Fewer but Better:

Sudden Stops, Firm Entry, and Financial Selection

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Abstract

We combine the real business cycle small open economy framework with the endogenous growth literature to study the 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 plant-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 entrants doubles, which increases the welfare cost by 30%.

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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. 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, the empirical studies of large economic downturns by Cerra and Saxena (2008) and Reinhart and Rogoff (2014) have documented persistent output losses associated with large economic downturns, pointing to permanent losses in total factor productivity. 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. This paper develops a framework that links short-run financial crises with long-run output losses through distortions in firm entry.

Two aspects are key for a meaningful study of the entry margin. First, behind every firm lies an entrepreneur's idea, and ideas are not born alike. In fact, drastic innovations are a scarce resource. Second the financial system does not allocate funding randomly, and not every idea has the same chance of being granted an opportunity. Not surprisingly, when resources are scarce, banks adopt higher lending standards, and fund only the most promising projects. The main novelty of this study is the recognition that the scarcity of good ideas and 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 use micro-data to document 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 paper: what is the productivity cost of the forgone entry during a sudden stop?

In order to answer this question, we generalize the real business cycle small open economy model of Neumeyer and Perri (2005) to include entry-driven endogenous growth in the tradition of Grossman and Helpman (1991) and Aghion and Howitt (1992).[2] We extend this hybrid framework in two dimensions. First, we model business plan heterogeneity and scarcity by introducing a financial intermediary with a portfolio of 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 improvements. Hence, projects are *ex-post* heterogeneous in terms

[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. See Calvo and Talvi (2005) for details of that episode.

[2] This combination renders endogenous the trend distortions that Aguiar and Gopinath (2007) use to explain business cycles in small open economies.

of the productivity advantage that they enjoy after entering the industry, and they are also *ex-ante* heterogeneous with respect to their idiosyncratic probability of generating a drastic innovation. Moreover, because only a few ideas are highly likely to give birth to outstanding incumbents, promising projects are scarce. The second extension introduces financial selection. In fact, the financial intermediary cannot unveil the *ex-ante* heterogeneity of the projects in her portfolio but she can observe noisy signals of their potential. The optimal allocation of funding follows a cut-off rule based on the signal, which introduces a linkage between the size of the entrant cohort and the average efficiency gain generated by its members. 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 financial intermediary borrows at the stochastic interest rate to finance start-ups. Therefore, 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 studies the Chilean sudden stop of 1998-2000 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) plant level data for Chilean manufacturing firms is publicly available, and this data 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 4 shows that, after controlling by individual characteristics, firms born during normal times are on average 30% less profitable during their life span than firms born during the sudden stop.

In the quantitative section of the paper, 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. This stylized model with a single shock is able to capture more than 40% of the decrease in firm entry, 20% of the conditional increase in profitability, and one-third of the observed decrease in firms' values. 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: one is a model with exogenous growth, and the other is 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.

Three important features arise from the comparisons of these models. First, distortions in the entry margin trigger permanent losses in output in the models with endogenous technological change. The composition margin shapes the long-run cost of these short-run crises. In fact, the model with no heterogeneity predicts a permanent loss in output two times larger than the one predicted by the baseline model, implying a 30% larger welfare cost, in consumption equivalent terms. This is a large economic magnitude that can bias public policy during a crisis toward entry subsidies or indiscriminate government lending. Second, including endogenous technological progress amplifies the medium-run effects of a crisis. For instance, the baseline model amplifies the effects of a sudden stop in output by 30%, compared to the model with exogenous growth. Third, including heterogeneity among intermediate goods producers triggers compositional dynamics that increase the medium-run persistence of these episodes. A final experiment studies the importance of the allocative function of the financial system during these crises. More developed economies suffer more in the short run but endure much better the medium-run effects of the crisis. Moreover, they are subject to a lower permanent productivity loss. The calibrated model also suggests that the benefits of financial development are decreasing in the level of financial development.

The structure of the paper is as follows. Section 2 reviews the related literature. Section 3 introduces our model and characterizes the existence and uniqueness of an interior balanced growth path. Section 4 presents the analysis of the Chilean economy as a *pseudo* natural experiment for the model, exploring at the macro and micro level the consequences of the sudden stop for the Chilean economy. Section 5 presents the calibration of the model and the quantification of the long-run cost of a sudden stop. Finally, Section 6 concludes the paper and suggests avenues for future research.

2 Related Literature

This paper belongs to the intersection between the endogenous growth and the small open economy literature.[3] This is not the only paper introducing endogenous growth into the small open economy real business cycle framework of Mendoza (1991). For example, Queraltó (2013) studies the long-lasting productivity effects of a financial crisis; in his model an interest rate shock triggers a balance sheet channel, which harms the processes of invention and implementation. Ergo, fewer firms enter the market and fewer ideas are developed for future use. The endogenous growth model at the core of that paper is the framework that Comin and Gertler (2006) build around Romer (1990). Guerrón-Quintana and Jinnai (2014) use a similar framework to study the effect of the liquidity crash in 2008-2009 on U.S. economic growth. Gornemann (2013) combines the endogenous default model 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.

[3]Obstfeld (1994) studying the growth effect of international risk sharing is one of the first papers at this edge.

This paper makes three contributions to the existing research. First, by introducing endogenous growth as in Aghion and Howitt (1992) instead of Romer (1990), it recognizes the dual effect of firm entry: new comers are also a destructive force that replaces incumbents. Second, it develops a tractable framework to include heterogeneity in this class of models. This dimension has proven to be key in separately analyzing, the short-run and the long-run behavior of an economy. In fact, as noted by Bilbiie et al. (2012), firm heterogeneity significantly affects the short-run fluctuations of an economy. Moreover, the quantitative literature on innovation also shows that firm heterogeneity is crucial for understanding the long-run effects of policies. A salient example of the latter can be found in Acemoglu et al. (2013). Therefore, including heterogeneity when studying the link between short-run fluctuations and long-run productivity is a natural extension and an important element to consider. The third contribution is the use of firm level data to provide evidence of the main driving force in the model and bring discipline to the quantitative experiment. This class of models, where the main driving force is micro-funded, should be compared not only to macro aggregates, but also to firm level data. This paper is a step in that direction, but much remains to be done in linking micro data to macro models. This paper is therefore related to the empirical literature that uses firm level data to study financial crises. Two papers in that literature are particularly related to our study. Firstly, Schnabl (2012) uses the sudden stop triggered by the Russian default to document how international banks reduced lending to Peruvian banks, and how Peruvian banks diminished lending to Peruvian firms during the crisis. Secondly, Hallward-Driemeier and Rijkers (2013) evaluate the effects of recessions using firm level data from Indonesia during the Asian crisis of 1997. They do not find conclusive evidence of better reallocation among incumbents. In line with our findings, they do find an increase in the contribution of the entry margin to aggregate productivity during the crisis.

3 A Stochastic Open Economy Model with Entry and Selection

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.[4] 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 out of the market.[5] 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

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

[5] Bartelsman et al. (2009) use cross-country firm level data to quantify the importance of the entry margin for productivity growth. Its direct effect ranges from 20% to 40%.

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 high (H) productivity improvement (step size) or a low (L) improvement 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 advantage 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 a 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 Neumeyer and Perri (2005) to introduce exogenous interest rate shocks into the model. 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).

