act of 1995.[9] This Act requires filers to disclose detailed information about

[9]This Act was strengthened by the Honest Leadership and Open Government Act of 2011. Because the law did not change the mandatory disclosure, we decided to use the complete data for this analysis. Nevertheless, our empirical analysis is robust to the exclusion of this part of the data.

lobbying expenditures above $3,000 during a quarter.[10] Lobbying activity is reported under one of 78 issue areas and the expenditure allocated to lobbying on a particular bill must be declared. The information on firm's characteristics comes from Compustat. This database contains detailed information on sales, employment, assets, and tax expenditures, among other variables, for publicly traded companies in the U.S. economy. Table (9) summarizes the raw data for the period spanning 1998 - 2011.

	Lobbying data	Compustat	Lobbying in Compustat
# of obs. (firm-year)	72,110	159,111	4,978
Lobbying Expenditure ($ million)	14,130	N/A	6,674 (47.2%)
Total Asset ($ million)	N/A	873,200,000	289,000,000 (33.1%)

Table 9: Lobbying Data and Compustat

Although the CRP data contains not only corporate lobbying but also lobbying by organizations, individuals, and even foreign governments, lobbying firms account for 47% of the total lobbying expenditures in CRP. Therefore, most corporate lobbying activity is likely to be reflected in our sample. In addition, lobbying firms account for 33% of the total asset values in Compustat. Therefore, given the relevance of actors involved in lobbying, lobbying behavior is likely to have a sizable impact on the aggregate economy. Moreover, the data shows that the primary purpose of lobbying is taxation.

As shown in Table (10), the percentage of total lobbying expenditures spent on taxation issues over the period of 1998-2011 is well above every other issue.[11] Appendix C.2 presents this analysis for each year. Taxation ranks first every year except 2009.[12]

[10]Firms with in-house lobbying activities are also required to report the relevant information. However, the CRP data do not include bribes, other under-the-table payments or firms' illegal expenditures aiming to influence policy outcomes.

[11]Each bill might contain multiple issues, so we discount the dollar amount by the number of issues. Then we build the total amount for every issue during the period and rank them accordingly. Ranking is based on the matched data set before sample selection.

[12]The health care reform in 2009 placed health issues at the top.

Issue	%
Taxes	10.68
Health Issues	7.47
Energy/Nuclear	5.30
Budget/Appropriations	5.22
Medicare/Medicaid	5.02
Trade (Domestic & Foreign)	4.93
Defense	4.15
Telecommunications	3.81
Environmental/Superfund	3.77
Financial Institutions/Investments/Securities	3.53

Table 10: Percentage of Aggregate Expenditures by Issues (Top 10, 1998 – 2011)

3.3.2 Lobbying at the Extensive and Intensive Margin

Table (11) and Figure (18) show descriptive statistics for lobby data.[13] In our sample, the number of lobbying firms has increased over the years. In particular, the number of lobbying firms was practically constant at around 80 firms for the first five years, and then it has been increasing steadily, and double the number in the last year of the sample. This implies that lobbying participation increased by more than double during the past decade. The intensive margin also follows a similar pattern, i.e., the average lobbying expenditure almost doubled during the period. Introducing the median into the analysis, we see considerable inequality among lobbying expenditures, where few firms account for most of the expenditures. This inequality grows steadily over time. Finally, the dispersion in lobbying expenditure essentially doubles during the period. Figure (18) illustrates the trends in lobbying activities at both the intensive and extensive margins over time. The increasing trend is obvious for all variables: the total lobbying expenditure, the proportion of lobbying firms, the average lobbying expenditure, and the standard deviation of lobbying expenditure. In addition, each variable more than doubles over the period of 1998-2011.

[13] Hereafter, we focus on lobby invoices that are issued for tax subjects. Appendix C.3 describes the sample selection procedure, the removal of outliers and the basic variables of the data set used for the rest of this section.

year	# of firms	# of lob firms	% lob firms	lob exp per firm	median (lob exp)	SD(lob exp)	total exp
1998	2146	78	3.63	1.09	0.2	1.83	85.35
1999	1952	83	4.25	0.92	0.24	1.46	76.23
2000	1748	84	4.81	1.13	0.22	1.76	94.65
2001	1480	69	4.66	1.1	0.19	1.93	75.83
2002	1433	63	4.4	1.17	0.15	2.02	73.72
2003	1592	85	5.34	1.02	0.35	1.71	86.99
2004	1768	102	5.77	1.21	0.38	1.84	123.22
2005	1801	115	6.39	1.35	0.34	2.66	154.71
2006	1766	124	7.02	1.23	0.4	2.03	153.12
2007	1657	132	7.97	1.34	0.45	2.28	176.48
2008	1353	127	9.39	1.73	0.57	3.2	219.46
2009	1236	127	10.28	1.68	0.39	2.92	213.99
2010	1402	160	11.41	2.22	0.61	4.41	355.81
2011	1479	153	10.34	1.99	0.64	3.29	304.57
average	1629.5	107.29	6.83	1.37	0.37	2.38	156.72
sum	22813	-	-	-	-	-	2194.13
98-99 avg	2049	80.5	3.94	1.01	0.22	1.65	80.79
10-11 avg	1440.5	156.5	10.88	2.11	0.63	3.85	330.19

[1] Lobbying expenditure (million dollars) is deflated by the GDP deflator (index=100 at 1998).
[2] Lobbying expenditure per firm is the average lobbying expenditure among lobbying firms.
[3] Lobbying statistics are based on bills that are issued for tax. Appendix C.3 describes the sample selection procedure.

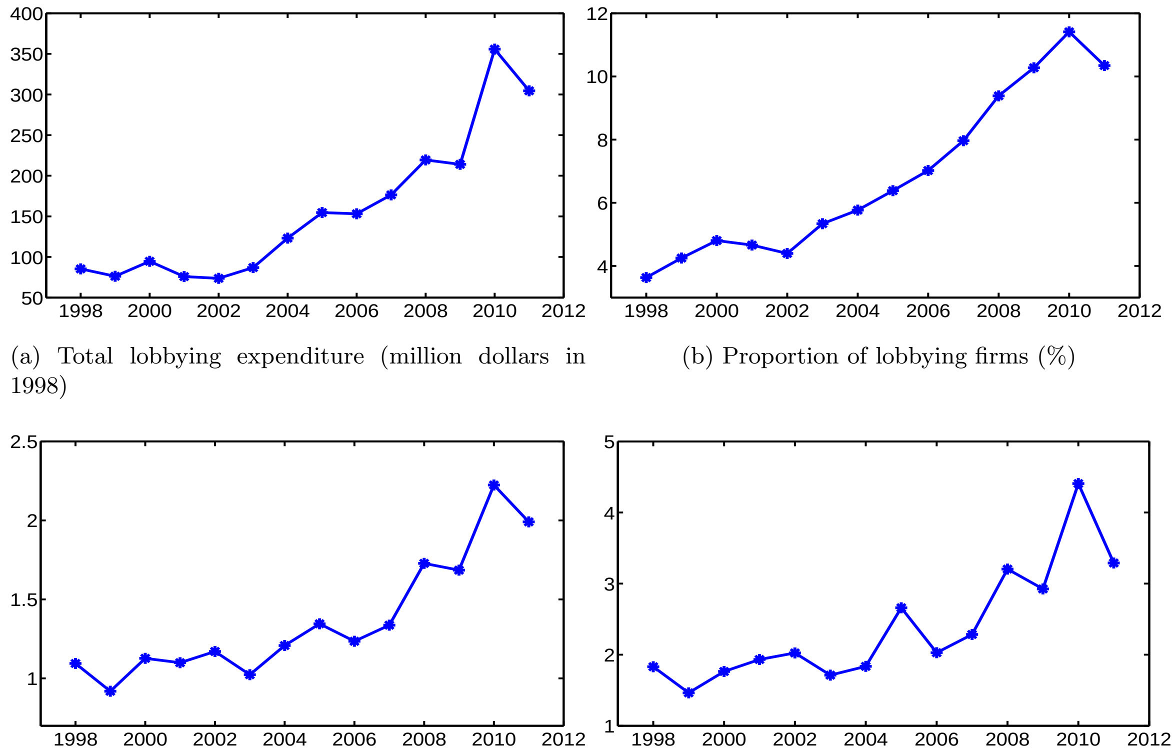
Table 11: Descriptive Statistics for Lobby Data

3.3.3 Conditional Correlations: Effective Tax Rate, Capital Intensity, and Lobbying Activity

The statutory corporate tax rate is generally flat at 35% in the U.S. economy for our sample. This is the highest corporate tax rate among the O.E.C.D. countries. Nevertheless, the effective tax rates actually paid by U.S. companies are well below this rate. We calculate effective tax rates in our sample following the definition of Richter et al. (2009). In a nutshell, the effective tax rate is taxes paid divided by taxable income reported to stockholders. Each company's effective tax rate is computed using entries from Compustat as follows:

$$ETR = \frac{\text{Income Taxes Total} - \text{Deferred Taxes}}{\text{Pre-Tax Income} - \text{Equity in Earnings} - \text{Special Items} + \text{Interest Expense}}.$$

As mentioned above, firms in our sample on average pay an effective tax rate of 21.8%, considerably lower than the statutory tax rate. Moreover, there is considerable hetero-



(a) Total lobbying expenditure (million dollars in 1998)

(b) Proportion of lobbying firms (%)

(c) Lobbying expenditure per firm (million dollars in 1998)

(d) Standard deviation of lobbying expenditure

Figure 18: Lobbying Data Statistics

Source: Lobbying statistics and authors' calculation.

geneity across firms with respect to their effective tax rate. Lobby data suggests that corporate lobbying seems to influence a potential pattern for this heterogeneity. In particular, the time-series of ETR conditional on lobbying activity suggests that lobbying firms face consistently lower effective tax rates than their non-lobbying counterparts. This section provides more compelling evidence of the correlation between corporate lobbying activity and effective tax rates. Table (12) presents the results of five panel regressions estimated using random effects. The dependent variable in every specification is the effective tax rate. More details on variables can be found in Appendix C.4.

Reg (1) and Reg (2) provide evidence on the correlation between effective tax rates and corporate lobbying activity at the extensive margin. Reg (1) confirms that the effective

	Reg (1)	Reg (2)	Reg (3)	Reg (4)	Reg (5)
if_lob_{t-1}	-0.014**	-0.010**			-0.006
	(0.006)	(0.005)			(0.006)
$\log lob_{t-1}$			-0.020**	-0.018***	-0.014*
			(0.009)	(0.006)	(0.007)
cap_int	-0.575***	-0.354***	-0.572***	-0.359***	-0.360***
	(0.067)	(0.045)	(0.067)	(0.045)	(0.045)
$\log lob_{t-1} \times cap\_int$				0.109	0.105
				(0.080)	(0.079)
ETR_{t-1}		0.343***		0.343***	0.343***
		(0.013)		(0.013)	(0.013)
lev	-0.196***	-0.142***	-0.195***	-0.142***	-0.142***
	(0.010)	(0.008)	(0.010)	(0.008)	(0.008)
inv_int	1.432**	1.165**	1.447**	1.162**	1.159**
	(0.655)	(0.466)	(0.656)	(0.466)	(0.466)
$R\&D\_int$	-0.675	0.346	-0.547	0.522	0.569
	(3.055)	(2.194)	(3.063)	(2.206)	(2.207)
$size$	0.009***	0.005***	0.009**	0.005***	0.005***
	(.001)	(.001)	(.001)	(.001)	(.001)
Year dummy	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
Random effect model	Yes	Yes	Yes	Yes	Yes
R2	0.140	0.344	0.140	0.344	0.344
# of observations	15743	15743	15743	15743	15743

[1] $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.01$.
[2] † Variable descriptions are provided in Appendix C.4.

Table 12: Effective Tax Rate Panel Regression

tax rate differential between lobbying firms and non-lobbying firms is significant even after controlling by capital intensity, leverage, investment intensity, R&D intensity, size, year and industry dummies. In particular, just controlling for the extensive margin, we see that, on average, lobbying firms face effective tax rates 1.4% lower. As Reg (2) shows, this result is robust when the lagged effective tax rate is included in the regression. This result also holds at the intensive margin, as shown in Reg (3) and Reg (4). Firms that lobby more face lower effective tax rates. When including both extensive and intensive margins, Reg (5) shows that both effects maintain their signs, but only the intensive margin is statistically significant. Interestingly, capital intensity is associated with a lower effective tax rate in every specification. This points to the capital-based tax benefits that constitute most of the tax expenditures in the U.S. These results are in line with those of Richter et al. (2009) and Meade and Li (2012).

3.4 Model Economy

To study the mechanism that links tax benefits and firms' lobbying activities and its effect on resource misallocation, this section presents a dynamic model of heterogeneous firms with endogenous lobbying decisions to obtain tax preferential treatment. The model is adapted from Hopenhayn (1992). In the model, the industry is composed of a continuum of firms which produce a homogeneous product. Firms behave competitively, taking prices as given. They decide on the level of capital and lobbying spending. In addition, there is a government, which grants tax benefits to firms in the form of tax deductions or tax credits. A part of tax benefits is standard, applied to all firms, while the other part can be influenced by lobbying activity, namely, preferential tax treatment. However, the government has limited resources for tax expenditures. In the model, the benefits are allocated sequentially, starting with the firms that value them the most, until the total amount of funds available for tax benefits is reached. Therefore, in equilibrium, only a subset of the firms lobby.

3.4.1 Firms

An operating firm starts the period with capital k and debt b. It produces output using a production function that combines productivity z, capital k, and labor n. The production function has a decreasing return to scale:

$$y = f(z, k, n) = zk^{\alpha}n^{\eta}, \tag{3.1}$$

where $0 < \alpha + \eta < 1$ and $\alpha, \eta \in (0, 1)$. The productivity z follows

$$\ln(z_{t+1}) = (1 - \rho)\ln(\mu) + \rho \ln(z_t) + \epsilon_{t+1}, \qquad \epsilon_{t+1} \sim \mathcal{N}\left(0, \sigma^2\right) \tag{3.2}$$

After producing and selling the output, the firm is subject to the statutory tax of τ on its net income. However, the government grants tax benefits to firms in the form of tax deductions or tax credits associated with the firm's capital stock. A part of tax benefits is standard, applying to all firms, while the other part can be influenced by lobbying activity. Because the government has limited resource to spend on tax credits, not every firm is granted those additional tax benefits in equilibrium. We assume that standard benefits are granted to every firm first. Then, if there are still resources to be allocated, those lobby-dependent tax benefits are granted. In particular, we assume that lobby-induced benefits are allocated sequentially, starting with the firms that are willing to lobby the most[14]. Note that, because the information is perfect, every agent knows in equilibrium what the order is. In the firm's problem, this is equivalent to the existence of a threshold of lobbying effort, $\underline{l}$, above which the firm receives preferential tax treatment. Therefore, the firm lobbies if and only if its non-strategic lobbying decision is above the threshold $\underline{l}$. In addition, the firm can accumulate capital over time. It finances the new capital k' and dividends d with after-tax profits net of debt payment and a new loan b'. However, the loan is subject to the collateral constraint such that there is no default.

The timing of the decision for an operating firm within each period is as follows. At the beginning of the period υ, a fraction of firms exogenously exit. All surviving firms realize their idiosyncratic productivity z. A firm with capital k, debt b and productivity z makes the decision on labor and lobbying spending. It then chooses a new loan, capital for the following period, and dividends. At the end of each period, firms with negative values exit.

[14]This assumption is for tractability, as it allows us to have a single equilibrium associated with lobbying. It mimics the case that big corporations are allowed to negotiate before small companies.

The firm value function is given by

$$V(k,b,z;\underline{l}) = \max\left\{V^l(k,b,z;\underline{l}), V^{nl}(k,b,z;\underline{l}), 0\right\}, \tag{3.3}$$

where

$$V^l(k,b,z;\underline{l}) = \max_{n,k',b',l\geq \underline{l}} d^l + \frac{1-\upsilon}{1+r}\mathbb{E}_{z'|z}V(k',b',z';\underline{l}') \tag{3.4}$$

$$V^{nl}(k,b,z;\underline{l}) = \max_{n,k',b'} d^{nl} + \frac{1-\upsilon}{1+r}\mathbb{E}_{z'|z}V(k',b',z';\underline{l}') \tag{3.5}$$

subject to a non-negative dividend condition given by

$$d^l = (1-\tau)\pi + \tau\mathcal{R}\left(l,\underline{b},k\right) + (1-\delta)k - k' - b + \frac{1}{1+r}b' - \Gamma(l) \geq 0, \tag{3.6}$$

$$d^{nl} = (1-\tau)\pi + \tau\mathcal{R}\left(0,\underline{b},k\right) + (1-\delta)k - k' - b + \frac{1}{1+r}b' \geq 0, \tag{3.7}$$

$$\pi = zk^\alpha n^\eta - wn. \tag{3.8}$$

$\mathcal{R}\left(l,\underline{b},k\right)$ is the firm-specific tax deduction, which depends on the standard tax benefits $\underline{b}$, lobbying effort l, and capital k. Tax benefits reduce net income that is subject to tax. This function will be specified in the next section. Even though the firm decides not to lobby, it can still get the standard tax benefits. By making lobbying effort l, the firm receives extra tax benefits but incurs the cost of $\Gamma(l) = \frac{\gamma}{2}l^2$. Flows are discounted at the interest rate $1+r$[15].

3.4.2 Government and Tax Policy

The government grants corporate tax benefits to reduce a tax burden. Mostly , firms obtain tax benefits, notably through research and experimentation credits and accelerated depreciation schedules tailored to specific types of capital equipment.[16] As stated in the

[15]In this model, there is no aggregated risk; therefore, we can think of r as the long-run interest rate implied by the discount factor of a representative household owning every firm.

[16]See Bartlett and Steele (1988), McIntyre and Nguyen (2000, 2004), and Richter et al. (2009).

previous section, a firm-specific tax deduction follows the function $\mathcal{R}(l, \Omega, k)$, where

$$\mathcal{R}(l, \Omega, k) = \min\left\{(\psi l^{\varphi} + \Omega) k^{\phi}, \chi\pi\right\} \qquad 0 < \varphi, \phi < 1 \tag{3.9}$$

How much a firm can reap tax benefits depends on its capital k, in line with the fact that most tax benefits are tied to capital, either in the form of research activities or accelerated depreciation of machinery and equipment.[17] Without any effort in lobbying, the tax burden decreases by $\tau\Omega k^{\phi}$. If a firm lobbies, it obtains preferential tax treatment, where the additional tax benefit is increasing in the lobbying effort. To ensure that, at least, a minimum amount of income tax is paid in spite of the legitimate use of deductions, the maximum tax deduction is limited by a firm's profit, $\chi\pi$.

Finally, the government can only forgo a limited fraction of its revenue on corporate tax expenditures.[18] Because the amount of tax expenditures is limited, the government only grants preferential tax treatment to firms that put in more lobbying efforts, until it runs out of resources. Tax benefits, therefore, are partly determined by other firms' lobbying spending and the total amount of tax expenditures. There is a threshold $\underline{l}$ such that firms receive preferential tax treatment according to their lobbying effort only if their lobbying effort is higher than this threshold. The government tax expenditure constraint is

$$\tau \int \mathcal{R}(l(k,b,z) \times \mathbf{1}\{l(k,b,z) \geq \underline{l}\}, \Omega, k)\, d\Psi(k,b,z) = \theta\tau \int (zk^{\alpha}n^{\eta} - wn) d\Psi(k,b,z). \tag{3.10}$$

That is, the government is willing to lose a θ fraction of its revenue on corporate tax expenditures.

[17] In 2011, accelerated depreciation of machinery and equipment and credit for increasing research activities accounted for 48% of corporate tax revenue losses.

[18] A corporate tax expenditure is a debatable issue for policymakers. Although it supports federal policy goals to provide incentives and assist certain businesses, estimated revenue loss due to corporate tax expenditures is relatively large.

3.4.3 Entrants

The problem for a potential entrant is simple in this model. All entrants enter with no debt. Capital collected from exiting firms is distributed equally among entrants, and their initial productivity is drawn from the ergodic distribution associated with Equation (3.2). Thus, the value for a potential entrant is given by

$$V^e(z) = V(\bar{k}_0, 0, z; \underline{l}), \tag{3.11}$$

where $\bar{k}_0$ is the capital distributed equally among entrants. To ensure that the mass of firms does not change, the mass of entrants must be the same as the mass of firms that exit, either exogenously or voluntarily.

3.4.4 Definition of Equilibrium

Definition 5. *Given a wage rate w and interest rate r, a stationary partial equilibrium under the tax policy rule $\mathcal{R}$ is a set of value functions $\{V, V^l, V^{nl}, V^e\}$, decision rules $\{n(k,b,z), k'(k,b,z), b'(k,b,z)\ , l(k,b,z)\ \}$, an exit decision, a threshold $\underline{l}$,and a distribution $\Psi(k,b,z)$ such that, given prices, the following conditions are satisfied:*

1. *Firms' value functions, their decision rules and exit decisions are consistent with (3.3)-(3.8), and (3.11).*

2. *A stationary distribution Ψ.*

3. *The government tax expenditure constraint (3.10) holds.*

3.5 Quantitative Exercise

In this section, we perform a quantitative exploration of the model introduced in Section 3.4 to assess the impact of capital-based tax benefits on resource misallocation in the economy and their interaction with firms' rent-seeking behavior. In particular, we calibrate the model to the firm level data presented in Section 3.3 for the period 2010-11. We evaluate the calibrated model using two sets of non-targeted moments. The first test is to compare the distribution of the marginal product of capital that is implied by the model to its data counterpart. Despite its parsimony, the model is able to match the shape and the first two moments of the data-generated distribution fairly well. The second challenge faced by the model tests its ability to replicate the conditional correlation analysis in Section 3.3. The model-generated data, like the U.S. data, suggest that effective tax rates are negatively correlated with a firm's lobbying activities and capital intensity, and positively correlated with a firm's values. Moreover, we show that the empirically observed persistence in the lobbying status of the firms can be generated by the model through the interaction between tax benefits and capital holdings. In particular, because capital stock is endogenously persistent, it imparts this property to the lobby participation margin.

We then use the calibrated model to learn more about the lobbying process and its implications for the allocation of capital in the economy. In the first experiment, we show that an increase in the fraction of revenue loss from tax expenditures between 1998-99 and 2010-11 can explain a decrease in the overall effective tax rate and also can explain an increase in both the intensive and extensive margin of lobbying during the period. In the second experiment, we use the calibrated model to study the impact of lobbying and capital-based tax benefits on resource misallocation in the U.S. economy. We document that lobbying can account for at least 20% of capital misallocation, measured as the variance of the marginal product of capital.

3.5.1 Calibration

We calibrate our model to the U.S. economy. Parameters are grouped into two categories. The first category includes parameters for which the values are either taken from other literature or directly obtained from the data. The second category includes parameters chosen so that endogenous outcomes from the model match salient features of the U.S. firm-level data in 2010-11.

The productivity process is discretized following the method in Tauchen (1986). The number of grid points for z is set to 20. The productivity distribution of entrants is assumed to be the ergodic distribution obtained from the transition matrix. The parameters governing the productivity process are set to those estimated for the U.S. manufacturing sector by Cooper and Haltiwanger (2006). In particular, $\rho = 0.885$, $\mu = 1$, and $\sigma = 0.2$. The return to scale $\alpha + \eta$ is set to 0.85, as in Restuccia and Rogerson (2008). A standard value of the income share of labor is 0.64, implying $\alpha = 0.31$ and $\eta = 0.54$. The depreciation rate δ is taken from D'Erasmo and Moscoso Boedo (2012) in their firm dynamics model for the formal sector of the U.S. economy. The exogenous exit probability, υ, is in the range used in the U.S. data, $3\% - 6\%$.[19] The maximum bound on tax benefits, χ, ensures that, at least, a minimum amount of income tax is paid in spite of the legitimate use of tax credits.[20] Finally, the taxation parameters, τ and θ, are taken directly from the statutory tax rate and tax credits in the U.S. In particular, the statutory corporate tax rate is 35% and the tax expenditure ratio is calculated from the IRS corporate income tax returns balance sheet.

Five internally calibrated parameters are those governing tax benefits and lobby spending: Ω, ϕ, φ, ψ, and γ. Although these parameters are calibrated jointly to match six targeted moments, each parameter value is mostly related to a particular moment. The base tax deduction that is independent of lobbying expenditure, Ω, pins down the average

[19] Its only role is to ensure the existence of a stationary distribution by preventing firms from accumulating capital without bounds.

[20] This rules out highly negative effective tax rates. In the baseline calibration, this constraint binds for 10% of firms.

	Value	Description	Source
Predetermined Parameters			
θ	0.33	Revenue loss by tax expenditure	IRS corporate tax returns balance sheet
α	0.31	Production function, capital	Income share, Restuccia and Rogerson (2008)
η	0.54	Production function, labor	Income share, Restuccia and Rogerson (2008)
δ	0.07	Depreciation of capital	D'Erasmo and Moscoso Boedo (2012)
τ	0.35	Statutory tax rate	U.S. statutory corporate tax rate
r	0.04	Interest rate	D'Erasmo and Moscoso Boedo (2012)
υ	0.06	Exogenous exit rate	Restuccia and Rogerson (2008)
χ	1.5	Maximum benefit	Mininum ETR = 1st percentile ETR samples
ρ	0.89	Autocorrelation	Cooper and Haltiwanger(2006)
μ	1	Mean of productivity	Cooper and Haltiwanger(2006)
σ	0.2	Std Dev of stochastic component	Cooper and Haltiwanger(2006)
Calibrated Parameters			
$\underline{b}$	0.075	Tax benefit, base deduction	Mean ETR of non-lobbying firms
ϕ	0.35	Tax benefit, capital exponent	Fraction of capital held by lobbying firms
φ	0.04	Tax benefit, lobby exponent	Mean ETR of lobbying firms
ψ	2.5	Tax benefit, lobby scale	Fraction of lobbying firm
γ	41.6	Lobby cost, scale	Lobbying expenditure to sales

Table 13: Parameter Values

effective tax rate of the non-lobbying firms in the data. ϕ, which represents the link between the capital level of the firm and its tax deductions, is closely related to the fraction of total capital held by lobbying firms in equilibrium. The exponent of lobbying in the benefit function, φ, closely links to the average effective tax rate of lobbying firms in the economy. The scale of the benefit function, ψ, has a direct nexus to the minimum lobbying expenditure that allows for benefits, $\underline{l}$, and therefore it affects the fraction of lobbying firms in equilibrium. Lastly, the scale parameter of the lobbying cost function, γ, determines how firms allocate their profit to lobbying activities, so it is mostly related to the ratio of lobbying expenditure to sales in the economy. Table (13) summarizes all parameter values. The targeted moments are reported in Table (14).

The model-based counterpart of the data is based on the stationary distribution of the economy. Despite its parsimony, the model is able to successfully match the targets. The model does a good job of generating the small fraction of lobbying firms, which own more than half of the total capital. In particular, approximately 60% of capital is owned by

	Moments	Data	Model
Average effective tax rate (%)	All firms	18.7	18.0
	Lobbying firms	15.5	10.8
	Non-lobbying firms	19.1	19.2
Lobbying firms (%)		10.9	13.5
Capital owned by lobbying firms (%)		60	64
Lobby expenditure over sales (%)		0.06	0.11

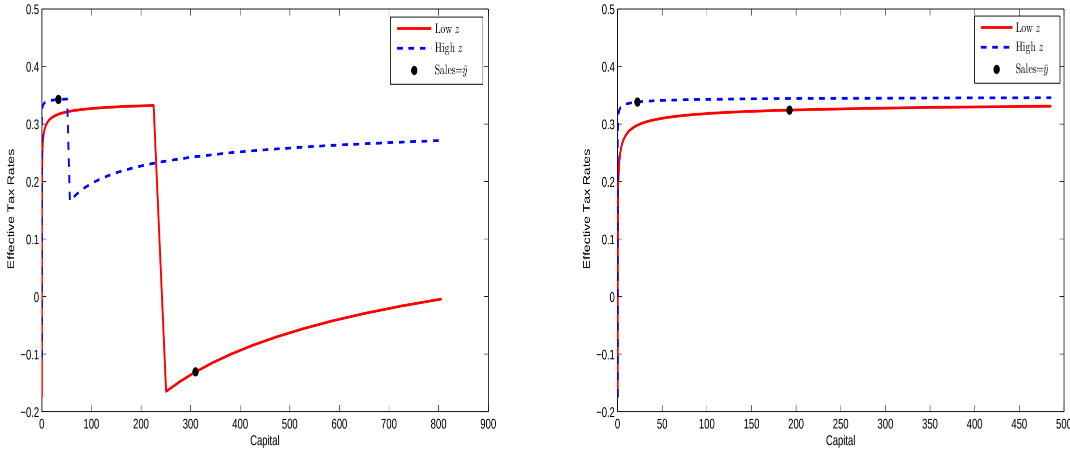
Table 14: Targeted Moments

lobbying firms, which only account for 10% of firms. The model also generates the result that lobbying firms, on average, pay lower effective tax rates. Although matching well the average effective tax rate of non-lobbying firms, the model underestimates the effective tax rate of lobbying firms.

3.5.2 Results and Non-Targeted Moments

Lobbying firms, on average, pay lower effective tax rates. This is mainly due to preferential tax treatment granted when they exert lobbying efforts. The right panel of Figure (19) shows that, without lobbying benefits, the effective tax rate is increasing in productivity and capital. This is because the standard deductions are tied only to capital, and with a decreasing return. Once lobbying benefits are introduced to the policy function, i.e. $\psi > 0$, large firms find it profitable to lobby and become entitled to additional deductions. The left panel of Figure (19) illustrates how lobbying effort can change the relative effective tax rate for lobbying firms and non-lobbying firms. For firms with the same level of productivity, large firms enjoy significantly lower effective tax rates when they decide to exert lobbying effort, compared to small, non-lobbying firms. However, lobbying benefits, measured by effective tax rates, seem to be less prominent for highly productive firms because the benefits are only tied to capital.

To make it clearer, the black dots in Figure (19) show two firms with the same amount



(a) Baseline Model

(b) Model without Lobbying benefits ($\psi = 0$)

Figure 19: Effective Tax Rate Functions for Baseline Model and Model without Lobbying Benefits

of income. Effective tax rates faced by large, unproductive firms are substantially lower than those faced by small, productive firms in the baseline model, while the difference is less noticeable in the model without lobbying benefits. This obviously has implications for resource misallocation issues. On the one hand, large, unproductive firms enjoy tax benefits, encouraging them to accumulate more capital. On the other hand, small, productive firms face high effective tax rates, reducing their after-tax profit and preventing them from accumulating capital.

Marginal Product of Capital, Non-Targeted Moments

Because the model has a clear implication for resource misallocation and because further analyses will be conducted in Section 3.5.4 to explore how tax benefits and lobbying activities distort the allocation of capital, it is crucial to see how well the model can match the most common measure of resource misallocation, i.e., a dispersion of the marginal product of capital (MPK).

Table (15) reports four non-targeted moments: the relative mean and standard devi-

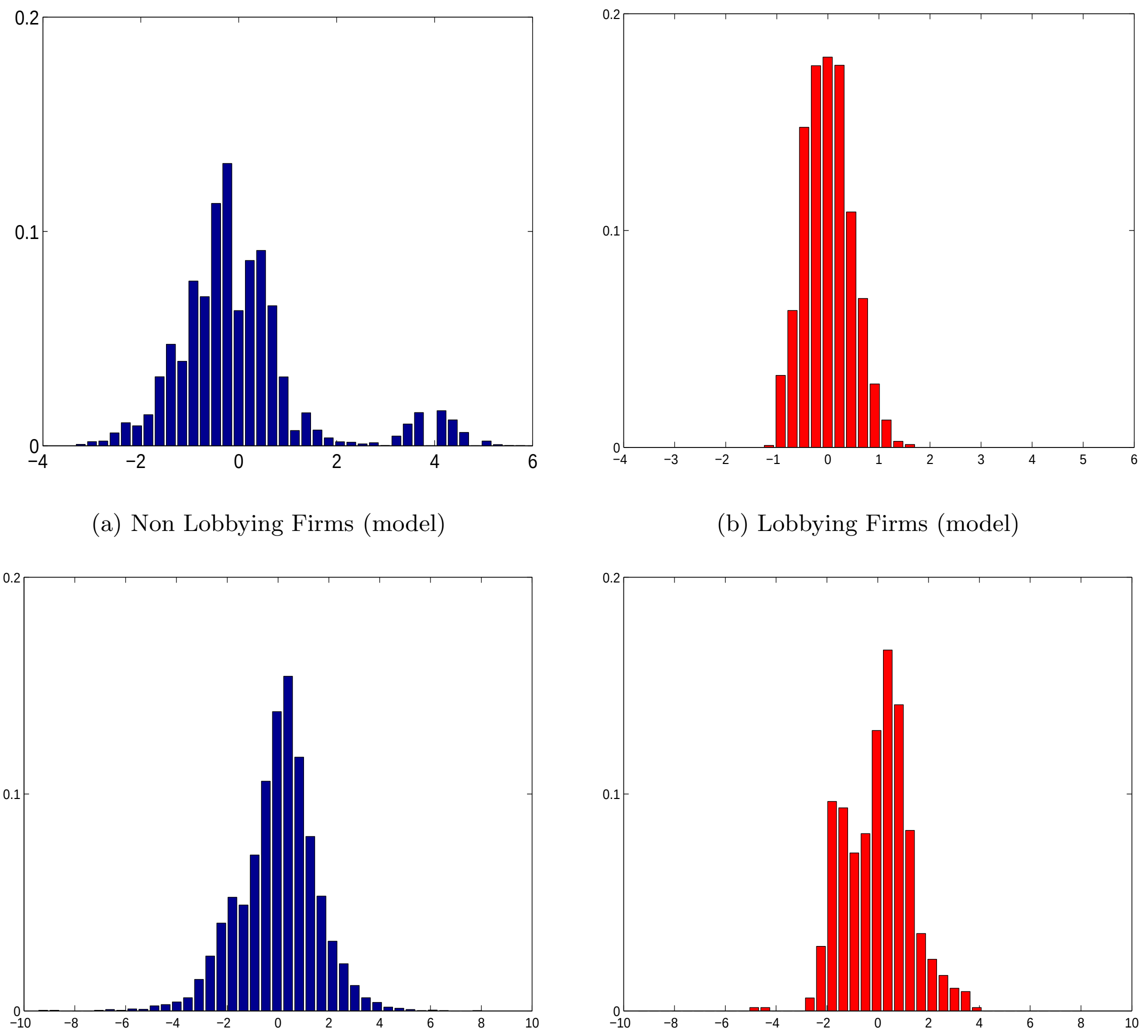
Moments		Data	Model
mean(MPK)	(Lobbying firms)/(All firms)	0.71	0.71
	(Non-lobbying firms)/(All firms)	1.04	1.04
std. dev.(MPK)	(Lobbying firms)/(All firms)	0.57	0.09
	(Non-lobbying firms)/(All firms)	1.04	1.07

Table 15: Marginal Product of Capital (MPK), Non-Targeted Moments

ation of the marginal product of capital for both lobbying and non-lobbying firms. The data show that lobbying firms have, on average, lower marginal product of capital than the average firm, and that non-lobbying firms have, on average, higher marginal product of capital. The data also suggest that the marginal product of capital is two times less dispersed among lobbying firms than non-lobbying firms. Most of these facts are captured well by the model.