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 to make decisions in period t. 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 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:

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

Equation (1) is an extension of a standard unit elastic 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, she borrows at the interest rate at the beginning of the period and pays back just after production takes place.[6] Uribe and Yue (2006) show that this constraint can be summarized as a wedge in the cost of the input when interest rates are positive. 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:

$$\max_{\{X_j(s^t)\}_{j\in[0,1]}, K(s^{t-1})} \left\{ Y(s^t) - \left(1 + \underbrace{\eta(R(s^t) - 1)}_{\text{Cost wedge}}\right) \int_0^1 X_j(s^t) p_j(s^t) dj - K(s^{t-1}) r(s^t) \right\} \tag{2}$$

where the final good price is used as the *numeraire*. An interior solution to (2) is characterized by the following set of first order conditions:

$$X_j(s^t) = \frac{\alpha Y(s^t)}{p_j(s^t)\left(1 + \eta(R(s^t) - 1)\right)} \quad \forall j \quad , \tag{3}$$

$$K(s^{t-1}) = \frac{(1-\alpha) Y(s^t)}{r(s^t)}. \tag{4}$$

Both demands are unit elastic; in particular, a monopolist facing the demand in equation (3) would choose $p_j(s^t) \to \infty$ and hence $X_j(s^t) \to 0$. Only the existence of a potential competitor can force the intermediate producer to set a finite price.

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 and the technology has constant marginal productivity $(q_j(s^t))$. Thus, the production of variety j is given by:

$$X_j(s^t) = L_j(s^t) q_j(s^t). \tag{5}$$

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

[6] 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 F 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.

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 of $1+\sigma^L$, where $\sigma^H > \sigma^L > 0$.[7] Innovations in this economy come exclusively from newcomers. 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:

$$q_j(s^t) = \left[1 + I_j^H(s^{t-1}, s_t) \times \sigma^H + I_j^L(s^{t-1}, s_t) \times \sigma^L\right] \times q_j(s^{t-1}). \tag{6}$$

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, the last period's incumbent continues to dominate the product line.

In line with the endogenous growth literature, we assume 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 ($p_j(s^t)$) at the marginal cost of the closest follower. We denote the efficiency level of the closest follower by $\tilde{q}_j(s^t)$. Then, given wage ($W(s^t)$), the optimal price is set to:

$$p_j(s^t) = \frac{W(s^t)}{\tilde{q}_j(s^t)}. \tag{7}$$

Note that (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 (3), we derive the following expression for the profits ($\Pi_j^d(s^t)$) of the leader in product line j with productivity advantage d:

$$\Pi_j^d(s^t) \quad = \quad X_j(s^t)\left(p_j(s^t) - \frac{W(s^t)}{q_j(s^t)}\right) = \frac{\alpha\sigma^d}{(1+\sigma^d)\,(1+\eta(R(s^t)-1))}Y(s^t). \tag{8}$$

Note that profits are independent of the product line, because the type of the current leader is the only relevant characteristic of product line j. 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 $M(s^t, s_{t+1}) \in (0, 1]$ 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

[7] We allow for 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.

$1-\lambda M(s^t, s_{t+1})$. Finally, using the stochastic discount factor of the representative household ($m(s^t, s_{t+1})$), the expected discounted value $V^d(s^t)$ of owning any product line j of a type d leader at time t can be defined recursively by:[8]

$$V^d(s^t) \quad = \quad (1-\tau)\Pi^d(s^t) + E\left[m(s^t, s_{t+1})\underbrace{\left(1-\lambda M(s^t, s_{t+1})\right)}_{\text{survival probability}} V^d(s^t, s_{t+1})|s^t\right] \tag{9}$$

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 $\mu(s^t) \in [0, 1]$.

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.[9] 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, in particular, how the *ex-ante* heterogeneity in projects is related to the *ex-post* heterogeneity of incumbents.[10]

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

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

[8]See 3.5 for the characterization of $m(s^t, s_{t+1})$.

[9]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.

[10]For the heterogeneity and scarcity of ideas, see the high skewness in firm level related variables. See, for instance, Scherer (1998) and Silverberg and Verspagen (2007).

The mean of this distribution reflects the expected proportion of type H entrants when projects are enacted randomly. In fact, for any $M(s^t)$, random selection implies that, for all z, $prob(z \in M) = M$. 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 $\nu = 3$, then 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 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.

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.[11] 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 in 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.[12] 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 $z \in [1 - M(s^t), 1]$. However, z is unobservable. In order to introduce selection, we define a costless,

[11]For empirical studies documenting financial selection, see, for instance Dell'Ariccia et al. (2012) and Jiménez et al. (2014). Alfaro et al. (2004) document that more developed financial system can better materialize Foreign Direct Investment into economic growth. Moreover, Holmstrom and Tirole (1997), Chan-Lau and Chen (2002), and Agénor et al. (2004), study how lending standards vary with macroeconomic conditions.

[12]Alternatively, we can assume that the representative household owns the projects but does not have access to any screening technology. Hence, in equilibrium, it sells the projects to the representative financial intermediary at the expected profits net of financing costs, and the financial intermediary earns no profits. A similar motivation is used by Jovanovic and Rousseau (2014).

yet imperfect, screening technology that delivers the following stochastic signal $\tilde{z}$ of the underlying ranking z:

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

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.[13]

Proposition 1. *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 1 shows that the optimal strategy is to set a cut-off for the signal.[14] When the financial intermediary uses this technology optimally to select a mass $M(s^t) = 1 - \bar{z}(s^t)$ 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:

$$\tilde{\mu}(\bar{z}(s^t)) \quad = \quad \frac{1}{\lambda M(s^t)} \int_0^1 \lambda \times prob(\tilde{z} \geq \bar{z}(s^t)|z) \times P^H(z)\, dz = \underbrace{\frac{1}{\nu+1}}_{\underline{\tilde{\mu}}} \times \underbrace{\left[1 - \rho + \rho \frac{1 - (\bar{z}(s^t))^{\nu+1}}{1 - \bar{z}(s^t)}\right]}_{\geq 1}. \quad (10)$$

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:

$$\max_{\bar{z}(s^t) \in (0,1)} \left\{ \underbrace{\lambda(1 - \bar{z}(s^t))}_{\text{Cohort's mass}} \left[\underbrace{\tilde{\mu}(\bar{z}(s^t))V^H(s^t) + (1 - \tilde{\mu}(\bar{z}(s^t)))V^L(s^t)}_{\text{Cohort's expected value}} \right] - \underbrace{(1 - \bar{z}(s^t))R(s^t)W(s^t)\kappa}_{\text{Total cost of enaction}} \right\}. \quad (11)$$

The bracketed term is the expected return of the portfolio with composition $\tilde{\mu}(\bar{z}(s^t))$. The intermediary needs to pay back the borrowed amount plus the interest. Because the objective function is strictly concave, the first order conditions are sufficient for optimality.[15] As equation (10) 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

[13] For instance, 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.

[14] As the expected value is strictly increasing in the signal, and the enacting cost is fixed, the cut-off strategy is optimal and unique.

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

the mass of projects enacted, but it also decreases the average value of the entrant cohort. If an interior solution ($\bar{z}(s^t) \in (0,1)$) exists, it is unique and characterized by:

$$\bar{z}_t(s^t) = \left(\frac{\frac{W(s^t)\kappa}{\lambda} R(s^t) - \left[\frac{1}{1+\nu} V^H(s^t) + \frac{\nu}{1+\nu} V^L(s^t)\right]}{\rho(V^H(s^t) - V^L(s^t))} + \frac{1}{\nu+1} \right)^{\frac{1}{\nu}}. \tag{12}$$

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.[16] 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:

$$\mu(s^t) = \mu(s^{t-1}) + \lambda \left[1 - \bar{z}(s^t)\right] \left[\tilde{\mu}(\bar{z}(s^t)) - \mu(s^{t-1})\right]. \tag{13}$$

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

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 costs are very popular in the business cycle literature, and they become particularly 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.[17] Schmitt-Grohé 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.[18]

[16] 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.

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

[18] Strong precautionary motives can alter this conclusion. Nevertheless, in this set-up, precautionary savings are very limited because there is no borrowing constraint.

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:

$$\max_{\{B(s^t),C(s^t),L(s^t),I(s^t)\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t E\left[u(C(s^t), L(s^t))|s_0\right] \tag{14}$$

subject to:

$$\begin{aligned} C(s^t) &\leq W(s^t)L(s^t) + r(s^t)K(s^{t-1}) + B(s^{t-1})R(s^{t-1}) + T(s^t) + \Pi(s^t) - I(s^t) - B(s^t) - \Psi(\bullet) && (15) \\ I(s^t) &= K(s^t) - (1-\delta)K(s^{t-1}) + \Phi(\bullet). && (16) \end{aligned}$$

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 (15), the price of consumption is set to unity because we use the final good as the *numeraire*. The program also requires the transversality conditions on capital and bond 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 aggregate labor productivity $(A(s^t))$ grows at an endogenous rate, the scaling is time-variant.[19] We also take from them the functional forms for Ψ and Φ:

$$\begin{aligned} u(C(s^t), L(s^t)) &= \frac{1}{1-\gamma}\left(C(s^t) - \Theta_l A(s^t)\left(L(s^t)\right)^{\chi}\right)^{1-\gamma} && (17) \\ \Psi(B(s^t), Y(s^t)) &= \frac{\psi}{2}Y(s^t)\left(\frac{B(s^t)}{Y(s^t)} - \bar{b}\right)^2 && (18) \\ \Phi(K(s^{t-1}), K(s^t)) &= \frac{\phi}{2}K(s^{t-1})\left[\frac{K(s^t)}{K(s^{t-1})} - (1+g_{bgp})\right]^2. && (19) \end{aligned}$$

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, because $\bar{b}$ is the long-run household debt-output ratio and g_{bgp} the long-run growth of the economy, the household pays neither

[19] 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. Therefore, if non-market labor productivity grows at the same rate as market labor productivity, the dis-utility of labor must be scaled by it. 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.

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

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

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

$$B(s^t): \quad 1 + \psi \left(\frac{B(s^t)}{Y(s^t)} - \bar{b}\right) = E\left[m(s^t, s_{t+1})|s^t\right] R(s^t) \tag{20}$$

$$K(s^t): \quad E\left[m(s^t, s_{t+1}) \frac{r(s^t, s_{t+1}) + (1-\delta) - \frac{\phi}{2}\left([1+g_{bgp}]^2 - \left[\frac{K(s^t, s_{t+1})}{K(s^t)}\right]^2\right)}{1 + \phi\left[\frac{K(s^t)}{K(s^{t-1})} - (1+g_{bgp})\right]} |s^t\right] = 1 \tag{21}$$

$$L(s^t): \quad W(s^t) = \Theta_l A(s^t) \chi \left(L(s^t)\right)^{\chi - 1} \quad \Rightarrow \quad L(s^t) = \left(\frac{W(s^t)}{\Theta_l A(s^t) \chi}\right)^{\frac{1}{\chi - 1}}. \tag{22}$$

Note that, as equation (22) shows, if wage and aggregate productivity grow at the same rate in the long-run, 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 an 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.

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:[20]

$$\ln\left(\frac{R(s^t)}{\bar{R}}\right) = \rho_r \ln\left(\frac{R(s^{t-1})}{\bar{R}}\right) + \sigma_r \epsilon_t \quad \text{where} \quad \epsilon_t \overset{iid}{\sim} N(0, 1), \tag{23}$$

[20] 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. Neither procedure alters the qualitative behavior of the model.

where $\bar{R}$ is the long-run interest rate in the economy. We can easily define net exports as the difference between production and all its uses (i.e., consumption, investment, and the bond holding cost):[21]

$$NX(s^t) \;=\; Y(s^t) - C(s^t) - I(s^t) - \Psi(B(s^t), Y(s^t)). \tag{24}$$

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 in every period.[22]

$$D(s^t) \;=\; B(s^{t-1}) \underbrace{-\eta \frac{\alpha Y(s^t)}{1+\eta(R(s^t)-1)} - (1-\bar{z}(s^t))\kappa W(s^t)}_{\text{Working Capital and Project Enaction}}. \tag{25}$$

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 (1) using equation (5), recognizing that intermediate labor depends only on the step size of the incumbent.

$$Y(s^t) = \underbrace{\left(A(s^t)\right)^\alpha}_{\text{TFP}} \left[\left(L^H(s^t)\right)^{\mu(s^t)} \left(L^L(s^t)\right)^{1-\mu(s^t)}\right]^\alpha \left(K(s^{t-1})\right)^{1-\alpha} \tag{26}$$

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

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

The TFP in this economy is endogenous and we can characterize it using the evolution of firm level labor productivity in equation (6), together with the entry rate of the economy. In particular, the following

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

[22] 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.

expression for TFP growth explicitly accounts for both mass and composition of the entrant cohort:

$$\begin{aligned}
\ln\left(\frac{A(s^t)}{A(s^{t-1})}\right) &= \int_0^1 \ln\left(\frac{\left(1+I_j^H(s^{t-1},s_t)\sigma^H + I_j^L(s^{t-1},s_t)\sigma^L\right) q_j(s^{t-1})}{q_j(s^{t-1})}\right) dj \\
&= \int_0^1 \ln\left(1+I_j^H(s^{t-1},s_t)\sigma^H + I_j^L(s^{t-1},s_t)\sigma^L\right) dj \\
&= \lambda(1-\bar{z}(s^t))\left[\tilde{\mu}(s^t)\ln\left(1+\sigma^H\right) + (1-\tilde{\mu}(s^t))\ln\left(1+\sigma^L\right)\right]. \qquad (27)
\end{aligned}$$

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.

3.8 Stationary System and Definitions

In order to render the model stationary, we adopt 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.[23] With this transformation, we define a stationary competitive equilibrium for this economy:

Definition 1. *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* (14) *subject to* (15) *and* (16).
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).
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* (7).
4. *Financial intermediary optimally chooses $\{\bar{z}(s^t)\}$ given values and prices in order to maximize* (11).

[23] Appendix A derives the normalized system that characterizes the model, and provides a proof for the Lemma 1.