In the model, as suggested by the policy functions in Figure (19), lobbying firms hold large amounts of capital. The average amount of capital is even larger for less productive firms. The model, thus, naturally delivers the low average marginal product of capital among lobbying firms.

Figure (20) compares the model-implied distribution of the logarithmic marginal product of capital, in the top panel, to the actual distribution from the data for the period 2010-11, in the bottom panel. Note that the model is able to replicate the distribution of the marginal product of capital of both groups of firms. In fact, the support of model-implied demeaned distribution is very similar to the support of the demeaned distribution in the data. Moreover, just as in the data, the distribution of non-lobbying firms (left panel) is significantly more dispersed than the distribution of lobbying firms (right panel). Finally, the shapes of the distributions are also very similar; in fact, the only difference is in the non-lobbying distribution, where, in the model, there are some signs of a bimodal distribution. Therefore, because the model is able to capture the main features of the distribution of the marginal product of capital, it is well suited to study the misallocation of capital in



(a) Non Lobbying Firms (model)

(b) Lobbying Firms (model)

(c) Non Lobbying Firms (data)

(d) Lobbying Firms (data)

Figure 20: Distribution of $\ln(MPK)$

the economy.

Lobbying and Effective Tax Rates, Non-Targeted Moments

When calibrating the model, the targeted moments are the average effective tax rates of lobbying firms and non-lobbying firms. To check the model performance, a conditional correlation between lobbying activities and effective tax rates from the model's predictions can be compared with the correlation from the data. In particular, the panel regressions (1)

Variables		Reg (1)			Reg (3)		
Data†	Model	Data	Model	Same Sign	Data	Model	Same Sign
if_lob_{t-1}	$\mathbf{1}(l_{-1} > 0)$	-0.014^{**}	-0.136	yes			
$\log lob_{t-1}$	$log(l_{-1}+1)$				-0.020^{**}	-0.022	yes
cap_int	k/n	-0.575^{***}	-0.003	yes	-0.572^{***}	-0.003	yes
lev	b/k	-0.196^{***}	-0.270	yes	-0.195^{***}	-0.267	yes
$size$	$\log(V)$	0.009^{***}	0.306	yes	0.009^{***}	0.308	yes

[1] † Variable descriptions are provided in Appendix C.4.
[2] $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.01$.
[3] See Table (12) for regressions with data.

Table 16: ETR Regressions, Non-Targeted Moments

and (3) reported in Table (12) of Section 3.3 are compared to their model counterparts in a test performed with 100,000 simulated samples from the benchmark model.[21] Table (16) reports the regression results from model-simulated observations along with those from the data for the period 1998-2011.

Although the model is calibrated to 2010-11 data, it yields correct predictions of the sign of all regression coefficients, including lobbying activities, capital intensity, leverage ratio, and total assets. Regression 1 shows the effect of lobbying at the extensive margin. Firms that engage in lobbying activity have, on average, lower effective tax rates. Regression 2 shows the effect of lobbying at the intensive margin. By spending a larger amount on lobbying activity, firms enjoy lower effective tax rates. The higher capital intensity and leverage ratio the firm has, the lower effective tax rate the firm pays. This is because tax benefits are tied to capital. Capital intensive firms can claim higher tax benefits. The negative coefficient for the leverage ratio is influenced by small, unproductive firms that are highly leveraged but take large benefits from base deductions. These firms pay very low effective tax rates. Lastly, a proxy for the volume of assets is the firm's value. Firms with large volumes of assets pay higher effective tax rates. This prediction arises in the model from the fact that tax benefits are tied to capital with a decreasing return. Large firms, and, particularly, productive large firms, can then possibly face higher effective tax rates because of their large sales volume. Those that pay low effective tax rates are unproductive

[21] Because there are no model counterparts for R&D intensity and inventories, these variables are dropped from the analysis.

firms, which generally have lower values.

3.5.3 The Persistence of Lobbying

A resilient fact of corporate lobbying documented by Kerr et al. (2014) is that lobby status is highly persistent at the firm level. Before proceeding to the analysis of the calibrated model, it is interesting to see this moment delivered by the model. Tables (18a) to (18c) show the average transition probabilities in the data between lobbying and non-lobbying firms for three different periods. In line with the results from Kerr et al. (2014), lobbying decisions are highly persistent states. They suggest that this persistence is due mainly to the option value generated by the interaction between entry cost to lobby and returns to experience in lobbying.

Table (18d) shows the model-implied transition probability for the baseline calibration. The baseline model captures more than 70% of the persistence in lobby status without fixed entry cost to lobby or returns to political experience. The fact that tax benefits are tied to capital holdings and that capital is highly persistent implies that benefits from lobbying are also persistent. Therefore, at least for tax-related lobbying, this chapter provides an alternative mechanism that can explain the persistence in firms' political activism.

	$lob_t = 0$	$lob_t = 1$
$lob_{t-1} = 0$	98.74	1.26
$lob_{t-1} = 1$	20.31	79.69

(a) Data (1998 – 1999)

	$lob_t = 0$	$lob_t = 1$
$lob_{t-1} = 0$	98.23	1.77
$lob_{t-1} = 1$	14.29	85.71

(b) Data (2010 – 11)

	$lob_t = 0$	$lob_t = 1$
$lob_{t-1} = 0$	98.45	1.55
$lob_{t-1} = 1$	14.59	85.41

(c) Data (1998 – 2011)

	$lob_t = 0$	$lob_t = 1$
$lob_{t-1} = 0$	92.67	7.33
$lob_{t-1} = 1$	38.1	61.9

(d) Model (Baseline Calibration)

Table 17: Transition Matrix of Lobbying Decision

3.5.4 Quantitative Experiment

Changes in Tax Expenditures: How do Lobbying and Tax Evolve from 1998?

The first experiment is to see how well the model can capture changes in lobbying activities and effective tax rates between 1998-1999 and 2010-11, the first and the final two years of the data set. Because the level of tax expenditures determined by the government is observed directly in the data, the only change to the baseline calibration is in θ. In 1998-1999, revenue losses from tax expenditures are 23%, compared to 33% in 2010-11.[22] In particular, all targeted moments in the benchmark calibration are obtained for the model with benchmark parameters but with $\theta = 0.23$.

		1998-1999		2010-11		Change (%)	
		Data	Model	Data	Model	Data	Model
Effective tax rate (%)	All firms	24.4	21.9	**18.7**	**18.0**	-23.4	-17.8
	Lobbying firms	21.2	16.7	**15.5**	**10.8**	-26.9	-35.3
	Non-lobbying firms	24.6	22.3	**19.1**	**19.2**	-22.4	-13.90
lobbying firms (%)		4.0	7.0	**10.9**	**13.5**	172.5	92.8
Capital owned by lobbying firms (%)		28	59	**60**	**64**	114.3	8.5
Lobbying expenditures to sales (%)		0.07	0.09	**0.06**	**0.11**	-14.3	22.2

[1] Numbers in bold are targeted. They are reported in Table (14).
[2] All parameters but θ are common. $\theta = 0.23$ for the model replicating 1998-99.

Table 18: Lobbying and Effective Tax Rate Moments in 1998-1990 and 2010-11

The first column of Table (18) shows the data moments from the period of 1998-99. Although several other parameters might have changed over the past decade, by adjusting only the fraction of tax expenditures, the model is able to qualitatively predict all changes observed in the data except the ratio of lobbying expenditures to sales. The last column of Table (18) compares the percentage changes observed in the data and those predicted by the model. In fact, other than under-predicting the change in capital owned by lobbying firms and over-predicting the change in lobbying expenditures over sales, the model quantitatively

[22] IRS corporate tax returns balance sheet.

predicts all changes relatively well.

In the model, the increase in tax expenditures reduces the average effective tax rate for every group of firms, with lobbying firms experiencing a larger decrease. The rise in tax expenditures allows more firms to benefit from lobbying activities, resulting in a larger fraction of lobbying firms. Most of these new lobbying firms have low productivity but not high enough capital, so they were not able to spend a large enough amount on lobbying activities when preferential tax treatment was more limited. These firms' optimal lobbying spending is relatively lower but, once they are granted preferential treatment, their effective tax rates become substantially lower than those of existing lobbying firms, which generally have higher productivity and greater capital. As a result, the ratio of lobbying expenditures to sales decreases, and the average effective tax rate of lobbying firms falls substantially. For the group of non-lobbying firms, the only effect is that there is a lower proportion of firms with a large amount of capital, which, in general, have slightly higher effective tax rates, as discussed above. As a result, the average effective tax rate falls by a smaller percentage. Lastly, the share of the total capital owned by lobbying firms increases. This is mainly due to a larger fraction of lobbying firms in the economy. All these predictions are confirmed in the data, with considerable success even at the quantitative level.

Resource Misallocation

The effective tax rate functions shown in Figure (19) suggest that a non-negligible distortion is created by the presence of lobbying activities on top of a distortion from the standard tax benefits, which are applied evenly across firms. Hsieh and Klenow (2009) point out that the more dispersed is the marginal product of capital, the more severe is the resource misallocation in the economy. This is because capital can be reallocated across firms to achieve a higher level of output.

Table (19) shows the dispersion of the marginal product of capital generated by the

Measure	(1) Benchmark	(2) $\psi = 0, \underline{b} = 0$	(3)† $\psi = 0, \underline{b} = 0.075$	(4)†† $\psi = 0, \underline{b} = 0.8$
Variance MPK	1.58	0.07	1.29	0.50
% Tax Expenditures	33%	0%	4%	33%

† The parameter value, $\underline{b}$, is kept at a benchmark value.
†† The parameter value, $\underline{b}$, is reassigned so that revenue losses from tax expenditure account for 33%.

Table 19: Dispersion of Marginal Product of Capital

model with different sets of parameter values. The model with the benchmark parameter values is reported in the first column. The second column is the model without tax benefits. The last two columns are the models without lobbying benefits, one with the same base deduction as the benchmark and the other with the base deduction, which yields the benchmark's fraction of tax expenditures. The benchmark parameters result in the most severe misallocation. Removing tax benefits washes out almost all of the misallocation except that created by entrants, driving down the variance of the marginal product of capital practically to zero.[23] Removing lobbying benefits yield intermediate results. Therefore, tax benefits, either base deductions or preferential tax treatment, endogenously generate a larger dispersion in the marginal product of capital, implying inefficiencies in the allocation of resources. When base deductions are high, there are a number of highly productive firms clustered around high levels of capital. Low-productivity firms choose to have low levels of capital because they can still enjoy very low effective tax rates. When base deductions are low, more firms, including productive firms, cluster around low levels of capital. As a result, the variance of the marginal product of capital is larger in the model with lower base deductions.

In summary, this section shows that the calibrated version of the model introduced in Section 3.4 successfully replicates the data features highlighted in Section 3.3. Moreover, the model suggests that the evolution of effective tax rates and lobbying activity in the U.S. economy between 1998-2011 can be attributed to a relative increase in the availability

[23]Exit firms are replaced by entrants with capital holdings equal to the total capital of exit firms; only after a period are they able to adjust their holdings.

of corporate tax benefits tied to capital usage. Finally, the calibrated model implies that corporate rent-seeking is responsible for at least 20% of capital misallocation in the U.S. economy.

3.6 Conclusion

In this chapter, we document a wide heterogeneity in the effective corporate taxation paid by U.S. corporations. In particular, firms in the U.S. pay on average an effective tax rate that is more than ten percentage points lower than the statutory tax rate, with a great dispersion among them. This is mainly due to tax benefits granted by the government. These benefits are not exogenous for every firm. In fact, large, capital-intensive firms are able to lobby for tailored benefits that fit their profiles. Because most tax provisions are tied to capital holding, different firms face different marginal benefits depending on their capital accumulation. Therefore, corporate lobbying can be an endogenous mechanism driving capital misallocation in the economy.

The heterogeneous firm dynamic model presented in this chapter formalizes this mechanism and provides a framework to quantify the role of capital-based tax benefits and firms' rent-seeking behavior in the economy. In the model, firms are granted tax benefits tied to their capital holdings, and lobbying firms are granted extra benefits depending on their lobbying expenditure. Because benefits available through lobbying are limited, only a small fraction of firms lobby in equilibrium. However, these firms are large and they can potentially hold most of the capital in the economy; therefore, the presence of capital-based tax benefits and lobbying behavior can potentially create important capital misallocation in the economy.

The calibrated model matches the targeted and non-targeted moments in the data. In particular, it is accurate when replicating the non-targeted moments, such as the first two moments of the marginal product of capital for a group of lobbying and non-lobbying firms.

The two main quantitative results of the chapter can be summarized as follow. First, the increase in the availability of tax benefits in the U.S. economy between 1998-99 and 2010-11 can explain most of the decrease in the effective tax rate, and can also explain the increase in lobbying activity at both the intensive and extensive margins. Second, corporate lobbying accounts for more than 20% of the variance in the marginal product of capital in the U.S. economy, which measures the degree of misallocation.

This chapter provides a new mechanism that can endogenously generate misallocation of resources in the economy. The main alternative channel in the literature to endogenize capital misallocation is the existence of credit-constrained firms that cannot achieve their optimal scale. Future research should contrast the two channels and quantify the contribution of each channel to the misallocation of capital. For this particular sample, the credit constraint channel does not seem to be particularly important. In fact, credit access has not been an issue for large and publicly-held firms in the U.S., even during the Great Recession. Nevertheless, in a developing economy where small firms are likely to be constrained, and weak institutions give wide access to rent-seeking behavior, the distinction of the two channels is fundamental for the efficient design of public policy.

Appendix A

Appendix to Chapter 1

A.1 Proposition 1

Proof. First note that, for any $\bar{\theta} \in [0, 1]$, the probability of a randomly drawn project $e \in [0, 1]$ having a probability $\theta(e) \leq \bar{\theta}$ is given by:

$$F(\bar{\theta}) = \left(\bar{\theta}\right)^{\frac{1}{\nu}}$$

Then, $F(\theta)$ is the cumulative density function of θ, and we can use it to find its probability density function:

$$f(\theta) = \frac{\partial F(\theta)}{\partial \theta} = \frac{1}{\nu} (\theta)^{\frac{1}{\nu}-1}$$

More algebra delivers:

$$
\begin{aligned}
E[\theta] &= \int_0^1 \frac{\theta}{\nu}(\theta)^{\frac{1}{\nu}-1}\, d\theta = \frac{1}{\nu+1} \\
V[\theta] &= E\left[(\theta - E[\theta])^2\right] = \frac{\nu^2}{(\nu+1)^2(2\nu+1)} \\
S[\theta] &= \frac{E\left[(\theta - E[\theta])^3\right]}{\left(E\left[(\theta - E[\theta])^2\right]\right)^{\frac{3}{2}}} = \frac{2(\nu-1)\sqrt{1+2\nu}}{1+3\nu}
\end{aligned}
$$

□

Note that $\nu = 1$ corresponds to a uniform distribution. For $\nu \geq 1$ this distribution resembles a Truncated Pareto distribution, but it behaves better on the neighborhood of 0.

A.2 Proposition 2

Proof. Denote by $P(H|\tilde{e})$ the expected probability of a project generating a drastic innovation conditional on delivering a signal $\tilde{e}$. Then:

$$
P(H|\tilde{e}) = \rho\tilde{e}^{\nu} + (1-\rho)\frac{1}{\nu+1}
$$

$P(H|\tilde{e})$ is increasing in the signal $\tilde{e}$. Then if $V_t^H > V_t^L$, the expected benefits of enacting a project is also increasing in $\tilde{e}$. As the cost of enacting a project is independent of the signal, the optimal strategy is to pick the desired mass M of projects with the highest signal. Finally, in order to get a mass M, the cut-off $\bar{e}$ must satisfy:

$$
\int_0^{\bar{e}} (1-\rho)(1-\bar{e})\, de + \int_{\bar{e}}^1 \{(1-\rho)(1-\bar{e}) + \rho\}\, de = M \Leftrightarrow \bar{e} = 1 - M
$$

□

A.3 Proposition 4

Proof. We start solving for the profits of the intermediate good sector. Given (1.7), (1.9), and (1.16) the profits of a type d firm are given by

$$\pi_{j,t}^{d} = l_{j,t}^{d} q_{j,t} \left(\frac{w_t}{\tilde{q}_{j,t}} - \frac{w_t}{q_{j,t}} \right) = l_{j,t}^{d} w_t \sigma^d = \frac{\sigma^d}{(1+\sigma^d)} Y_t. \tag{A.1}$$

Thus, $\forall j \in [0,1]$, $\pi_{j,t}^{d} = \pi_t^d$. Then, by (1.10), we have $\forall j \in [0,1]$, $V_{j,t}^{d} = V_t^d$. Also, as $\sigma^H > \sigma^L$, we have $\pi_t^H > \pi_t^L$, and then $V_t^H > V_t^L$. This rationalizes the equilibrium cut-off strategy of the financial intermediary. Moreover, σ^d determines the constant markup of type d leader in any product line.

The last part of equation (A.1) reveals that $l_{j,t}^{d} = l_t^d$ for all industries. Using (1.14) and (A.1) we can find the expression for the labor demand that only depends on the type of the leader, d:

$$l_t^L = \frac{(1+\sigma^H)\left[L - (1-\bar{e}_t)\kappa\right]}{1+\sigma^H - \mu_t^H(\sigma^H - \sigma^L)}; \qquad l_t^H = \frac{(1+\sigma^L)\left[L - (1-\bar{e}_t)\kappa\right]}{1+\sigma^H - \mu_t^H(\sigma^H - \sigma^L)}. \tag{A.2}$$

Note that $l_t^L > l_t^H$. □

A.4 Dynamic System

From (A.1) and (A.2) we get the following expression for wages:

$$w_t = \frac{\left[1+\sigma^H - \mu_t^H(\sigma^H - \sigma^L)\right]}{(1+\sigma^L)(1+\sigma^H)\left[L - (1-\bar{e}_t)\kappa\right]} Y_t. \tag{A.3}$$

Now, we are able to characterize the output growth in the model:

$$(1+g_t) \quad = \quad \frac{Y_{t+1}}{Y_t} = e^{\left(\int_0^1 \left\{ \ln \frac{l_{j,t+1}}{l_{j,t}} \right\} dj + \int_0^1 \left\{ \ln \frac{q_{j,t+1}}{q_{j,t}} \right\} dj \right)}. \tag{A.4}$$

Recall that $Q_t \equiv \exp(\int_0^1 \ln q_{j,t} dj)$. Then:

$$\begin{aligned}
\ln(Q_{t+1}) &= \lambda M_{t+1} \left\{ \tilde{\mu}^H_{t+1} \int \ln[q_{jt}(1+\sigma^H)]\, dj + \left(1-\tilde{\mu}^H_{t+1}\right) \int \ln[q_{jt}(1+\sigma^L)]\, dj \right\} + \\
&\quad (1-\lambda M_{t+1}) \int \ln q_{jt}\, dj \\
\Rightarrow \quad & \ln\left(\frac{Q_{t+1}}{Q_t}\right) = \lambda M_{t+1} \left\{ \tilde{\mu}^H_{t+1} \ln(1+\sigma^H) + \left(1-\tilde{\mu}^H_{t+1}\right) \ln(1+\sigma^L) \right\} \qquad \text{(A.5)}
\end{aligned}$$

We also have:

$$\int_0^1 \ln\left(l_{j,t}\right) dj = \mu^H_t \ln\left(l^H_t\right) + (1-\mu^H_t) \ln\left(l^L_t\right) \qquad \text{(A.6)}$$

Using (A.5) and (A.6) on (A.4) we get:

$$(1+g_{t+1}) = \left(\frac{(l^H_{t+1})^{\mu^H_{t+1}} (l^L_{t+1})^{1-\mu^H_{t+1}}}{(l^H_t)^{\mu^H_t} (l^L_t)^{1-\mu^H_t}} \right) \left(\left[(1+\sigma^H)^{\tilde{\mu}^H_{t+1}} (1+\sigma^L)^{1-\tilde{\mu}^H_{t+1}} \right]^{\lambda(1-\bar{e}_{t+1})} \right) \qquad \text{(A.7)}$$

Finally, combining equations (1.4) and 1.17 we get the following quilibrium relationship between output growth and interest rate:

$$\frac{(1+g_{t+1})^\gamma}{\beta} = 1 + r_{t+1} \qquad \text{(A.8)}$$

The following nine equation dynamic system fully characterizes the equilibrium of this economy. The system is written in its stationary form.

$$1 + r_{t+1} = \frac{(1+g_{t+1})^{\gamma}}{\beta} \tag{A.9}$$

$$\mu_t^H = \mu_{t-1}^H + \lambda(1-\bar{e}_t)\left[\frac{1}{\nu+1}\left(1-\rho+\frac{\rho}{1-\bar{e}_t}\left(1-\bar{e}_t^{\nu+1}\right)\right)-\mu_{t-1}^H\right] \tag{A.10}$$

$$l_t^H = \frac{(1+\sigma^L)(L-(1-\bar{e}_t)\kappa)}{1+\sigma^H-\mu_t^H(\sigma^H-\sigma^L)} \tag{A.11}$$

$$l_t^L = \frac{(1+\sigma^H)(L-(1-\bar{e}_t)\kappa)}{1+\sigma^H-\mu_t^H(\sigma^H-\sigma^L)} \tag{A.12}$$

$$\begin{aligned} 1+g_{t+1} = {} & \left[\left(1+\sigma^H\right)^{\mu_{t+1}^H-\mu_t^H(1-\lambda(1-\bar{e}_{t+1}))}\left(1+\sigma^L\right)^{\lambda(1-\bar{e}_{t+1})-\left(\mu_{t+1}^H-\mu_t^H(1-\lambda(1-\bar{e}_{t+1}))\right)}\right] \\ & \left[\frac{(l_{t+1}^H)^{\mu_{t+1}^H}(l_{t+1}^L)^{1-\mu_{t+1}^H}}{(l_t^H)^{\mu_t^H}(l_t^L)^{1-\mu_t^H}}\right] \end{aligned} \tag{A.13}$$

$$\frac{w_t}{Y_t} = \frac{(1+\sigma^H-\mu_t^H(\sigma^H-\sigma^L))}{(1+\sigma^L)(1+\sigma^H)(L-(1-\bar{e}_t)\kappa)} \tag{A.14}$$

$$\frac{V_t^H}{Y_t} = \frac{(1-\tau)\sigma^H}{1+\sigma^H}+\frac{1-\lambda(1-\bar{e}_{t+1})}{1+r_{t+1}}(1+g_{t+1})\left(\frac{V_{t+1}^H}{Y_{t+1}}\right) \tag{A.15}$$

$$\frac{V_t^L}{Y_t} = \frac{(1-\tau)\sigma^L}{1+\sigma^L}+\frac{1-\lambda(1-\bar{e}_{t+1})}{1+r_{t+1}}(1+g_{t+1})\left(\frac{V_{t+1}^L}{Y_{t+1}}\right) \tag{A.16}$$

$$\bar{e}_t = \left[\frac{\frac{\kappa}{\lambda}\frac{w_t}{Y_t}(1+r_t)-\frac{V_t^L}{Y_t}}{\rho\left(\frac{V_t^H}{Y_t}-\frac{V_t^L}{Y_t}\right)}-\frac{1-\rho}{\rho(\nu+1)}\right]^{\frac{1}{\nu}} \tag{A.17}$$

Note that, since the model has no capital, the composition μ_t^H drives all the dynamics.

A.5 Lemma 1

Proof. First we characterize the system of two equations that defines an interior BGP.

A.5.1 The System on BGP

Note that, (A.8) implies that the interest rate is constant along the BGP. Then, as $\gamma \geq 1$, we can collapse (1.10) using (A.1) and (A.8):

$$V_t^d = \frac{(1-\tau)\sigma^d}{\beta\left[(\lambda(1-\bar{e}_t)-1)(1+g)^{1-\gamma}+\frac{1}{\beta}\right](1+\sigma^d)} Y_t. \tag{A.18}$$

In an interior BGP (1.13) must hold, so, using (A.3) and (A.18), we obtain the following relationship:

$$\begin{aligned} \rho\bar{e}_t^{\nu} &= \frac{(1+g)^{\gamma}\left[1+\sigma^H-\Delta\tilde{\mu}^H\right]\left[\left(1-\bar{e}-\frac{1}{\lambda}\right)(1+g)^{1-\gamma}+\frac{1}{\lambda\beta}\right]}{\Gamma_0\left[\frac{L}{\kappa}-(1-\bar{e})\right]} - \\ & \quad \frac{(1+\sigma^H)(1-\tau)\sigma^L}{\Gamma_0} - \frac{1-\rho}{(\nu+1)} \end{aligned} \tag{A.19}$$

where $\Gamma_0 = (1-\tau)\Delta$ and $\Delta = \sigma^H - \sigma^L$. The last formula proves that indeed, $\bar{e}_t$ is constant on BGP, and so is $\tilde{\mu}_t^H$, hence, $\tilde{\mu}^H = \mu^H$. Then, from (A.2), it follows that l_t^d is also constant. Hence, (A.7) becomes

$$1+g = \left[\left(1+\sigma^H\right)^{\mu^H}\left(1+\sigma^L\right)^{1-\mu^H}\right]^{\lambda(1-\bar{e})}. \tag{A.20}$$

Then, the system is characterized by (A.19), (A.20), and

$$\mu^H(\bar{e}) = \frac{1}{\nu+1}\left[1-\rho+\frac{\rho}{1-\bar{e}}\left(1-\bar{e}^{\nu+1}\right)\right].$$

Now we find sufficient conditions for existence and uniqueness of a solution to that system.

A.5.2 Existence and Uniqueness

Preliminary Derivations

$$\begin{aligned}\frac{\partial[1+g(\bar{e})]}{\partial \bar{e}} &= \lambda[1+g(\bar{e})]\left[\left[\ln(1+\sigma^H)-\ln(1+\sigma^L)\right]\left[(1-\bar{e})\frac{\partial \mu^H(\bar{e})}{\partial \bar{e}}-\mu^H(\bar{e})\right]-\ln(1+\sigma^L)\right]\\ \frac{\partial \mu^H(\bar{e})}{\partial \bar{e}} &= \frac{\rho}{\nu+1}\left[\frac{1-\bar{e}^{\nu+1}-(\nu+1)(1-\bar{e})\bar{e}^{\nu}}{(1-\bar{e})^2}\right]>0.\end{aligned}$$

This implies:

$$\frac{\partial[1+g(\bar{e})]}{\partial \bar{e}}=-\lambda[1+g(\bar{e})]\left[\left[\ln(1+\sigma^H)-\ln(1+\sigma^L)\right]\left(\rho\bar{e}^{\nu}+\frac{1-\rho}{\nu+1}\right)+\ln(1+\sigma^L)\right]<0.$$

Uniqueness

Define the following function of $\bar{e}$:

$$A(\bar{e})=\frac{(1+g)^{\gamma}\left[1+\sigma^H-\Delta\mu^H\right]\left[\left(1-\bar{e}-\frac{1}{\lambda}\right)(1+g)^{1-\gamma}+\frac{1}{\lambda\beta}\right]}{\left[\frac{L}{\kappa}-(1-\bar{e})\right]}$$

Then we can rewrite (A.19) as:

$$\rho\bar{e}^{\nu}=\frac{1}{\Gamma_0}\left(A(\bar{e})-(1+\sigma^H)(1-\tau)\sigma^L\right)-\frac{1-\rho}{(\nu+1)} \tag{A.21}$$

Note that, the left hand side of (A.21) is increasing in $\bar{e}$. Then, if the right hand side of (A.21) is decreasing in $\bar{e}$ any interior solution must be unique. The right hand side of (A.21) is decreasing if and only if $A(\bar{e})$ is decreasing.

Note that, as $\gamma \geq 1$ and as equation (A.8), we have $\forall e \in [0,1]$ all the multiplicative terms are positive. So, we can study the derivative of $\ln(A(\bar{e}))$:

$$\begin{aligned}\ln(A(\bar{e})) &= \gamma \ln[1+g(\bar{e})] + \ln[1+\sigma^H - \Delta\mu^H(\bar{e})] + \\ &\quad \ln\left[(1-\bar{e}-\frac{1}{\lambda})\,(1+g)^{1-\gamma} + \frac{1}{\lambda\beta}\right] - \ln\left[L-(1-\bar{e})\kappa\right]\end{aligned}$$

Differentiating we get:

$$\begin{aligned}\frac{\partial \ln(A(\bar{e}))}{\partial \bar{e}} &= \gamma\frac{\partial \ln[1+g(\bar{e})]}{\partial \bar{e}} - \frac{\frac{\partial \mu^H(\bar{e})}{\partial \bar{e}}\Delta}{1+\sigma^H-\mu^H(\bar{e})(\sigma^H-\sigma^L)} \\ &- \frac{(1+g)^{1-\gamma}-(1-\bar{e}-\frac{1}{\lambda})(1-\gamma)(1+g)^{-\gamma}\frac{\partial(1+g(\bar{e}))}{\partial \bar{e}}}{(1-\bar{e}-\frac{1}{\lambda})\,(1+g)+\frac{1}{\lambda\beta}} - \frac{\kappa}{L-(1-\bar{e})\kappa}\end{aligned}$$

As $0 \leq \lambda \leq 1$ and $\gamma \geq 1$ we have $\frac{\partial \ln(A(\bar{e}))}{\partial \bar{e}} < 0$. Then if the system composed by (A.19) and (A.20) has an interior solution, it is unique.

Existence

Now we need to find sufficient conditions for the existence of $\bar{e} \in [0,1]$ that solves (A.21). Note that (A.21) is continuous in $\bar{e}$, then if the right hand side of (A.19) is smaller than ρ when $\bar{e} \to 1$, and positive at $\bar{e} = 0$, the existence of an interior solution is guaranteed. The first condition will hold if:

$$\rho \quad > \quad -\frac{1-\rho}{(\nu+1)} + \frac{1}{\Gamma_0}\left[A(1)-(1+\sigma^H)(1-\tau)\sigma^L\right]$$

Note that, $\lim_{\bar{e}\to 1}\mu^H(\bar{e}) = \bar{\mu}^H = \frac{1+\nu\rho}{\nu+1}$, and $g(1) = 0$. Then:

$$A(1) = \left[1+\sigma^H - \frac{1+\nu\rho}{\nu+1}\Delta\right]\left[\frac{1-\beta}{\lambda\beta}\right]\frac{\kappa}{L}$$

We can then find the following condition on $\frac{\kappa}{L}$, the percentage of the labor force needed to enact all the projects of the economy:

$$b = \frac{\lambda\beta}{1-\beta}\left[\frac{\Gamma_0\left(\rho + \frac{1-\rho}{(\nu+1)}\right) + (1+\sigma^H)(1-\tau)\sigma^L}{1+\sigma^H - \frac{(1+\nu\rho)\Delta}{\nu+1}}\right] \quad > \quad \frac{\kappa}{L}$$

Let's study now the case where $\bar{e} = 0$. We need:

$$\frac{1-\rho}{(\nu+1)}\Gamma_0 \quad < \quad A(0) - (1+\sigma^H)(1-\tau)\sigma^L$$

Note that, $\mu^H(0) = \underline{\mu}^H = \frac{1}{\nu+1}$, and $1 + g(0) = \left[(1+\sigma^H)^{\underline{\mu}^H}\left(1+\sigma^L\right)^{1-\underline{\mu}^H}\right]^{\lambda}$. Then:

$$A(0) = \frac{\left[1+\sigma^H - \frac{\Delta}{1+\nu}\right]\left[\left(1-\frac{1}{\lambda}\right)(1+g(0)) + \frac{(1+g(0))^{\gamma}}{\lambda\beta}\right]}{\left[\frac{L}{\kappa} - 1\right]}$$

We can then find the following condition on $\frac{\kappa}{L}$:

$$a = \frac{\kappa}{L} \quad > \quad \frac{\frac{1-\rho}{(\nu+1)}\Gamma_0 + (1+\sigma^H)(1-\tau)\sigma^L}{\left[1+\sigma^H - \frac{\Delta}{1+\nu}\right]\left[\left(1-\frac{1}{\lambda}\right)(1+g(0)) + \frac{(1+g(0))^{\gamma}}{\lambda\beta}\right] + \frac{1-\rho}{(\nu+1)}\Gamma_0 + (1+\sigma^H)(1-\tau)\sigma^L}$$

Then $\forall \frac{\kappa}{L} \in [a, b]$ we have existence and uniqueness of an interior solution. Finally, after solving for $\{e, g\}$ in equations (A.19) and (A.20), all the other variables can be recovered.