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

6. *Capital markets clear in every history, and intermediate good markets clear in every history and product line.*

7. *Labor, asset, and final good markets clear in every history:*

$$L(s^t) = \tilde{\mu}(s^t)L^H(s^t) + (1-\tilde{\mu}(s^t))L^L(s^t) + \kappa(1-\bar{z}(s^t)) \tag{28}$$

$$d(s^t) = \frac{b(s^{t-1})}{1+a(s^{t-1},s_t)} - \eta\frac{\alpha y(s^t)}{1+\eta(R(s^t)-1)} - (1-\bar{z}(s^t))\kappa w(s^t) \tag{29}$$

$$nx(s^t) = y(s^t) - c(s^t) - i(s^t) - \psi(b(s^t)-\bar{b})^2 \tag{30}$$

8. $\{v_j(s^t), q_j(s^t)\}_{j\in[0,1]}$ *and* $\mu(s^t)$ *evolve according to* (6)*,* (9)*, and* (13)*.*

9. *Transversality and non-negativity conditions are met.*

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

Definition 2. *A BGP is a non-stochastic* ($\sigma_r = 0$) *equilibrium where* $\{\bar{z}(s^t)\}$ *is constant, and consumption, bond holdings, capital, wages, intermediate goods production, investment, net exports, and output grow at a constant rate.*

Appendix A 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 theorem:

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

Theorem 1 is fundamental for the quantitative analysis in Section 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 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.

4 The Chilean Case: Fewer, but Better

This section explores Chilean 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 on Chile 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 introduce first the firm level data set, and then we show that firms born in crisis are not just *fewer*, they are also *better*.

4.1 The 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.[24] 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. One of the most successful economies of Latin America, Chile, also suffered the consequences of the Russian default.[25] The real interest rate peaked in 1998:III, increasing by 5 percentage points 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. The macroeconomic consequences of a sudden stop in emerging markets have been widely studied, but the effects of the firm entry dynamics triggered by these episodes have not. From a Schumpeterian point of view, those changes in entry are 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.

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 sober, 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 perform a *pseudo* 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,

[24] For a detailed time-line of the Russian default, see Chiodo and Owyang (2002).

[25] See Appendix B for a general picture of the Chilean Economy and the macroeconomic effects of the Sudden Stop.

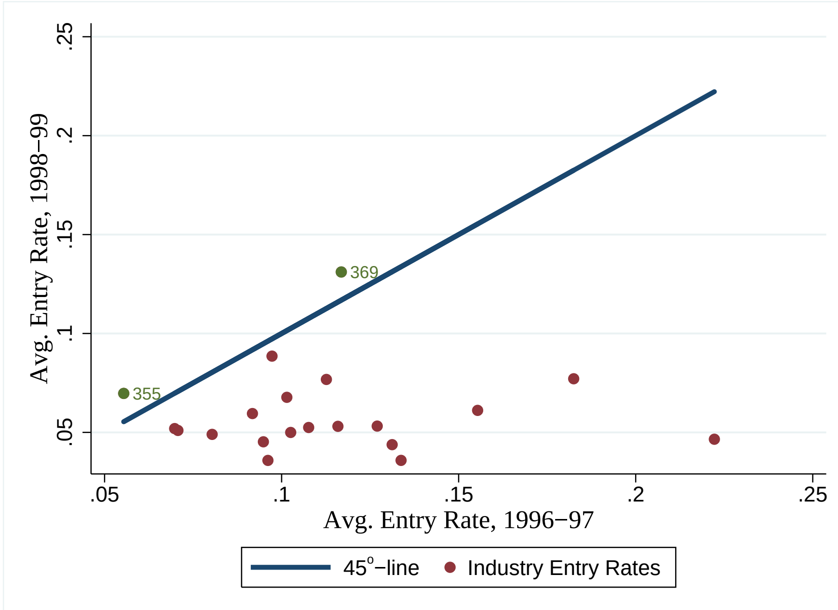


Figure 1: Mass (quantity)

collecting plant level data from every unit with more than ten employees.[26] 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 the information in the surveys between 1995 and 2007 to build a panel.[27] We take the first appearance in the data as the entry year and the last appearance as the exit date.[28] The sample contains practically 4000 plants and $18,000$ observations.[29]

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 11 in Appendix (C) presents two-year average entry rates for every industry in the sample. Figure 1 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 average entry rate during the crisis.

For all industries but two (355 (rubber based products) and 369 (other non-metallic products)), the average entry rate in $1998-99$ is lower than in $1996-97$. Moreover, Table 11 shows that, for practically every industry, entry rates remain low until $2002-03$. Entry dropped dramatically at the industry level

[26]In 1996, 95% of firms in the survey were single plants.

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

[28]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. To minimize this issue, we focus on plants with more than eleven workers. The results are also robust to a threshold of fifteen workers. Because of lack of entry in some industries, we restrict our attention to 20 of the 29 industries. For example, the tobacco industry is characterized by only $1-2$ plants, and we observe a positive entry in only two years.

[29]Appendix (C) shows the details of the data construction, and a summary of the variables used in the analysis grouped by clusters of cohorts (born before, during, and after the crisis).

during the Chilean sudden stop. In fact, the average percentage change in the entry rate is -40% between $1996-97$ and $1998-99$.

Although it is clear that *fewer* firms are born during the crisis, we still have to analyze whether they are *better*. In this sense, we want to show that firms born during the sudden stop are intrinsically more profitable. To capture the profitability of each plant every year, we build the following measure:

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

Define a firm that is one standard deviation above the mean profitability of its industry, at its first year of life (second observation), as a *superstar* entrant. The two moments are calculated using every plant operating in a given year.[30] We estimate the probability of being a superstar firm using the following logit specification:

$$Pr(\text{Superstar} = 1|\text{age} = 1) = \frac{e^{x_i'\beta}}{1+e^{x_i'\beta}} \quad \text{where} \quad x_i'\beta = \alpha + \alpha_j + \alpha_r + \beta \ln(L_{i,0}) + \gamma_{\text{cohort}} + u_{i,t}, \tag{31}$$

where α_j is an industry control, α_r is a geographical control, and $L_{i,0}$ uses workers at entry to control for size. The cohort coefficient indicates whether a firm was born during the sudden stop window or another cohort specific characteristic. Table 1 presents the results for five alternative regressions. The first regression compares cohorts born during the crisis (1998-2000) against every other cohort. Firms born during the crisis are statistically more likely to become superstars in their industries. In fact, evaluating the regression at the mean for the most populated region (central) and two-digit industry code (31), we find that the probability of being a superstar is 21% for firms born during the episode, while the probability for a firm born outside this window is 13.4%. The second specification shows that allowing cohorts born before and after the episode to differ does not change the results. In line with the *fewer but better* hypothesis, the third specification shows that larger cohorts at the industry level are associated with lower probability of being a superstar. The fourth and fifth specifications show that the results do not change when the probability of being a superstar is evaluated at the year of entry or two years after entering.[31] Although this exercise is suggestive, the prediction of the model is stronger. In fact, the model predicts that firms born during crises are on average more profitable during their entire life, even after controlling by *after entry* decisions. In this context, we must explore both the continuous nature of the profitability variable

[30] In particular, we do not drop the firms born before 1995 from the sample to calculate these moments.

[31] If a cohort dummy is introduced year by year, beside the three crisis years, only firms born in 2006 have a significant coefficient (but of lower magnitude than the crisis years). Controlling by initial capital instead of initial workers also does not change the results. Results are available upon request.

	(1)	(2)	(3)	(4)	(5)
	Superstar at age 1			Superstar at age 0	Superstar at age 2
Crisis Dummy	0.540^{***}			0.295^{***}	0.312^{**}
	(0.110)			(0.0970)	(0.135)
In Crisis		0.697^{***}			
		(0.134)			
After Crisis		0.240^{*}			
		(0.126)			
$\text{entry}_{j,0}$			-1.575^{**}		
			(0.803)		
$\ln(L_{i,0})$	0.222^{***}	0.216^{***}	0.209^{***}	0.146^{***}	0.153^{**}
	(0.0527)	(0.0526)	(0.0521)	(0.0436)	(0.0605)
Ind. Control (α_j)	Yes	Yes	Yes	Yes	Yes
region Control (α_r)	Yes	Yes	Yes	Yes	Yes
Constant (α)	Yes	Yes	Yes	Yes	Yes
Observations	3197	3197	3197	4220	2618

Standard errors in parentheses, bootstrapped (250)
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1: Probability of a superstar firm

and the panel dimension of the data. In general, we would like to estimate the following equation:

$$P_{i,t} = \alpha + \beta_1 X_{i,t}^1 + \beta_2 X_{i,t}^2 + \gamma_1 Z_i^1 + \gamma_2 Z_i^2 + \mu_i + u_{i,t} \quad (32)$$

where $X_{i,t}^1$ represents exogenous time-varying variables (e.g., vacancy index of the economy), $X_{i,t}^2$ refers to endogenous time-variant variables (e.g., number of workers), Z_i^1 correspond to exogenous time-invariant variables (e.g., region of the country), and Z_i^2 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 (32).[32]

Table 2 presents the results for six different specifications. In the first four regressions, the dependent variable is $P_{i,t}$. The only difference in the first three specifications 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 a higher observable fixed effect μ_i) are expected to enter in years of crisis. In the case of the third specification, when *fewer* firms enter, we expect them to be *better*. The fourth regression changes the initial size measurement from workers to capital; the aim of this is to verify that the results are not driven by the initial collateral held by the firm.[33] The last two regressions focus on alternative measures of firm quality. In particular, the fifth regression uses output per worker as a measure of labor productivity and the sixth specification studies the propensity to accumulate physical capital.

[32]See Appendix C.5 for a succinct explanation. 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; see Schaffer and Stillman (2011). After every estimation, we perform the Sargan-Hansen test to assess the validity of the instrumental variables procedure at the core of Hausman and Taylor (1981). The null hypothesis is that the instruments are valid, so the higher the p-value, the better.

[33]In fact, it is plausible that firms with high collateral are more likely to enter during the crisis.

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.[34] The coefficients associated with these variables are stable across the profitability regressions. The signs of the significant coefficients suggest that profitability is higher when production is high, labor costs are low, and inflation in producer prices is also low. Note that the fifth specification suggests that labor productivity increases in bad times. In particular, a high unemployment rate is associated with higher labor productivity.[35] There are four endogenous time-variant variables ($X^2_{i,t}$),: electricity consumption, number of workers, capital stock, and the age of the plant. The signs of the significant coefficients suggest that older firms and firms that are increasing their capital stock are more profitable. Also note that the fifth and sixth specifications point to a strong complementary relationship between labor and capital. We use five geographic regions and two-digit industry controls as time-invariant exogenous variables (Z^1_i). Besides the coefficients of interest, we include the initial size of the plant, specified as the initial number of workers or the initial capital holdings. In order to control for competition at the moment of entry, we also include the Herfindahl-Hirschman concentration index of the industry at the particular region in the year of entry among the time-invariant endogenous variables (Z^2_i). In line with the firm dynamic's literature, larger entrants are more profitable, more productive, and accumulate capital faster than smaller entrants. Finally, firms that enter into more concentrated industries are more profitable than firms facing more competition.

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 controlling for initial size, macroeconomic conditions, and post-entry decisions, firms born during the sudden stop have, on average, a profitability index 8.8 percentage points higher. This coefficient is robust to allowing post-crisis cohorts to differ from before-crisis cohorts (specification 2) and is also robust when we control for initial capital (specification 4). Table 2 also shows the relative effect evaluated at the means, that is, the predicted profitability of a firm born during normal times divided by the predicted profitability of a firm born during the crisis, minus one. The baseline regressions suggest that, if we focus on a fictitious firm, setting every observable at its mean and changing only the period of entry, we find that being born in normal times implies 31% lower profitability.[36] 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 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

[34] 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.

[35] This seems to point more to a cleansing rather than a sullying effect of recessions.

[36] The raw data in Appendix C shows that firms born before the crisis have an average lifetime profitability of 23%, while firms born during the crisis have an average lifetime profitability of 24%.

	(1) $P_{i,t}$	(2) $P_{i,t}$	(3) $P_{i,t}$	(4) $P_{i,t}$	(5) $\log \frac{Y_{i,t}}{L_{i,t}}$	(6) $\frac{K_{i,t}-K_{i,t-1}}{K_{i,t}}$
Crisis dummy	0.0877**			0.0814***	0.325**	0.0527**
	(0.0423)			(0.0313)	(0.136)	(0.0233)
In Crisis		0.0861**				
		(0.0397)				
After Crisis		0.00952				
		(0.0241)				
avg. Entry$_{j,t_0}$			-0.682**			
			(0.337)			
log Manu. Prod.$_t$	0.125***	0.121***	0.120***	0.127***	-0.332***	0.134***
	(0.0387)	(0.0387)	(0.0382)	(0.0437)	(0.113)	(0.0471)
Unemp. Rate$_t$	0.211	0.198	0.210	0.229	1.427***	0.0277
	(0.147)	(0.149)	(0.148)	(0.150)	(0.428)	(0.220)
log PPI/WPI$_t$	-0.871**	-0.844**	-0.873**	-0.923**	4.11***	0.886
	(0.0408)	(0.409)	(0.410)	(0.453)	(1.51)	(0.584)
log Labor Cost$_t$	-0.335**	-0.360**	-0.388**	-0.288	-0.379	-0.266
	(0.159)	(0.166)	(0.161)	(0.182)	(0.528)	(0.231)
log Elec. Con.$_{i,t}$	-0.0804	-0.0786	-0.0732	-0.0891	5.90***	-0.690**
	(0.256)	(0.257)	(0.257)	(0.273)	(0.865)	(0.275)
log labor$_{i,t}$	-0.113	-0.114	-0.113	-0.118		0.261***
	(0.0734)	(0.0734)	(0.0735)	(0.0719)		(0.0688)
log Capital$_{i,t}$	0.669**	0.663**	0.661**	0.690**	3.40***	
	(0.269)	(0.269)	(0.269)	(0.283)	(0.814)	
log age$_{i,t}$	0.103*	0.118*	0.146***	0.0799	-0.139	-0.507***
	(0.0550)	(0.0668)	(0.0542)	(0.0501)	(0.170)	(0.0431)
HHI$_{j,t_0,r}$	0.451***	0.428***	0.326***	0.220**	0.678	0.0432
	(0.137)	(0.148)	(0.101)	(0.0937)	(0.524)	(0.0713)
log labor$_{i,t_0}$	0.453***	0.430***	0.351***			
	(0.0971)	(0.111)	(0.0692)			
log Capital$_{i,t_0}$				0.119***	0.656***	0.0554***
				(0.0238)	(0.119)	(0.0177)
Ind. Control	Yes	Yes	Yes	Yes	Yes	Yes
Region Control	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Relative effect at means[a]	−31.2%	−31.3%	–	−28.4%	−32.5%	−29.2%
Sargan-Hansen (p)	0.4545	0.2333	0.1230	0.0476	0.0395	0.7702
Observations	16834	16834	16834	16371	15583	16388

Standard errors in parentheses (bootstrapped (250), clustered by firm)
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Hausman and Taylor

[a] No crisis prediction at means divided by crisis (or pre-crisis) prediction at means minus 1, evaluated at the most populated region (central) and industry (31). For regression five, it is the difference between the predictions.

profitability of the firm by 0.68%. Note that specifications five and six show that this result is robust to other performance measures, as firms born during the crisis are permanently more productive and more prone to capital accumulation.