A.5.3 Recovering all Variables

$$\begin{aligned}
\left(\mu_t^H\right)_{bgp} &= \mu^H = \frac{1}{\nu+1}\left[1-\rho+\frac{\rho}{1-\bar{e}}\left(1-\bar{e}^{\nu+1}\right)\right] \\
\left(r_{t+1}\right)_{bgp} &= r = \frac{(1+g)^\gamma}{\beta}-1 \\
\left(l_t^H\right)_{bgp} &= l^H = \frac{(1+\sigma^L)\left[L-(1-\bar{e})\kappa\right]}{1+\sigma^H-\mu_t^H(\sigma^H-\sigma^L)} \\
\left(l_t^L\right)_{bgp} &= l^L = \frac{(1+\sigma^H)\left[L-(1-\bar{e})\kappa\right]}{1+\sigma^H-\mu^H(\sigma^H-\sigma^L)} \\
\left(\frac{V_t^H}{Y_t}\right)_{bgp} &= v^H = \frac{(1-\tau)\sigma^H}{\beta\left[\lambda(1-\bar{e})+\frac{1}{\beta}-1\right](1+\sigma^H)} \\
\left(\frac{V_t^L}{Y_t}\right)_{bgp} &= v^L = \frac{(1-\tau)\sigma^L}{\beta\left[\lambda(1-\bar{e})+\frac{1}{\beta}-1\right](1+\sigma^L)} \\
\left(\frac{w_t}{Y_t}\right)_{bgp} &= w = \frac{\left[1+\sigma^H-\mu^H(\sigma^H-\sigma^L)\right]}{(1+\sigma^L)(1+\sigma^H)\left[L-(1-\bar{e})\kappa\right]} \\
\left(\frac{C_t}{Y_t}\right)_{bgp} &= c = 1
\end{aligned}$$

□

A.6 Proposition 5 and Proposition 6

A.6.1 Entry

Preliminairies

Define the parameter set of the model as $\Omega \equiv \left\{\rho, \tau, \sigma^H, \sigma^L, \gamma, \nu, \beta, \lambda, \kappa, L\right\}$. We can rewrite equation (A.21) as:

$$A(\bar{e}, \Omega) = C(\bar{e}, \Omega) \tag{A.22}$$

Where $A(\bar{e},\Omega)$ is $A(\bar{e})$ from Appendix A.5 and:

$$C(\bar{e},\Omega) = (1-\tau)\left[\left(\rho\bar{e}^{\nu} + \frac{1-\rho}{\nu+1}\right)\Delta + (1+\sigma^H)\sigma^L\right]$$

Denoting the partial derivatives by sub indexes we have, for any fixed plausible set Ω satisfying the condition of Lemma 1, $\forall \bar{e} \in (0,1)$:

$$\begin{array}{ccc} A(\bar{e},\Omega) > 0 & ; & A_{\bar{e}}(\bar{e},\Omega) < 0 \\ C(\bar{e},\Omega) > 0 & ; & C_{\bar{e}}(\bar{e},\Omega) > 0 \end{array}$$

Then, using implicit derivative on equation A.22 for $\bar{e}$ and any parameter $p \in \Omega$ we get:

$$\frac{\partial \bar{e}}{\partial p} = \frac{A_p(\bar{e},\Omega) - C_p(\bar{e},\Omega)}{C_{\bar{e}}(\bar{e},\Omega) - A_{\bar{e}}(\bar{e},\Omega)} \Rightarrow sign\left(\frac{\partial \bar{e}}{\partial p}\right) = sign\left(A_p(\bar{e},\Omega) - C_p(\bar{e},\Omega)\right)$$

Enacting cost κ

$$\begin{aligned} sign\left(\frac{\partial \bar{e}}{\partial \kappa}\right) &= sign\left(A_\kappa(\bar{e},\Omega) - C_\kappa(\bar{e},\Omega)\right) = sign\left(A_\kappa(\bar{e},\Omega)\right) \\ &= sign\left(\frac{\partial \ln\left(A(\bar{e},\Omega)\right)}{\partial \kappa}\right) = sign\left(\frac{1-\bar{e}}{L-(1-\bar{e})\kappa}\right) \end{aligned}$$

We know by labor market clearing condition that $L-(1-\bar{e})\kappa > 0$. Hence, we have $\frac{d\bar{e}}{d\kappa} > 0$, and entry decreases in the enacting cost κ.

Discount factor β

$$\begin{aligned}
sign\left(\frac{\partial\bar{e}}{\partial\beta}\right) &= sign\left(A_{\beta}(\bar{e},\Omega) - C_{\beta}(\bar{e},\Omega)\right) = sign\left(A_{\beta}(\bar{e},\Omega)\right) \\
&= sign\left(\frac{\partial\ln\left(A(\bar{e},\Omega)\right)}{\partial\beta}\right) = sign\left(\frac{-\frac{1}{\lambda\beta^2}}{(1-\bar{e}-\frac{1}{\lambda})\,(1+g)^{1-\gamma}+\frac{1}{\lambda\beta}}\right)
\end{aligned}$$

As $\gamma \geq 1$ and given equation (A.8) we have: $(1-\bar{e}-\frac{1}{\lambda})\,(1+g)^{1-\gamma}+\frac{1}{\lambda\beta} > 0$. Hence, we have $\frac{d\bar{e}}{d\beta} < 0$, and entry increases in the discount factor β.

Corporate tax rate τ

$$\begin{aligned}
sign\left(\frac{\partial\bar{e}}{\partial\tau}\right) &= sign\left(A_{\tau}(\bar{e},\Omega) - C_{\tau}(\bar{e},\Omega)\right) = sign\left(-C_{\tau}(\bar{e},\Omega)\right) \\
&= sign\left(-\frac{\partial\ln\left(C(\bar{e},\Omega)\right)}{\partial\tau}\right) = sign\left(\frac{1}{1-\tau}\right) > 0
\end{aligned}$$

Hence, we have $\frac{d\bar{e}}{d\tau} > 0$, and entry decreases in the corporate tax rate τ.

Accuracy ρ

$$sign\left(\frac{\partial\bar{e}}{\partial\rho}\right) = sign\left(A_{\rho}(\bar{e},\Omega) - C_{\rho}(\bar{e},\Omega)\right)$$

Note first the following auxiliary results:

$$\begin{aligned}\frac{\partial \mu^H}{\partial \rho} &= \frac{1}{\nu+1}\left[\frac{1-\bar{e}^{\nu+1}}{1-\bar{e}}-1\right] > 0\\ \frac{\partial g}{\partial \rho} &= \frac{\partial g}{\partial \mu^H}\frac{\partial \mu^H}{\partial \rho} = (1+g)\lambda(1-\bar{e})\ln\left(\frac{1+\sigma^H}{1+\sigma^L}\right)\frac{\partial \mu^H}{\partial \rho} > 0.\end{aligned}$$

Now, we have:

$$\begin{aligned}A_\rho(\bar{e},\Omega) &= \frac{(1+g)\frac{\partial \mu^H}{\partial \rho}}{\left[\frac{L}{\kappa}-(1-\bar{e})\right]}\left(\left(1-\bar{e}-\frac{1}{\lambda}\right)\left(\lambda(1-\bar{e})\ln\left(\frac{1+\sigma^H}{1+\sigma^L}\right)\left[1+\sigma^H-\Delta\mu^H\right]-\Delta\right)\right.\\ &+ \left.\left(\frac{(1+g)^{\gamma-1}}{\lambda\beta}\left(\gamma\lambda(1-\bar{e})\ln\left(\frac{1+\sigma^H}{1+\sigma^L}\right)\right)\left[1+\sigma^H-\Delta\mu^H\right]-\Delta\right)\right)\\ &= \frac{(1+g)\frac{\partial \mu^H}{\partial \rho}}{\left[\frac{L}{\kappa}-(1-\bar{e})\right]}B(\bar{e},\Omega))\end{aligned}$$

Then $sign\,(A(\bar{e},\Omega))) = sign\,(B(\bar{e},\Omega)))$.

$$\begin{aligned}B_\rho(\bar{e},\Omega) &= \left(1-\bar{e}-\frac{1}{\lambda}+\frac{\gamma(1+g)^{\gamma-1}}{\lambda\beta}\right)\lambda(1-\bar{e})\ln\left(\frac{1+\sigma^H}{1+\sigma^L}\right)\left[1+\sigma^H-\Delta\mu^H\right]\\ &- \left(1-\bar{e}-\frac{1}{\lambda}+\frac{(1+g)^{\gamma-1}}{\lambda\beta}\right)\Delta\end{aligned}$$

Note that $f(x) = x - \ln(1+x)$ is increasing in x. This means that $\Delta > \ln\left(\frac{1+\sigma^H}{1+\sigma^L}\right)$. Hence, a sufficient condition for $A_\rho(\bar{e},\Omega) < 0$ is:

$$\bar{e} \geq \bar{e}_A = 1 - \frac{1}{\lambda\gamma\left[1+\frac{\sigma^L+\nu\sigma^H}{\nu+1}\right]}$$

Also note that:

$$C_\rho(\bar{e},\Omega) = (1-\tau)\Delta\left(\bar{e}^\nu - \frac{1}{\nu+1}\right)$$

$C_\rho(\bar{e},\Omega)$ is positive for $\bar{e} \geq \bar{e}_C = \left(\frac{1}{\nu+1}\right)^{\frac{1}{\nu}}$. Then we know that

$$\bar{e}(\rho) \geq \min\left\{\max\left(\bar{e}_A, \bar{e}_C\right), 1\right\} \equiv \bar{s} \Rightarrow \frac{\partial \bar{e}}{\partial \rho} < 0.$$

For $\bar{e} < \max\left(\bar{e}_A, \bar{e}_C\right)$, the sign of $\frac{\partial \bar{e}}{\partial \rho}$ is not clear. For example, for $\bar{e}(\rho) = 0$ we have $\frac{\partial \mu^H}{\partial \rho} = 0$, and hence $\frac{\partial \bar{e}}{\partial \rho} > 0$. This is quite intuitive, in fact, an economy performing no selection will have increasing incentives to select when they gain access to better screening technology. Nevertheless, we can also find a sufficient condition for $\frac{\partial \bar{e}}{\partial \rho} > 0$. First, a sufficient condition for $B_\rho(\bar{e},\Omega) > 0$ is given by:

$$\bar{e} \leq \underline{e}_A = 1 - \frac{\Delta}{\lambda\gamma \ln\left(\frac{1+\sigma^H}{1+\sigma^L}\right)\left[1 + \frac{\nu\sigma^H + \sigma^L - \Delta\rho\nu}{\nu+1}\right]}$$

Note that $\underline{e}_A < \bar{e}_A$. Then we know that

$$\bar{e}(\rho) \leq \max\left\{0, \min\left(\underline{e}_A, \bar{e}_C\right) \equiv \underline{s}\right\} \Rightarrow \frac{\partial \bar{e}}{\partial \rho} > 0.$$

Note that κ does not enter in $\bar{s}$ or $\underline{s}$ but it affects $\bar{e}$ monotonically. So, economies with high κ, characterized by a high $\bar{e}$ and a low entry rate, are likely to increase entry when ρ increases, but economies with low κ do just the opposite. We explore this margin on the quantitative illustration of the mechanism.

A.6.2 Growth

1. Given the former results and that $\frac{\partial g}{\partial \bar{e}} < 0$, we can easily show:

$$\begin{aligned}
\frac{\partial g}{\partial \kappa} &= \frac{\partial g}{\partial \bar{e}}\frac{\partial \bar{e}}{\partial \kappa} < 0 \\
\frac{\partial g}{\partial \beta} &= \frac{\partial g}{\partial \bar{e}}\frac{\partial \bar{e}}{\partial \beta} > 0, \\
\frac{\partial g}{\partial \tau} &= \frac{\partial g}{\partial \bar{e}}\frac{\partial \bar{e}}{\partial \tau} < 0
\end{aligned}$$

2. We can also study:

$$\frac{\partial g}{\partial \rho} = \underbrace{\frac{\partial g}{\partial \bar{e}}}_{<0}\underbrace{\frac{\partial \bar{e}}{\partial \rho}}_{?} + \underbrace{\frac{\partial g}{\partial \mu^H}\frac{\partial \mu^H}{\partial \rho}}_{>0}.$$

Note that $\frac{\partial \bar{e}}{\partial \rho} < 0 \Rightarrow \frac{\partial g}{\partial \rho} > 0$.

A.6.3 Composition

1. From previous results:

$$\begin{aligned}
\frac{\partial \mu^H}{\partial \kappa} &= \frac{\partial \mu^H}{\partial \bar{e}}\frac{\partial \bar{e}}{\partial \kappa} > 0 \\
\frac{\partial \mu^H}{\partial \beta} &= \frac{\partial \mu^H}{\partial \bar{e}}\frac{\partial \bar{e}}{\partial \beta} < 0, \\
\frac{\partial \mu^H}{\partial \tau} &= \frac{\partial \mu^H}{\partial \bar{e}}\frac{\partial \bar{e}}{\partial \tau} > 0
\end{aligned}$$

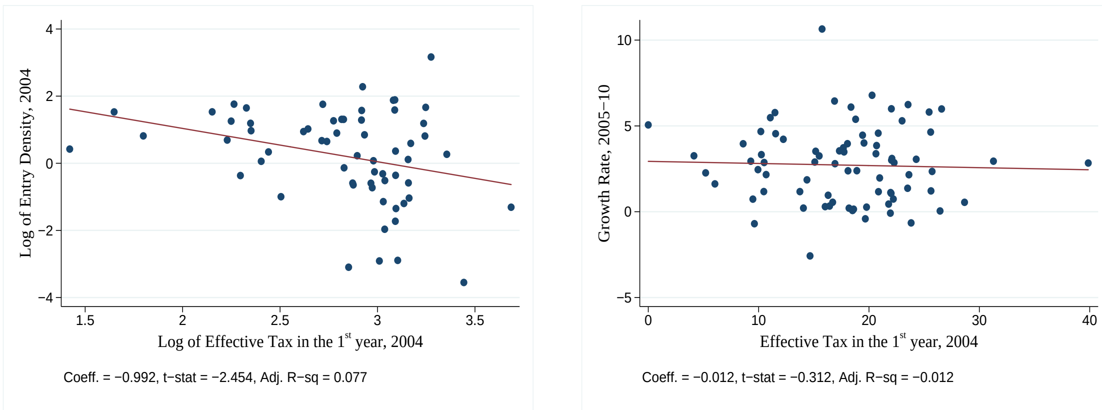
2. We can also study:

$$\frac{\partial \mu^H}{\partial \rho} = \underbrace{\frac{\partial \bar{e}}{\partial \rho}}_{?}\underbrace{\frac{\partial \mu^H}{\partial \bar{e}}}_{>0} + \underbrace{\frac{1-\bar{e}^{\nu+1}}{1-\bar{e}} - 1}_{>0}$$

Note that $\frac{\partial \bar{e}}{\partial \rho} > 0 \Rightarrow \frac{\partial \mu^H}{\partial \rho} > 0$

A.7 Corporate Tax, Entry, and Growth

As argued on the main text, empirical research points to a strong and significant effect of taxation in firm entry, nevertheless, the effect of taxation in long-run growth is practically insignificant. Figure (21) uses cross country data to illustrate this puzzle: Left panel of figure



(a) Entry

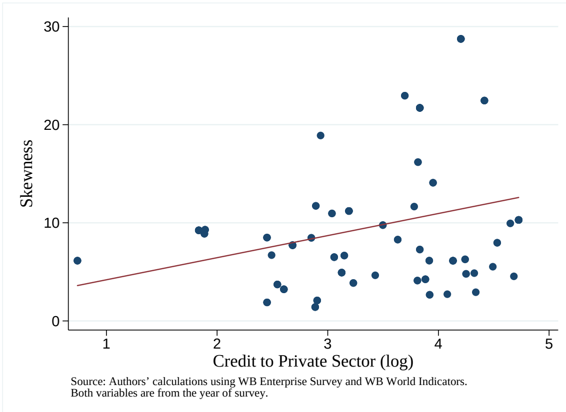
(b) Growth

Figure 21: Corporate Taxes, Entry and Growth

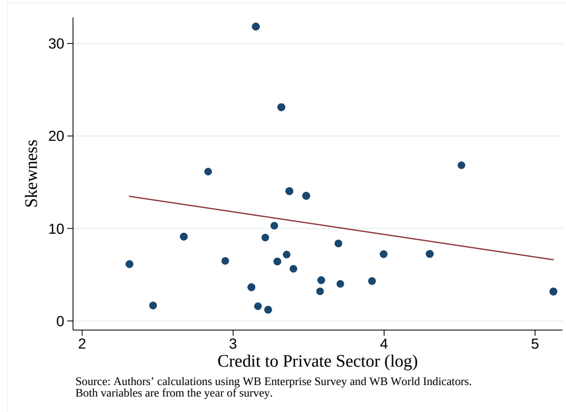
(21) plots the natural logarithm of entry density against the logarithm of effective first year corporate tax rates in 2004 for a set of 60 countries.[1] The right panel shows the relationship between the average growth rates of the next five years and effective first year corporate tax rates. It is easily discernible that higher corporate tax rates are associated with lower entry rates whereas there is no clear effect on the 5-year average of growth rates. According to our model, the explanation lies on project heterogeneity and financial selection: higher taxation induces stronger selection which reduces entry significantly decreasing the direct effect of a larger cohort, nevertheless, tighter selection also implies a better composition of the incoming cohort which might offset an important part of the negative effect on growth.

[1]The data for effective rates of corporate taxes in the first year of a firm is available in Djankov et al. (2010).

A.8 Skewness



(a) Above median entry



(b) Below median entry

Figure 22: Financial Development and Private Credit

Appendix B

Appendix to Chapter 2

B.1 Model Solution

In this section, we derive the system of equations that characterizes the normalized model. We follow the same order as in the main text, but here we report only the main equations. Then we derive the system that characterizes the balanced growth path, and finally we prove the Lemma that is shown in the main text.