One caveat related to *post-entry* selection can be added to the preceding results. If firms born during crisis were more likely to die early, then those cohorts would seem more profitable after that initial selection. Appendix D estimates a proportional hazard model in order to evaluate this concern. The main empirical question in the Appendix 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. 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.[37]

Summarizing, the Chilean sudden stop had strong macroeconomic consequences. At the firm level, the effect is relatively more complex. Cohorts born during the crisis, and in its aftermath, are 40% smaller; nevertheless, firms born in normal times are at least 30% less profitable after controlling for observables. 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, it is crucial to correctly assess the economic cost of that forgone entry. For this reason, we proceed to calibrate our model and quantify the long-run cost imposed by a sudden stop.

5 Quantitative Exploration: The Role of Financial 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 regularities of Section 4. The model can account for roughly 40% of the decrease in entry and more than 17% 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

[37] 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%.

selection when the economy is hit by an interest rate shock. For instance, including heterogeneity and selection amplifies the medium-run effects of a sudden stop in output when compared to the exogenous growth model. Moreover, the shock generates a long-run permanent loss in output due to the distortion in the entry market. The composition effect plays a considerable role in shaping the long-run cost of the crisis. In fact, the model with no heterogeneity doubles the estimation of the permanent loss. Thus, even at the macro level, the existence of selection is fundamental when assessing the cost of the forgone entrants.

5.1 Calibration to the Chilean Economy

5.1.1 Externally Calibrated Parameters

The twenty parameters of the model are calibrated to Chilean data on a quarterly basis. A first group of six parameters is externally calibrated according to the real business cycle small open economy literature. In particular, the capital share $(1-\alpha)$, the inter-temporal elasticity of substitution $(1/\gamma)$, and the Frisch elasticity of labor supply $(1/(1-\chi))$ are set in accordance with Mendoza (1991). The working capital requirement (η) is set to the value used by Neumeyer and Perri (2005), which implies that the final good producer needs to keep as working capital 100% of the cost of intermediate goods. The parameter governing the debt adjustment cost (ψ) is set to a small number that guarantees stationarity in every experiment.[38] A second group of eight parameters is calibrated directly to Chilean data. The depreciation rate of capital (δ) is set at 8% annually, consistent with the study by Bergoeing et al. (2002) of the Chilean economy. The corporate tax rate (τ) is set to 17%, in line with Chilean legislation of that time; the long-run interest rate $(\bar{R})$, the persistence of the interest rate process (ρ_r) and the dispersion of the shocks (σ_r) are estimated using the quarterly real Chilean interest rate on loans performed by commercial banks between 1996:I and 2008:IV. Because no debt holding costs are incurred along the balanced growth path, we set $\bar{b}$ to the quarterly debt-to-GDP ratio of Chile. The step sizes (σ^L, σ^H) are calibrated to match the 25% and 75% percentiles of the pre-crisis profitability distribution in Table 8. The calibrated step sizes point to a significant heterogeneity in mark-ups in the Chilean economy; specifically, drastic ideas are three times more productive than incremental ones. These values are in line with the empirical studies of Navarro and Soto (2006) for the Chilean manufacturing sector. Table 3 presents the values for every externally calibrated parameter.

[38] The debt adjustment cost is in the same order of magnitude as the one used by Uribe and Yue (2006).

Parameter	Symbol	Value	Source
Capital share	$1-\alpha$	0.32	Mendoza (1991)
Elasticity of Substitution ($1/\gamma$)	γ	2	Mendoza (1991)
Frisch Elasticity ($1/(1-\chi)$)	χ	1.455	Mendoza (1991)
Working Capital	η	1	Neumeyer and Perri (2005)
Debt adjustment cost	ψ	0.0001	Low
Depreciation rate	δ	1.94%	Bergoeing et al. (2002)
Corporate tax rate	τ	0.17	Data
Long-run interest rate	$\bar{R}$	1.015	Chilean Central Bank Data
Persistence of interest rate	ρ_r	0.836	Chilean Central Bank Data
Dispersion of interest rate shock	σ_r	0.33%	Chilean Central Bank Data
Long-run debt to GDP ratio	$\bar{b}$	$4*(-0.44)$	Chilean Central Bank Data
Low profitability ($\sigma^L/(1+\sigma^L)$)	σ^L	14.5%	ENIA
High profitability ($\sigma^H/(1+\sigma^H)$)	σ^H	55.5%	ENIA

Table 3: Externally Calibrated Parameters

5.1.2 Internally Calibrated Parameters

The remaining seven parameters are internally calibrated to match salient features of the Chilean economy. For a given long-run growth rate (a), there is only one value of the patience parameter (β) consistent with no payment of debt holding cost along the balanced growth path.[39] Five of the remaining six parameters ($\lambda, \kappa, \Theta_l, \rho, \nu$) are set to match the five moments summarized in Table 4.[40] Although every moment is related to the whole set of parameters, we can point to some strong relationships between targets and parameters. 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, 2.71% per quarter. The average cost of starting a firm as a proportion of the gross national income is obtained from the *Doing Business Indicators* from the *World Bank* database, which pins down the cost of enacting a project (κ). In the model, we set this target to 12.1% of 2004, the earliest year available. The dis-utility of labor (θ_l) is set to match a long-run labor supply of 33%. The novel parameters ρ and ν are more challenging to calibrate. 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. In the data, a proportion of the entrant cohort dies

[39] See equation (59) in Appendix A.

[40] We minimize the sum of the percentage absolute distance between model and data. The calibration is robust to different starting points.

during their first year; 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 15%, the average of that proportion in the pre-crisis portion of the data. Moreover, equation (27) relates the two step sizes of the model and the scarcity of drastic ideas (ν) to the long-run growth rate of the economy. We follow Neumeyer and Perri (2005) and target a yearly long-run growth rate of real GDP of 2.5%. Finally, the parameter governing the capital adjustment cost (ϕ) is set to match the standard deviation of the real investment growth rate in Chile of 3.7%.[41] The model is able to match the targets successfully. Table 4 presents the performance of the model regarding the five targets and Table 5 presents the calibration for the seven internally calibrated parameters in the model.

Target	Model	Data	Expression
Entry	2.71%	2.71%	$\lambda(1-\bar{z})$
Entry Cost	12.1%	12.1%	$\kappa(w/y)$
Working time	33.0%	33.0%	L
Fast exit	15.0%	15.0%	$(1-\rho)\,\bar{z}$
Growth	0.62%	0.62%	$a = \left(\left(1+\sigma^H\right)^{\mu^H}\left(1+\sigma^L\right)^{1-\mu^H}\right)^{\lambda(1-\bar{z})} - 1$

Table 4: Targets: Model and Data

Parameter	Symbol	Value	Main identification
Patience parameter	β	0.9975	$\beta = (1+a)^{\gamma}/\bar{R}$
Success probability	λ	5.36%	Entry
Enaction cost	κ	6.65%	Entry cost
Labor dis-utility level	Θ_l	1.73	Working time
Screening accuracy	ρ	69.7%	Fast exit
Scarcity	ν	4.51	Growth
Capital adjustment cost	ϕ	20	Investment volatility

Table 5: Internally Calibrated Parameters

The scarcity of good ideas implies that, under random selection, two out of eleven ideas (18.2%) generate a high step size. Nevertheless, given that the screening accuracy is 70%, the financial intermediary

[41]Because the balanced growth path is independent of ϕ, we calibrate it separately and match the desired volatility perfectly.

sets its credit standards to $\bar{z} = 49.4\%$, securing an *ex-post* fraction of high types equal to $\mu^H = 30\%$. This points to a non-trivial amount of selection by financial intermediaries. The fixed cost of enacting a project is 6.65% units of labor; this implies that 10.2% of the total working hours are used in project implementation. This 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. In terms of macro moments, the model generates an investment-output ratio of 23.8% and an annualized capital-output ratio of 2.34, slightly above the 23% and 2.0 averages during the period $1996-2007$, as shown in Table 6 in the Appendix B. Therefore, the calibration is consistent with the macroeconomic aggregates of the Chilean economy. Before exploring the role of firm heterogeneity and financial selection during sudden stops, we evaluate the quantitative performance of the calibrated model.

5.2 Validation of the Model: The Chilean Sudden Stop

In this section, we test the firm-based implications of the model when compared to the empirical regularities documented in Section 4. In particular, we feed the model with a smoothed version of the quarterly real interest rate, and we plot several non-targeted time series between 1998:I and 2002:I. We transform the interest rate of Figure 9 using the following function:

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

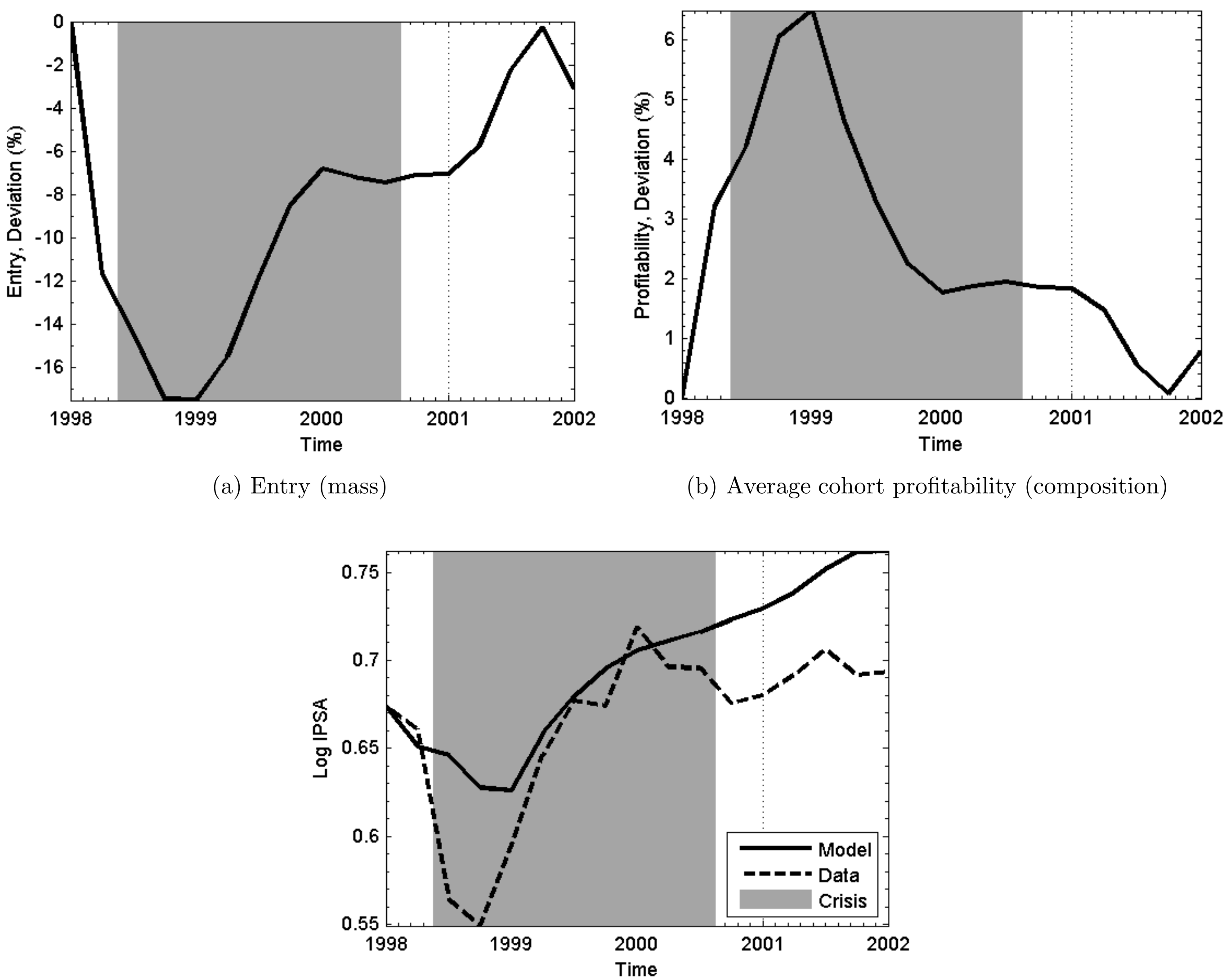
We chose to use this smoothed series for two reasons. First, decisions such as investment or labor are not taken every quarter; thus, instead of introducing a *time to adjust friction*, as in Uribe and Yue (2006), or a delay in the pass-through between the external shocks and the domestic variables, 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 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. We set the state variables of the model at their balanced growth path level in 1998:I.[42]

The model presented in this paper, unlike traditional small open economy real business cycle models, has strong predictions for the mass of new firms, the average profitability of each cohort, and the average value of incumbents.[43] We use those novel features to validate the calibration of the economy. Therefore, we use the empirical results of Section 4 to assess the ability of the model to capture the mass-composition

[42]The model is solved by second order perturbations using Dynare. We choose this solution method for two reasons. First, as discussed in Aruoba et al. (2006), higher order perturbation methods are appropriate for smooth systems with strong non-linearity and large shocks. Second, it allows for a meaningful welfare analysis.

[43]Appendix E show the results for hours, consumption, trade balance divided by GDP, and investment.

trade-off at the heart of this paper. Figure 2 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. The third graph in Figure 2 shows the logarithm of the Chilean stock index (IPSA) in real terms.[44] Note that the long-run calibration previously introduced did not target any of the information in these time series.



(a) Entry (mass)

(b) Average cohort profitability (composition)

(c) Stock Index

Figure 2: Model Performance

As Figure 2a shows, the change in the interest rate can account for roughly a 17.5% decrease in the entry rate. This is more than 40% of the average decrease observed at the industry level on Table

[44]The corresponding model-generated series for the IPSA is the average value of an intermediate good producer. We set the economy to its BGP on 1998:I and normalize the initial level.