B.1.1 Normalized Model: System of Equations

Final Good Producer

$$y(s^t) = \left((L^H(s^t))^{\mu(s^t)}(L^L(s^t))^{1-\mu(s^t)}\right)^{\alpha}\left(\frac{k(s^{t-1})}{1+a(s^{t-1},s_t)}\right)^{1-\alpha} \tag{B.1}$$

$$x_j(s^t) = \frac{\alpha y(s^t)}{p_j(s^t)\left(1+\eta(R(s^t)-1)\right)}. \tag{B.2}$$

$$k(s^{t-1}) = \frac{(1-\alpha)y(s^t)}{r(s^t)}\left(1+a(s^{t-1},s_t)\right) \tag{B.3}$$

Intermediate Good Producer

$$L^d(s^t) = \frac{\alpha y(s^t)}{w(s^t)(1+\sigma^d)\left(1+\eta\left(R(s^t)-1\right)\right)} \Rightarrow \frac{L^H(s^t)}{L^L(s^t)} = \frac{1+\sigma^L}{1+\sigma^H} \tag{B.4}$$

$$\pi_j^d(s^t) = \frac{\alpha\sigma^d}{(1+\sigma^d)\left(1+\eta(R(s^t)-1)\right)} y(s^t) \tag{B.5}$$

$$v^d(s^t) = (1-\tau)\pi^d(s^t) + E\left[m(s^t, s_{t+1})\left(1-\lambda M(s^t, s_{t+1})\right) v^d(s^t, s_{t+1})|s^t\right] \tag{B.6}$$

Financial Intermediary and Composition

$$\tilde{\mu}(\bar{z}(s^t)) = \tilde{\mu}^H(\bar{z})(s^t) = \frac{1}{\nu+1}\left[1-\rho+\rho\frac{1-\left(\bar{z}(s^t)\right)^{\nu+1}}{1-\bar{z}(s^t)}\right] \tag{B.7}$$

$$\rho(\bar{z}_t(s^t))^{\nu} = \frac{\frac{w(s^t)\kappa}{\lambda}(R(s^t)) - v^L(s^t)}{(v^H(s^t)-v^L(s^t))} - \frac{1-\rho}{(\nu+1)} \tag{B.8}$$

$$\mu(s^t) = \mu(s^{t-1}) + \lambda(1-\bar{z}(s^t))\left(\tilde{\mu}(\bar{z}(s^t)) - \mu(s^{t-1})\right) \tag{B.9}$$

Representative Household

$$1 = E\left[m(s^t, s_{t+1})|s^t\right] R(s^t) - \psi\left(\frac{b(s^t)}{y(s^t)} - \bar{b}\right) \tag{B.10}$$

$$E\left[m(s^t, s_{t+1})\frac{r(s^t, s_{t+1}) + (1-\delta) - \frac{\phi}{2}\left([1+g_{bgp}]^2 - \left[\frac{k(s^t, s_{t+1})}{k(s^t)}(1+a(s^t, s_{t+1}))\right]^2\right)}{1+\phi\left[\frac{k(s^t)}{k(s^{t-1})} - (1+g_{bgp})\right]}|s^t\right] = 1 \tag{B.11}$$

$$L(s^t) = \left(\frac{w(s^t)}{\Theta_l\chi}\right)^{\frac{1}{\chi-1}} \tag{B.12}$$

with:

$$m(s^{t+1}) = \frac{E\left[\frac{\beta}{\left(1+a(s^t,s_{t+1})\right)^{\gamma}}\left\{\left(c(s^{t+1}) - \Theta_l \left(L(s^{t+1})\right)^{\chi}\right)^{-\gamma}\right\} | s^t\right]}{\left(c(s^t) - \Theta_l \left(L(s^t)\right)^{\chi}\right)^{-\gamma}}$$

Open Economy Variables

$$\ln\left(\frac{R(s^t)}{\bar{R}}\right) = \rho_r \ln\left(\frac{R(s^{t-1})}{\bar{R}}\right) + \sigma_e \epsilon_t \quad \text{where} \quad \epsilon_t \overset{iid}{\sim} N(0,1) \tag{B.13}$$

$$nx(s^t) = y(s^t) - c(s^t) - i(s^t) - \frac{\psi}{2} y(s^t)\left(\frac{b(s^t)}{y(s^t)} - \bar{b}\right)^2 \tag{B.14}$$

$$d(s^t) = \frac{b(s^{t-1})}{1 + a(s^{t-1}, s_t)} - \eta \frac{\alpha y(s^t)}{1 + \eta(R(s^t) - 1)} - (1 - \bar{z}(s^t))\kappa w(s^t) \tag{B.15}$$

Labor Market Clearing

$$\left(\frac{w(s^t)}{\Theta_l \chi}\right)^{\frac{1}{\chi-1}} = \frac{\alpha y(s^t)\left(\mu(s^t) + (1-\mu(s^t))\frac{1+\sigma^H}{1+\sigma^L}\right)}{w(s^t)(1+\sigma^H)\left(1+\eta\left(R(s^t)-1\right)\right)} + (1 - \bar{z}(s^t))\kappa \tag{B.16}$$

Output Growth

$$\begin{aligned} \ln(1 + g(s^{t-1}, s_t)) &= \alpha \int_0^1 \ln\left(\frac{L_j(s^t)}{L_j(s^{t-1})}\right) + \ln\left(\frac{q_j(s^t)}{q_j(s^{t-1})}\right) dj + \\ &\quad (1-\alpha)\ln\left(\frac{K(s^{t-1})}{K(s^{t-2})}\right) \end{aligned} \tag{B.17}$$

Let's work term by term:

$$\begin{aligned}\int_0^1 \ln\left(\frac{L_j(s^t)}{L_j(s^{t-1})}\right) dj &= \mu(s^t)\ln\left(\frac{L^H(s^t)}{L^L(s^t)}\right) - \mu(s^{t-1})\ln\left(\frac{L^H(s^{t-1})}{L^L(s^{t-1})}\right) + \ln\left(\frac{L^L(s^t)}{L^L(s^{t-1})}\right) \\ &= (\mu(s^t) - \mu(s^{t-1}))\ln\left(\frac{1+\sigma^L}{1+\sigma^H}\right) + \ln\left(\frac{L^L(s^t)}{L^L(s^{t-1})}\right)\end{aligned}$$

Second term:

$$\int_0^1 \ln\left(\frac{q_j(s^t)}{q_j(s^{t-1})}\right) dj = \lambda(1-\bar{z}(s^t))\left(\tilde{\mu}(s^t)\ln(1+\sigma^H) + (1-\tilde{\mu}(s^t))\ln(1+\sigma^L)\right)$$

Third term:

$$\ln\left(\frac{K(s^{t-1})}{K(s^{t-2})}\right) = \ln\left(\frac{k(s^{t-1})}{k(s^{t-2})}(1+a(s^{t-2},s_{t-1}))\right)$$

B.1.2 Balanced Growth Path

First note that the three components of equation (B.17) imply that the long-run growth rate is given by:

$$1+g(\bar{z}) = \left((1+\sigma^H)^{\mu(\bar{z})}(1+\sigma^L)^{(1-\mu(\bar{z}))}\right)^{\lambda(1-\bar{z})} = 1+a(\bar{z})$$

From equation (B.11) we get:

$$\frac{(1+a(\bar{z}))^{\gamma}}{\beta} = 1+r-\delta \tag{B.18}$$

From equation (B.4) we get:

$$L^d(y,w) = \frac{\alpha y}{w(1+\sigma^d)\left(1+\eta\left(\bar{R}-1\right)\right)} \tag{B.19}$$

And we characterize $k(y,\bar{z})$ using (B.3) and (B.18):

$$k(y,\bar{z}) = \frac{(1-\alpha)\left(1+a(\bar{z})\right)}{\frac{(1+a(\bar{z}))^{\gamma}}{\beta}-1+\delta}y \tag{B.20}$$

Replacing equations (B.20), and (B.19) in equation (B.1), we write $w(\bar{z})$ as:

$$w(\bar{z}) \quad = \quad \left(\frac{\alpha\left(1+a(\bar{z})\right)^{\frac{1}{\lambda(\bar{z}-1)}}}{\left(1+\eta\left(\bar{R}-1\right)\right)}\right)\left(\frac{(1-\alpha)}{\frac{(1+a(\bar{z}))^{\gamma}}{\beta}-1+\delta}\right)^{\frac{1-\alpha}{\alpha}} \tag{B.21}$$

We characterize $y(\bar{z})$ using (B.16):

$$y(\bar{z}) = \frac{\left(1+\sigma^{H}\right)\left(1+\eta\left(\bar{R}-1\right)\right)\left((w(\bar{z}))^{\frac{\chi}{\chi-1}}\left(\Theta_{l}\chi\right)^{\frac{1}{1-\chi}}-(1-\bar{z})\kappa w(\bar{z})\right)}{\alpha\left(\frac{1+\sigma^{H}}{1+\sigma^{L}}-\mu(\bar{z})\frac{\sigma^{H}-\sigma^{L}}{1+\sigma^{L}}\right)}$$

Given $y(\bar{z})$, we write $L^{d}(\bar{z})$ and $k(\bar{z})$ using equations (B.20) and (B.19). Moreover, as normalized profits are constant over the BGP, we write $v^{d}(\bar{z})$ as:

$$v^{d}(\bar{z}) \quad = \quad \frac{\alpha(1-\tau)\sigma^{d}}{\left(1+\sigma^{d}\right)\left(1+\eta(\bar{R}-1)\right)\left(1-\left(1-\lambda(1-\bar{z})\right)\beta(1+a(\bar{z}))^{1-\gamma}\right)}y(\bar{z})$$

Finally, $\bar{z}$ must also be the unique solution to the Financial Intermediary problem:

$$\rho(\bar{z})^{\nu} = \frac{\frac{w(\bar{z})\kappa}{\lambda}(\bar{R})-v^{L}(\bar{z})}{\left(v^{H}(\bar{z})-v^{L}(\bar{z})\right)}-\frac{1-\rho}{(\nu+1)} \tag{B.22}$$

The former equation pins down $\bar{z}$, and hence the complete balanced growth path of this open economy model. The long-run level of bond holding $b(\bar{z})$ is characterized by equation (B.10):

$$\frac{\bar{R}}{1+\psi\left(\frac{b(\bar{z})}{y(\bar{z})}-\bar{b}\right)} \quad = \quad \frac{(1+a(\bar{z}))^{\gamma}}{\beta}\Rightarrow b(\bar{z}) = \left(\frac{\frac{\beta\bar{R}}{(1+a(\bar{z}))^{\gamma}}-1}{\psi}+\bar{b}\right)y(\bar{z})$$

This is the only level of debt consistent with the exogenous interest rate and the endogenous growth rate of the economy. Hence, it uniquely pins down household consumption, as the budget constraint holds with equality. Also note that imposing $\frac{b(\bar{z})}{y(\bar{z})} = \bar{b}$ implies $\beta\bar{R} = (1 + a(\bar{z}))^{\gamma}$, no matter what the value of $\bar{b}$ is.

B.1.3 Existence and Uniqueness

Uniqueness of an Interior Solution

Recall that $\chi > 1$ and $\gamma > 1$. Let's first find an expression for the right hand side of (B.22). Let's work term by term, first noting that:

$$v^H(\bar{z}) - v^L(\bar{z}) = \frac{(1-\tau)\left((w(\bar{z}))^{\frac{\chi}{\chi-1}}(\Theta_l\chi)^{\frac{1}{1-\chi}} - (1-\bar{z})\kappa w(\bar{z})\right)}{(1-(1-\lambda(1-\bar{z}))\,\beta(1+a(\bar{z}))^{1-\gamma})\left(\frac{1+\sigma^H}{\sigma^H-\sigma^L} - \mu(\bar{z})\right)}$$

Then we get:

$$\frac{v^L(\bar{z})}{v^H(\bar{z}) - v^L(\bar{z})} = \frac{1}{\frac{v^H(\bar{z})}{v^L(\bar{z})} - 1} = \frac{\sigma^L(1+\sigma^H)}{\sigma^H - \sigma^L}$$

Note that:

$$\frac{\frac{w(\bar{z})\kappa}{\lambda}}{v^H(\bar{z}) - v^L(\bar{z})} = \frac{\kappa}{\lambda(1-\tau)}\frac{\left(1-(1-\lambda(1-\bar{z}))\,\beta(1+a(\bar{z}))^{1-\gamma}\right)\left(\frac{1+\sigma^H}{\sigma^H-\sigma^L} - \mu(\bar{z})\right)}{\left(\left(\frac{w(\bar{z})}{\Theta_l\chi}\right)^{\frac{1}{\chi-1}} - (1-\bar{z})\kappa\right)} \tag{B.23}$$

Then, the right hand side of equation (B.22) is decreasing in $\bar{z}$ if and only if equation (B.23) also decreases in $\bar{z}$. Taking the natural logarithm of equation (B.23) and dropping the constant, we define the following function:

$$\begin{aligned} S(\bar{z}) &= \ln\left(1-(1-\lambda(1-\bar{z}))\,\beta(1+a(\bar{z}))^{1-\gamma}\right) + \ln\left(\left(\frac{1+\sigma^H}{\sigma^H-\sigma^L} - \mu(\bar{z})\right)\right) - \\ &\quad \ln\left(\left(\frac{w(\bar{z})}{\Theta_l\chi}\right)^{\frac{1}{\chi-1}} - (1-\bar{z})\kappa\right) \end{aligned}$$

Some preliminary derivatives are given by:

$$\begin{aligned}
\mu(\bar{z}) &= \frac{1}{\nu+1}\left[1-\rho+\frac{\rho}{1-\bar{z}}\left(1-\bar{z}^{1+\nu}\right)\right] \\
\frac{d(\mu(\bar{z}))}{d\bar{z}} &= \frac{\rho}{1+\nu}\frac{1+\bar{z}^{\nu}\left(\nu\bar{z}-(\nu+1)\right)}{(1-\bar{z})^2} > 0 \quad \text{and} \quad \lim_{\bar{z}\to 1}\frac{d(\mu(\bar{z}))}{d\bar{z}} = \frac{\rho\nu}{2} \\
\frac{d(1+a(\bar{z}))}{d\bar{z}} &= -(1+a(\bar{z}))\lambda\left[\left(\frac{1-\rho}{\nu+1}+\rho\bar{z}^{\nu}\right)\ln\left(\frac{1+\sigma^H}{1+\sigma^L}\right)+\ln(1+\sigma^L)\right] < 0 \\
\frac{d(w(\bar{z}))}{dz} &= \left(\frac{\gamma\lambda(1-\alpha)}{\alpha}\frac{\left[\left(\frac{1-\rho}{\nu+1}+\rho\bar{z}^{\nu}\right)\ln\left(\frac{1+\sigma^H}{1+\sigma^L}\right)+\ln(1+\sigma^L)\right]}{1-\frac{(1-\delta)\beta}{((1+a(\bar{z}))^{\gamma}}} - \right. \\
&\left. \frac{d\mu(\bar{z})}{d\bar{z}}\ln\left(\frac{1+\sigma^H}{1+\sigma^L}\right)\right) w(\bar{z}) \equiv \Gamma_0 w(\bar{z})
\end{aligned}$$

It is easy to show that the first two components of $S(\bar{z})$ are decreasing in $\bar{z}$. Now we find a condition that guarantees that the third component is also decreasing in $\bar{z}$.

$$sign\left(\frac{d\ln\left(\left(\frac{w(\bar{z})}{\Theta_l\chi}\right)^{\frac{1}{\chi-1}}-(1-\bar{z})\kappa\right)}{d\bar{z}}\right) = sign\left(\frac{\Gamma_0}{\chi-1}\left(\frac{w(\bar{z})}{\Theta_l\chi}\right)^{\frac{1}{\chi-1}}+\kappa\right)$$

Let's focus on the problematic region where $\Gamma_0 \leq 0$. Note that:

$$\Gamma_0 \geq \left(\frac{\gamma\lambda(1-\alpha)}{\alpha}\frac{\left[\left(\frac{1-\rho}{\nu+1}\right)\ln\left(\frac{1+\sigma^H}{1+\sigma^L}\right)+\ln(1+\sigma^L)\right]}{1-(1-\delta)\beta}-\frac{\nu\rho}{2}\ln\left(\frac{1+\sigma^H}{1+\sigma^L}\right)\right) \equiv \Gamma_1 \leq 0$$

So, a sufficient condition is given by:

$$\left(\frac{w(\bar{z})}{\chi\left(\frac{\kappa(1-\chi)}{\Gamma_1}\right)^{\chi-1}}\right) \leq \Theta_l$$

Note also that:

$$w(\bar{z}) \leq \left(\frac{\alpha}{\left(1+\eta\left(\frac{1}{\beta}-1\right)\right)}\right)\left(\frac{(1-\alpha)}{\frac{1}{\beta}-1+\delta}\right)^{\frac{1-\alpha}{\alpha}} = \Gamma_3$$

So, a sufficient condition for the existence of a unique solution to the above problem is given by:

$$\frac{\Gamma_3}{\chi\left(\frac{\kappa(1-\chi)}{\Gamma_1}\right)^{\chi-1}} \leq \Theta_l$$

Note that the third term of $S(\bar{z})$ is the labor used in intermediate production. Moreover, in the region where $\Gamma_0 < 0$ wages decrease in $\bar{z}$, given GHH preferences this implies that the supply of labor decreases in $\bar{z}$. Hence, a higher level of Θ_l decreases the response of labor supply to wages, so that part of the labor released by the decrease in project enactment is absorbed by intermediate producers. This translates into higher $y(\bar{z})$, increasing the value of each product line, and hence, increasing the incentives to enact projects.

Existence and Uniqueness of an Interior Solution

We need to find conditions such that equation (B.22) for $\bar{z} = 0$ becomes:

$$\begin{aligned}
\rho(0)^{\nu} &< \frac{\frac{w(0)\kappa}{\lambda}(\bar{R}) - v^L(0)}{(v^H(0) - v^L(0))} - \frac{1-\rho}{(\nu+1)} \\
\frac{w(0)}{v^H(0) - v^L(0)} &> \lambda\frac{\frac{1-\rho}{(\nu+1)} + \frac{\sigma^L(1+\sigma^H)}{\sigma^H-\sigma^L}}{\kappa\bar{R}} \\
\frac{1-(1-\lambda)\,\beta(1+a(0))^{1-\gamma}}{\left(\left(\frac{w(0)}{\Theta_l\chi}\right)^{\frac{1}{\chi-1}} - \kappa\right)} &> (1-\tau)\lambda\frac{\frac{1-\rho}{(\nu+1)} + \frac{\sigma^L(1+\sigma^H)}{\sigma^H-\sigma^L}}{\kappa\bar{R}\left(\frac{1+\sigma^H}{\sigma^H-\sigma^L} - \frac{1}{\nu+1}\right)}
\end{aligned}$$

A sufficient condition for this to hold is given by:

$$\begin{aligned}
\frac{1-(1-\lambda)\,\beta}{\left(\left(\frac{\Gamma_3}{\Theta_l\chi}\right)^{\frac{1}{\chi-1}} - \kappa\right)} &> (1-\tau)\lambda\frac{\frac{1-\rho}{(\nu+1)} + \frac{\sigma^L(1+\sigma^H)}{\sigma^H-\sigma^L}}{\kappa\bar{R}\left(\frac{1+\sigma^H}{\sigma^H-\sigma^L} - \frac{1}{\nu+1}\right)} \\
\kappa &> \frac{\left(\frac{\Gamma_3}{\Theta_l\chi}\right)^{\frac{1}{\chi-1}}(1-\tau)\left[\lambda\frac{1-\rho}{(\nu+1)} + \frac{\sigma^L(1+\sigma^H)}{\sigma^H-\sigma^L}\right]}{(1-(1-\lambda)\,\beta)\,\bar{R}\left(\frac{1+\sigma^H}{\sigma^H-\sigma^L} - \frac{1}{\nu+1}\right) + (1-\tau)\lambda\left[\frac{1-\rho}{(\nu+1)} + \frac{\sigma^L(1+\sigma^H)}{\sigma^H-\sigma^L}\right]}
\end{aligned}$$

We also need to have:

$$\begin{aligned}
\rho(1)^{\nu} &> \frac{\frac{w(1)\kappa}{\lambda}(\bar{R}) - v^L(1)}{(v^H(1) - v^L(1))} - \frac{1-\rho}{(\nu+1)} \\
\frac{\lambda}{\bar{R}}\left(\rho + \frac{1-\rho}{(\nu+1)} + \frac{\sigma^L(1+\sigma^H)}{\sigma^H - \sigma^L}\right) &> \kappa\frac{w(1)}{v^H(1) - v^L(1)} \\
\frac{\lambda}{\bar{R}}\left(\rho + \frac{1-\rho}{(\nu+1)} + \frac{\sigma^L(1+\sigma^H)}{\sigma^H - \sigma^L}\right) &> \kappa\frac{\left(1-\beta(1+a(1))^{1-\gamma}\right)\left(\frac{1+\sigma^H}{\sigma^H-\sigma^L} - \mu(1)\right)}{\left(\frac{w(1)}{\Theta_l\chi}\right)^{\frac{1}{\chi-1}}(1-\tau)} \\
\kappa &< \frac{\frac{\lambda}{\bar{R}}\left(\rho + \frac{1-\rho}{(\nu+1)} + \frac{\sigma^L(1+\sigma^H)}{\sigma^H-\sigma^L}\right)\left(\frac{w(1)}{\Theta_l\chi}\right)^{\frac{1}{\chi-1}}(1-\tau)}{\left(1-\beta(1+a(1))^{1-\gamma}\right)\left(\frac{1+\sigma^H}{\sigma^H-\sigma^L} - \mu(1)\right)}
\end{aligned}$$

We can state a sufficient condition as:

$$\kappa < \frac{\frac{\lambda}{\bar{R}}\left(\rho + \frac{1-\rho}{(\nu+1)} + \frac{\sigma^L(1+\sigma^H)}{\sigma^H-\sigma^L}\right)\left(\frac{\left(\frac{\alpha}{(1+\sigma^H)(1+\eta(\bar{R}-1))}\right)\left(\frac{(1-\alpha)}{\frac{1}{\beta}-1+\delta}\right)^{\frac{1-\alpha}{\alpha}}}{\Theta_l\chi}\right)^{\frac{1}{\chi-1}}(1-\tau)}{(1-\beta)\left(\frac{1+\sigma^H}{\sigma^H-\sigma^L} - \frac{1+\nu\rho}{\nu+1}\right)}$$

Intuitively, there is a lower and an upper bound on the enactment cost κ that guarantees an interior solution. In fact, when the cost is too low, every project is enacted; when it is too high, no project is realized.

B.2 ENIA and Empirical Analysis

Annual National Industrial Survey (ENIA) conducted the by National Statistics Institute (INE) of Chile covers all manufacturing firms in Chile with more than 10 workers. Our version extends from 1995 to 2007. According to Bergoeing et al. (2003), around 96.5% of plants observed in the 1980-1999 version of the data belong to single-plant enterprises. In addition to the procedures mentioned in the text, we apply further measures against potential measurement errors regarding entry and exit in the data, following Micco (1995). In particular, we eliminate observations with one or more of the following inconsistencies: worked days less than or equal to 0, electricity consumption less than or equal to 0, gross value of the production less than or equal to 0, value added less than or equal to 0, remuneration of workers equal to 0, size equal to zero, ISIC code less than 3000, and sales less than exports. Finally, as mentioned in the text, we dropped some industries due to an insufficient number of observations or inadequate entry dynamics. The 3-digit level ISIC codes of the eliminated industries are 314, 323, 353, 354, 361, 362, 371, 372 and 385. The following table presents descriptive statistics of key variables that are used in the empirical analysis.

	Mean	Std. Dev.	Obs.
Profitability	0.486	0.211	18355
$\log(\text{electricity}_{i,t})$	-0.598	1.891	18195
$\log(\text{worker}_{i,t})$	3.453	0.913	18365
$\log(\text{worker}_{i,t_0})$	3.384	0.872	$*18365$
$\log(\text{age}_{i,t})$	1.092	0.760	18365
Unemployment_t	0.078	0.012	$*18365$
$\log(\text{manufacture}_t)$	4.496	0.117	$*18365$
$\log(\text{ppi}_t)$	4.469	0.195	$*18365$
$\log(\text{labor cost}_t)$	4.545	0.057	$*18365$
Crisis dummy	0.234	0.424	18365

Table 20: Summary Statistics

Table 21 shows two-year average entry rates at the industry level. Note that almost every industry displays a U-shaped entry pattern that coincides with the Chilean sudden stop.

Cohorts	311	312	313	321	322	324	331	332	341	342
96 − 97	10.7%	12.9%	9.9%	9.0%	14.9%	6.1%	9.7%	17.5%	11.2%	5.9%
98 − 99	4.8%	3.5%	7.9%	3.2%	5.6%	4.9%	6.1%	7.3%	5.4%	4.5%
00 − 01	3.4%	4.2%	7.1%	3.4%	4.2%	3.3%	5.5%	8.6%	6.9%	5.6%
02 − 03	8.9%	8.8%	12.3%	5.3%	10.1%	4.7%	12.2%	10.7%	8.2%	18.3%
04 − 05	6.1%	6.7%	18.6%	5.1%	3.8%	1.8%	6.1%	10.3%	8.0%	5.1%

Cohorts	351	352	355	356	369	381	382	383	384	390
96 − 97	8.9%	8.5%	3.5%	6.3%	10.8%	11.8%	8.7%	8.5%	8.0%	21.9%
98 − 99	7.1%	4.1%	6.1%	4.3%	10.8%	3.6%	4.8%	5.1%	4.4%	4.4%
00 − 01	6.5%	2.7%	2.4%	4.3%	6.8%	7.1%	5.3%	5.7%	3.4%	7.0%
02 − 03	5.6%	10.3%	8.3%	11.8%	6.2%	11.0%	13.9%	12.2%	8.1%	4.7%
04 − 05	8.8%	5.3%	6.5%	6.0%	7.6%	8.1%	8.6%	5.3%	8.4%	8.0%

Table 21: Two year average entry rates by industry.

B.3 Macroeconomic Data

In this section, we present the sources of the macroeconomic data used in this chapter. We first present a general description of the Chilean economy from the *World Bank Database*, in Table 22.

	1995	2012
Population	14,440,103	17,464,814
GDP per capita	7,400.8	22,362.5
Trade to GDP	56.4%	66.6%
Gross capital formation to GDP	26.2%	25.6%
External debt to GNI	32.1%	41.0%

Table 22: Chilean Economy

To start, note that Chile is a small economy, both in terms of population and aggregate output. It has also experienced spectacular growth, which led it to be the first OECD member in South America (2010). Its trade and debt ratio justify the small open economy framework adopted in this chapter. In particular, while its trade to GDP ratio is quite high, according to the *World Trade Organization* database, in 2011 Chile had 0.45% of world's exports and 0.41% of world's imports. Chile is also the 7^{th} freest economy in the world (2013 *International Economic Freedom Ranking*).

The main source of data is the *International Financial Statistics* database from the IMF. From that, we use the following series between 1996:I and 2011:II: GDP volume index (22899BVPZF...), nominal GDP (22899B..ZF...), gross fixed capital formation (22893E..ZF...), changes in inventory (22893I..ZF...), exchange rate (228..RF.ZF...), exports (22890C..ZF...), imports (22898C..ZF...), financial accounts (22878BJDZF...), direct investment abroad (22878BD-DZF...), direct investment in Chile (22878BEDZF...), net errors and omissions (22878CADZF...), household consumption (22896F..ZF...), and government consumption (22891F..ZF...). We use employment data from the INE and hours worked per week from the *Encuesta de Ocupacion y Desocupacion* from the Economic Department of *Universidad de Chile*. We also use the average interest rate charged by commercial banks for one to three month loans from the Chilean Central Bank database. All the data is seasonally adjusted with the standard X-12 procedure of the US Census. We follow the data appendix of Bergoeing et al. (2002) to build real aggregate macroeconomic variables.[1]

[1]We build capital series using the perpetual inventory method; we assume an annual depreciation rate of 8%, and we solve for the initial stock that delivers an average annual capital to output ratio of 1.96.

B.4 Cox Estimation

This section complements the empirical results of Section 2.4. In particular, we show that the higher profitability of the cohorts born during the sudden stop is not due to *ex-post* selection. In order to show that firms born during that period are not more likely to die, we perform the following stratified proportional hazard estimation.

$$\begin{aligned} h_{mn}\left(t, \boldsymbol{X}_i\right) &= h_{0mn}\left(t\right) \exp\left[\beta_1 \log(elec_{it}) + \beta_2 \log\left(worker_{it}\right)\right. \\ &\quad \left. + \beta_3 \log\left(worker_{i0}\right) + \beta_4 \log(elec_{i0}) + \beta_5 \log(prft_{jt}) + \gamma \cdot industry\right] \end{aligned}$$

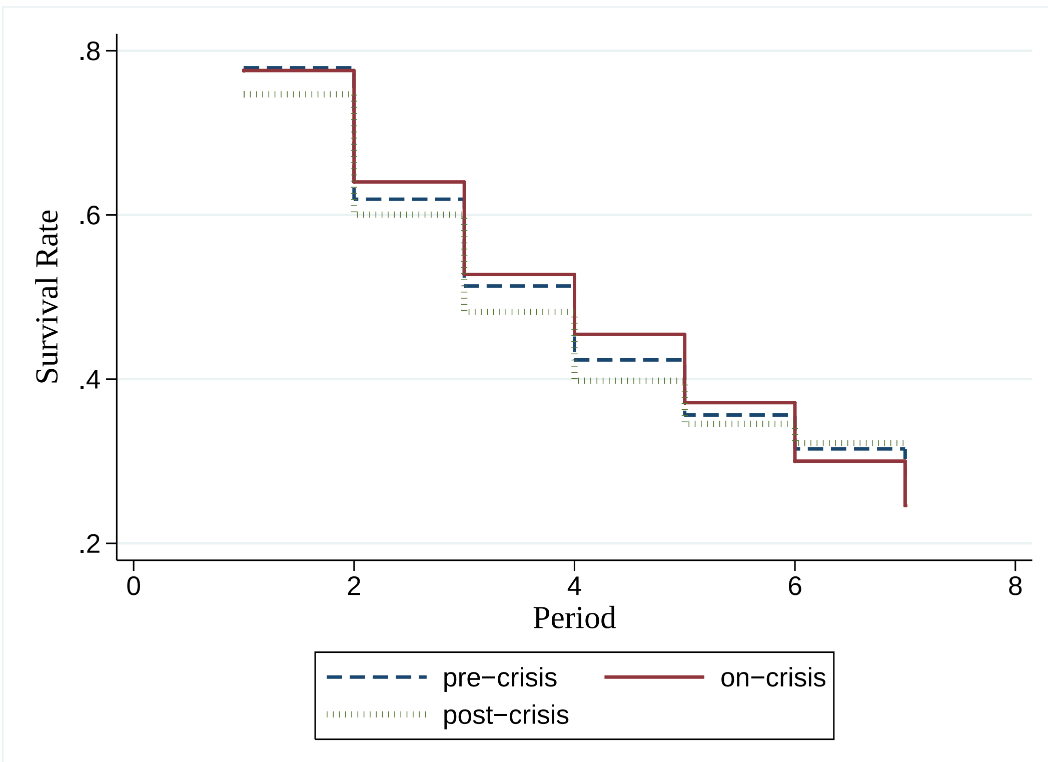
The two strata are geographical region and time period. This means that the baseline hazard h_{mn} varies across these two dimensions. We divide Chile into five geographical regions. The time periods correspond to the *pre-crisis*, *crisis*, and *post-crisis* period of the second specification in the Hausman and Taylor estimation of Section 2.4. The following table shows the estimates of the common covariates.

	Hazard
log(electricity$_{i,t}$)	-0.099^{***}
	(0.024)
log(worker$_{i,t}$)	-0.531^{***}
	(0.066)
log(worker$_{i,t_0}$)	0.396^{***}
	(0.065)
log(electricity$_{i,t_0}$)	0.044^{*}
	(0.024)
log(profitability$_{j,t}$)	-0.616
	(0.644)
Industry control	Yes
Observations	17958

Stratified by region and period.
Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 23: Cox Estimation

The Cox-Snell test cannot reject the proportional hazard structure with 95% confidence. Sub-index t refers to time, while i refers to a plant, and j to an industry. Note that bigger plants have less probability of exiting (for both electricity consumption and number of workers), while the initial size increases the probability of exiting. The specification controls for the industry cycle (using the average time varying profitability of the industry) and industry specific effects. Figure 9d plots the hazard rates at different horizons for cohorts born during the three different time periods in the central zone of Chile. We pick this zone because it concentrates most of the plants in the sample; the main message does not change when considering the other four regions.



Note that firms born during the crisis do not exit more than other cohorts. Moreover, they even seem stronger in this dimension, since, until year 6, they have a higher predicted survival probability than firms born either before or after the episode. Hence, *ex-post* selection does not explain the higher profitability of cohorts born during the sudden stop.

B.5 Robustness Checks

	(1) log(VA/L)	(2) log(VA/L)	(3) log(VA/L)	(4) log(VA)	(5) log(VA)	(6) log(VA)
Crisis dummy	0.476^{***}			0.479^{**}		
	(0.182)			(0.223)		
in Crisis		0.473^{***}			0.484^{***}	
		(0.111)			(0.116)	
after Crisis		0.138^{**}			0.194^{***}	
		(0.068)			(0.075)	
avg. Entry_{j,t_0}			-4.413^{***}			-5.168^{***}
			(1.253)			(1.592)
$\log(\text{electricity}_{i,t})$	0.041^{***}	0.041^{***}	0.041^{***}	0.069^{***}	0.069^{***}	0.069^{***}
	(0.006)	(0.007)	(0.006)	(0.005)	(0.007)	(0.005)
$\log(\text{worker}_{i,t})$				0.572^{***}	0.572^{***}	0.572^{***}
				(0.014)	(0.018)	(0.014)
$\log(\text{age}_{i,t})$	0.031^{**}	0.041^{**}	0.049^{***}	0.070^{***}	0.079^{***}	0.081^{***}
	(0.015)	(0.019)	(0.016)	(0.015)	(0.019)	(0.015)
$\log(\text{worker}_{i,t_0})$	2.193^{***}	1.870^{***}	1.579^{***}	3.043^{***}	2.527^{***}	2.368^{***}
	(0.435)	(0.302)	(0.251)	(0.551)	(0.337)	(0.339)
$\log(\text{manufacture}_t)$	-0.316^{***}	-0.330^{***}	-0.330^{***}	-0.042	-0.060	-0.049
	(0.103)	(0.126)	(0.105)	(0.099)	(0.125)	(0.101)
unemployment_t	0.553	0.503	0.567	-0.326	-0.382	-0.323
	(0.478)	(0.583)	(0.489)	(0.457)	(0.580)	(0.465)
$\log(\text{ppi}_t)$	0.225^{*}	0.233	0.219^{*}	0.044	0.057	0.041
	(0.128)	(0.155)	(0.131)	(0.122)	(0.155)	(0.124)
$\log(\text{labor cost}_t)$	0.039	-0.118	-0.186	-0.028	-0.166	-0.170
	(0.529)	(0.653)	(0.546)	(0.509)	(0.650)	(0.520)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Industry control	Yes	Yes	Yes	Yes	Yes	Yes
Region control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17769	17769	17769	17872	17872	17872
Sargan-Hansen (p)	0.168	0.048	0.031	0.140	0.016	0.090

[1] Source: WorldBank for Panel (a), own calculations using ENIA for Panel (b).

[2] Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[3] Crisis dummy takes the value one if a firm has entered in a crisis year. "in Crisis" takes 1 if the firm was born during crisis years, "in Crisis" takes 1 if the firm was born in years following the crisis.

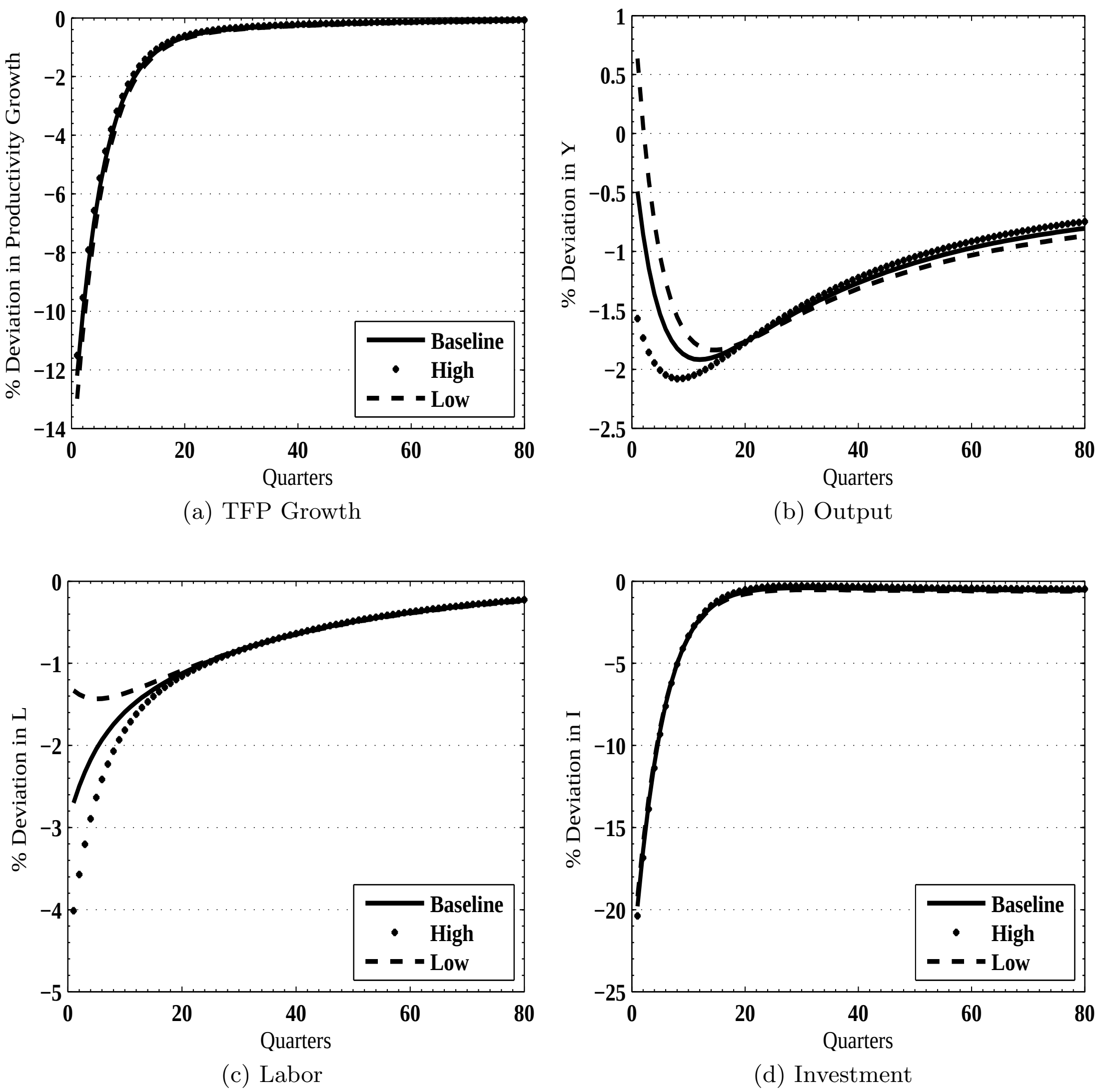
[4] Endogenous time-varying independent variables are electricity expense, age, number of workers. Endogenous constant independent variables are initial number of workers, average entry, region and industry controls.

Table 24: Hausman and Taylor Estimation - Alternative Specifications

Including a Herfindahl-Hirschman Index at the industry level to control for competition does not change the results. Because the associated coefficient is not significant at 10% for every specification, we do not report the results.

B.6 The Working Capital Channel

This section studies the role of working capital friction in the model. In particular, Figure 23 displays the responses of TFP growth, GDP, labor, and investment to a 100 basis point shock to the interest rate for three different levels of η, i.e., baseline ($\eta = 1$), low ($\eta = 0$), and high ($\eta = 2$).



(a) TFP Growth (b) Output

(c) Labor (d) Investment

Figure 23: The Role of Working Capital

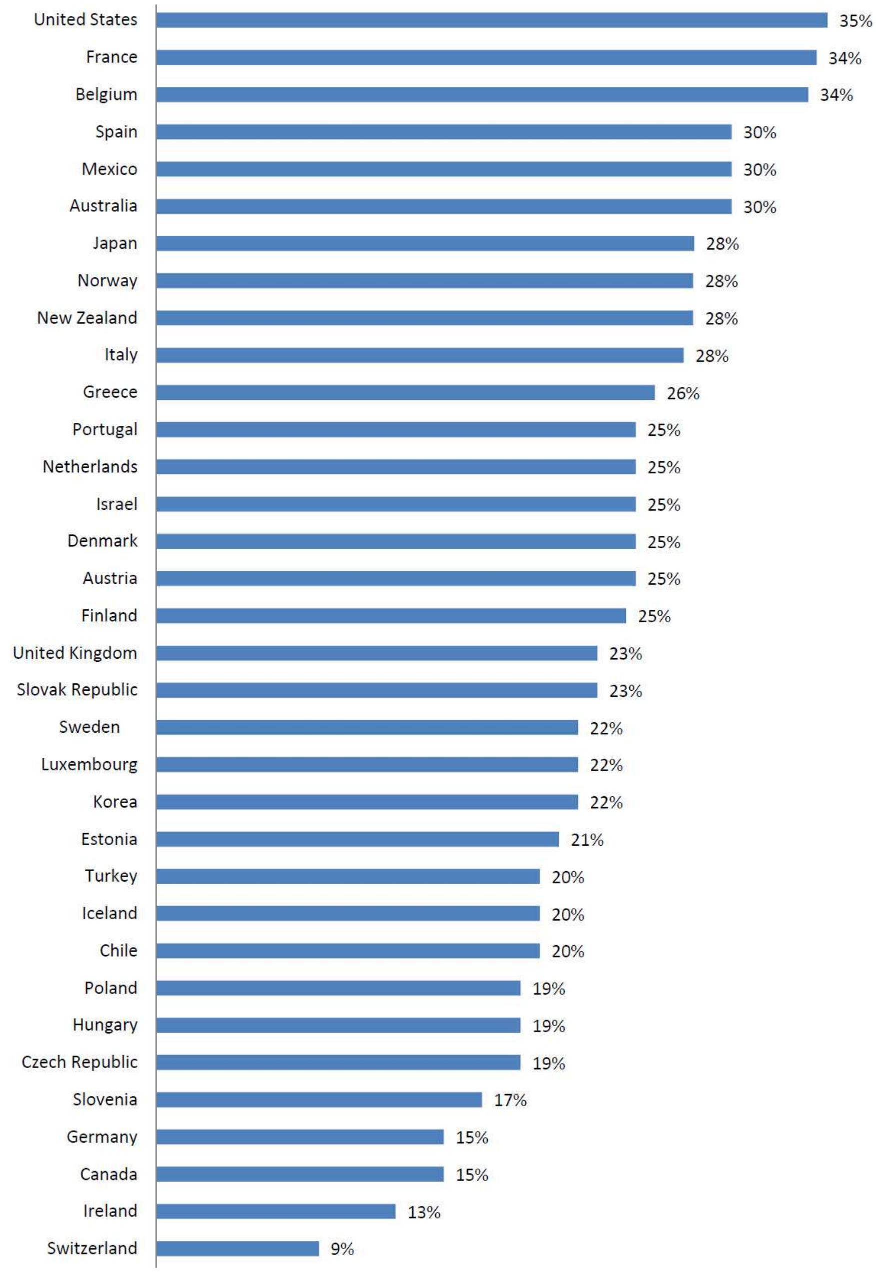
First, note that most of the impact of the working capital constraint takes place in the short run. In fact, a higher working capital constraint amplifies the effect on output trough a labor channel. As shown in Figure 23c, labor decreases 50% more on impact when comparing the high η case with the baseline. Also note that Figure 23d shows no major differences in term of investment. Thus, η provides amplification in the short run by exacerbating the labor channel. Second, and more importantly for the main point of this chapter, Figure 23a does not display strong differences in terms of TFP growth. Nevertheless, Figure 23b can be used to assess the long-run effect of η. Interestingly, greater working capital constraints reduce the long-run cost of the crisis. Note that higher η reduces the demand for intermediate goods, and, hence, intermediate good producers scale down their production and reduce their labor demand. But η does not have a direct effect on the cost of enacting new projects; in fact, it affects the problem of the financial intermediary only through general equilibrium effects, i.e., reduction in wages and in the value of each product line type. In this sense, the higher η is, the more the reduction in labor is directed to intermediate good production (this generates the short-run amplification mentioned above), and the less is absorbed by the financial intermediary. Hence, the higher the working capital friction is, the lower the effect on entry is, and thus, the lower the long run cost of the crisis. Note that, quantitatively, the long run conclusions are not highly affected by η; this parameter is mostly useful to match the short run response of labor and output.

Appendix C

Appendix to Chapter 3

C.1 Corporate Income Tax Rates in OECD Countries

Figure (24) shows that the current U.S. tax system taxes corporate income at a statutory rate of 35%, the highest rate among the Organization for Economic Co-operation and Development (OECD) nations. The Organization for Economic Cooperation and Development (OECD), however, face an average rate of 25%. Even corporations in high-tax European countries such as Belgium (34 %), France (34 %), and Sweden (22 %) face lower statutory rates than those in the United States.



Source: OECD Tax Database

Figure 24: Central Government Statutory (Flat or Top Marginal) Corporate Income Tax Rate by OECD Nation, 2013

C.2 Ranking of Lobbying Issues Based on Expenditures

Table (25) lists the top ten lobbying issues by lobbying firms in the Compustat database, according to proportions of lobby expenditure for specific issues. Ranking is based on the matched data set before the sample selection. Because there can be multiple issues for a single bill, we discount each lobbying expenditure by dividing the total amount by the number of issues reported in each bill. During 1998-2011, taxation issues stay at the top for every single year except 2009, when the health care reform places health issues at the top.

1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
TAX	TAX	TAX	TAX	TAX	TAX	TAX	TAX	TAX	TAX	TAX	HCR	TAX	TAX
TRD	TRD	TRD	TRD	TRD	DEF	BUD	BUD	BUD	ENG	ENG	MMM	ENG	ENG
BUD	HCR	HCR	HCR	HCR	TRD	HCR	HCR	TRD	HCR	HCR	PHA	HCR	BUD
DEF	TEC	TEC	TEC	DEF	HCR	DEF	TRD	HCR	TRD	TRD	TAX	FIN	ENV
ENV	DEF	DEF	DEF	ENG	BUD	TRD	DEF	ENG	BUD	BUD	ENG	BUD	HCR
TEC	ENV	BUD	BUD	BUD	TEC	TEC	TEC	DEF	CPT	DEF	BUD	ENV	TRA
HCR	BUD	ENV	ENG	TEC	ENG	ENG	ENG	TEC	DEF	ENV	ENV	DEF	FIN
TRA	UTI	ENG	ENV	MMM	MMM	MMM	MMM	CPT	MMM	CPT	TRD	TRD	TRD
ENG	ENG	LBR	AVI	ENV	FIN	TOR	TRA	MMM	TEC	MMM	FIN	CPT	CPT
UTI	LBR	TRA	TRA	FIN	TOR	FIN	FIN	RET	FIN	TEC	CPT	MMM	SCI

[1] See Table (28) for an explanation of abbreviation.

Table 25: Top 10 Lobbying Issues Based on Aggregate Expenditures

C.3 Data Source and Sample Selection

As explained in the main text, we link lobby data and data on firm characteristics from Compustat for the period of 1998–2011. We focus on lobby data on tax issues only and keep i) firm-year observations that have non-negative pre-tax income; ii) firms that are incorporated (or legally registered) in the U.S.; and iii) non-financial firms. Then, we further refine data by dropping extreme and missing values for variables considered in the regression. After selection, there are 28,710 firm-year observations, giving on average 2,050 firms each year. It is an unbalanced panel. Nominal variables are deflated by the GDP deflator so that they are in dollars in 1998.

Each company's effective tax rate is computed using data from Compustat as:

$$ETR = \frac{\text{Income Taxes Total} - \text{Deferred Taxes}}{\text{Pre Tax Income} - \text{Equity in Earnings} - \text{Special Items} + \text{Interest Expense}}. \quad \text{(C.1)}$$

Marginal product of capital is computed using data from Compustat as:

$$mpk = \frac{\text{SALE}}{\text{Property, Plant and Equipment - Total (Gross)}}.$$

C.4 List of Variables

Table (26) provides details and sources of all variables used in the empirical analysis. Table (27) presents the variables used as regressors in this exercise and their Compustat codes.

	Code	Variable description	Source
ETR related variables			
	TXT	Income Taxes – Total	Compustat
	TXFO	Income Taxes – Foreign	Compustat
	TXDI	Income Taxes – Deferred	Compustat
	TXDFO	Deferred Taxes – Foreign	Compustat
	PI	Pretax Income	Compustat
	PIDOM	Pretax Income Domestic	Compustat
	PIFO	Pretax Income Foreign	Compustat
	ESUB	Equity in Earnings – Unconsolidated Subsidiaries	Compustat
	SPI	Special Items	Compustat
	XINT	Interest and Related Expense	Compustat
	TXPD	Income Taxes Paid	Compustat
Other variables			
	AT	Assets – Total	Compustat
	PPEGT	Property, Plant and Equipment – Total (Gross)	Compustat
	DLTT	Long – Term Debt – Total	Compustat
	INVT	Inventories – Total	Compustat
	XRD	Research and Development Expense	Compustat
	SALE	Sales/Turnover (Net)	Compustat
	LT	Liabilities – Total	Compustat
	FCA	Foreign Exchange Income (Loss)	Compustat
	EMP	Employees	Compustat
Deflator			
	GDPDEF	Gross Domestic Product: Implicit Price Deflator	FRED

Table 26: Variable sources

Variable name	Variable description	Calculation
def	GDP deflator	-
ETR_t	Effective tax rate at t	See equation (C.1)
if_lob_t	Indicator variable takes one when firm lobbies	-
lob_t	Lobby expenditure in million dollar (in 1998)	-
$loglob\_t$	Natural logarithm of lob_t	$\log(lob_t + 1)$
cap_int	Deflated capital over workers (ppegt/emp/def)	$ppegt/emp/def$
inv_int	Deflated inventories over workers (invt/emp/def)	$invt/emp/def$
rnd_int	Deflated R&D over workers (xrd/emp/def)	$xrd/emp/def$
$size\_at$	Log transformation of deflated total assets	$\log(\text{at}/\text{def} + 1)$
lev	Leverage (liabilities divided by total assets)	lt/at

Table 27: Variable Definitions

C.5 List of Lobbying Issues

for specific issues. Ranking is based on the matched data set before the

Abbreviation	Full description	Abbreviation	Full description
ACC	Accounting	CSP	Consumer Issues/Safety/Protection
HOM	Homeland Security	RET	Retirement
ADV	Advertising	CON	Constitution
HOU	Housing	ROD	Roads/Highway
AER	Aerospace	CPT	Copyright/Patent/Trademark
IMM	Immigration	SCI	Science/Technology
AGR	Agriculture	DEF	Defense
IND	Indian/Native American Affairs	SMB	Small Business
ALC	Alcohol & Drug Abuse	DOC	District of Columbia
INS	Insurance	SPO	Sports/Athletics
ANI	Animals	DIS	Disaster Planning/Emergencies
INT	Intelligence and Surveillance	TAR	Miscellaneous Tariff Bills
APP	Apparel/Clothing Industry/Textiles	ECN	Economics/Economic Development
LBR	Labor Issues/Antitrust/Workplace	TAX	Taxation/Internal Revenue Code
ART	Arts/Entertainment	EDU	Education
LAW	Law Enforcement/Crime/Criminal Justice	TEC	Telecommunications
AUT	Automotive Industry	ENG	Energy/Nuclear
MAN	Manufacturing	TOB	Tobacco
AVI	Aviation/Aircraft/Airlines	ENV	Environmental/Superfund
MAR	Marine/Maritime/Boating/Fisheries	TOR	Torts
BAN	Banking	FAM	Family Issues/Abortion/Adoption
MIA	Media (Information/Publishing)	TRD	Trade (Domestic & Foreign)
BNK	Bankruptcy	FIR	Firearms/Guns/Ammunition
MED	Medical/Disease Research/Clinical Labs	TRA	Transportation
BEV	Beverage Industry	FIN	Financial Institutions/Investments/Securities
MMM	Medicare/Medicaid	TOU	Travel/Tourism
BUD	Budget/Appropriations	FOO	Food Industry (Safety, Labeling, etc.)
MON	Minting/Money/Gold Standard	TRU	Trucking/Shipping
CHM	Chemicals/Chemical Industry	FOR	Foreign Relations
NAT	Natural Resources	URB	Urban Development/Municipalities
CIV	Civil Rights/Civil Liberties	FUE	Fuel/Gas/Oil
PHA	Pharmacy	UNM	Unemployment
CAW	Clean Air & Water (Quality)	GAM	Gaming/Gambling/Casino
POS	Postal	UTI	Utilities
CDT	Commodities (Big Ticket)	GOV	Government Issues
RRR	Railroads	VET	Veterans
COM	Communications/Broadcasting/Radio/TV	HCR	Health Issues
RES	Real Estate/Land Use/Conservation	WAS	Waste (hazardous/solid/interstate/nuclear)
CPI	Computer Industry	WEL	Welfare
REL	Religion		

Table 28: List of Lobbying Issues

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