11. Figure 2b shows the increase in the average profitability of the entrant cohort. Cohorts born in the worst part of the crisis are 6.5% more profitable than an average cohort (1.3 percentage points difference). Therefore, the model is in line with the raw data in Tables 9 and 10, and it explains 20% of the conditional increase in profitability documented in Table 2. Moreover, during the crisis, the fraction of high types in the entrant cohort increases by 18%. This is in line with the logit regressions in Table 1, where the probability of a superstar arising during crises increases by roughly 50%. Finally, with only an interest rate shock, the model can mimic the bust and recovery of the Chilean stock market with reasonable success. In fact, this calibration suggest that the interest rate shock explains at least 1/3 of the decrease in firm values. Note that this framework is simple enough to introduce more shocks and frictions in order to close the gap between model and data in these and other aggregated variables. As the aim of this paper is to study the effects of an interest rate shock in the medium and long-run, we prefer the parsimony of a model with only one shock and a limited number of frictions. 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.

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 analyzing 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, because every entrant has the same step size. This unique step size is set so 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 log-deviations of a variable H from its last period value by a hat ($\hat{H}_t = \ln(H_t/H_{t-1})$), let's focus on output to highlight the source of the long-run cost:

$$y_t = \frac{Y_t}{A_t} \Rightarrow \hat{Y}_t \approx \hat{y}_t + \hat{A}_t \tag{33}$$

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

$$\tilde{x}^Y_t \approx \sum_{i=1}^{i=t} \left\{ \hat{y}_i + \hat{A}_i \right\} - t * a_{ss} \tag{34}$$

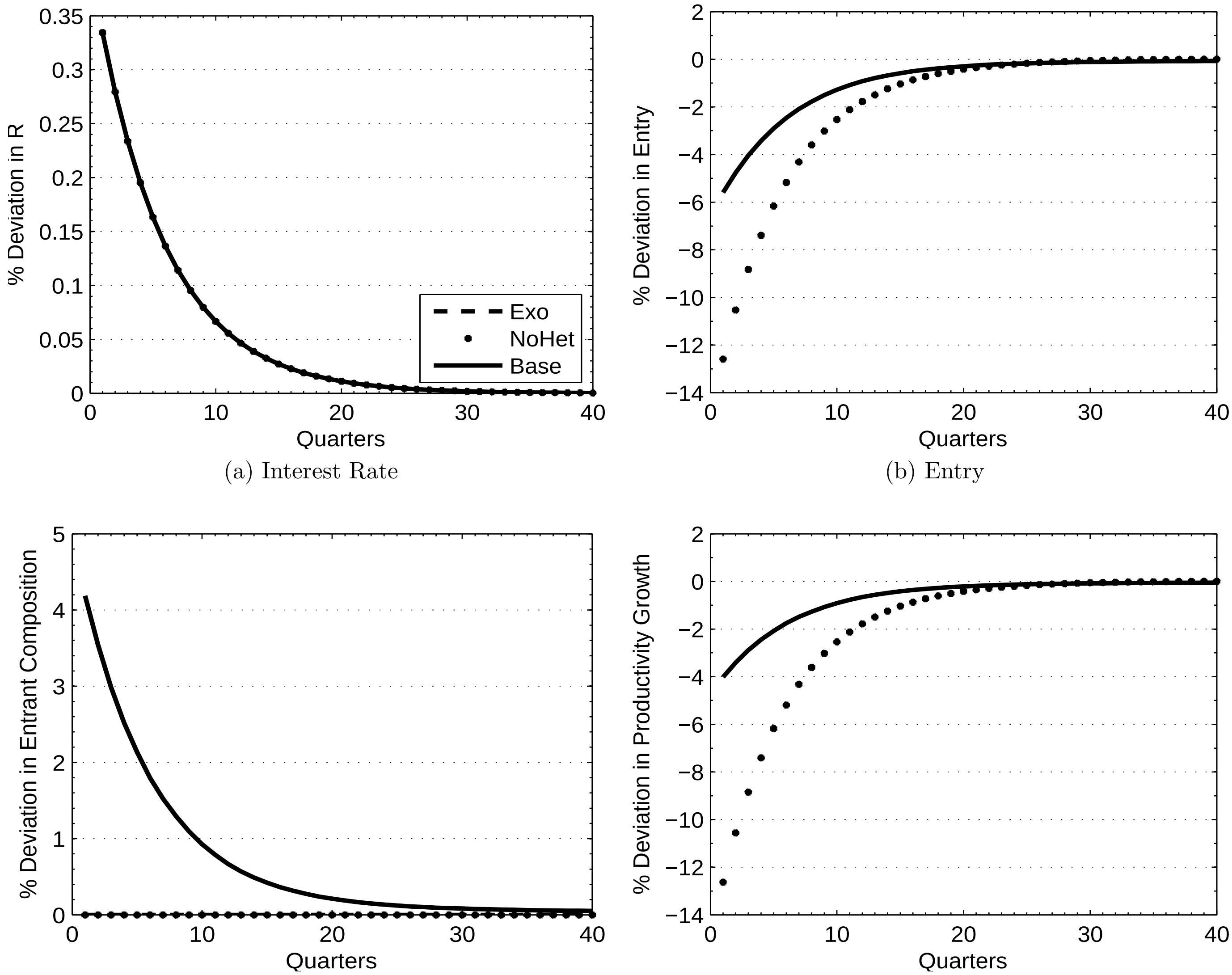
The main difference between *Exo* and the other two models is that, because growth is exogenous, $\hat{A}_t \approx a_{ss}$, and then $\tilde{x}^Y_t = \sum_{i=1}^{i=t} \hat{y}_i$. Because y_t is stationary, this term converges to zero when time goes to infinity. This illustrates why there is no long-run 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:

$$LRC \approx \lim_{t\to\infty} \left\{ t * a_{ss} - \sum_{i=1}^{i=t} \left\{ \hat{A}_i \right\} \right\} < \infty \tag{35}$$

Note that, as $\hat{A}_t$ converges to a_{ss}, this long-run cost is finite. Moreover, as is clear from equation (34), 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, because *NoHet* and *Baseline* have the same long run growth, the path of $\hat{A}_i$ fully determines their relative long-run cost. Having defined the long run-cost of a shock, we turn to the quantitative response of the models to a one standard deviation innovation in the interest rate R (33 basis points). Figures 3, 5, 6, and 7 show the responses of the models to this shock. The units on the y-axis are the percentage deviation from a counter-factual non-shocked path.

Figure 3a displays a one-time 33 basis point increase in the interest rate, for the three economies.[45] Figure 3b shows the response of firm entry in the two models that feature this margin. The decrease in entry is more than two times larger than for *NoHet* when compared to the baseline model. The main reason behind this difference lies in the compositional dynamics displayed in Figure 3c. In fact, the proportion of high type entrants in each cohort in *NoHet* is constant, while the baseline economy is able to adjust this margin. In particular, the entrant cohort contains an extra 4% of high type leaders at the time of impact. The last panel of Figure 3 shows the change in productivity growth generated by the disruption in the entry margin. Note that *NoHet* exhibits a large decrease in productivity growth at the time of impact of 15%, while the decrease in the baseline model is less than 4%. The reason behind this difference is seen in Figures 3b and 3c; in fact, when the shock hits the economy, the only margin of adjustment

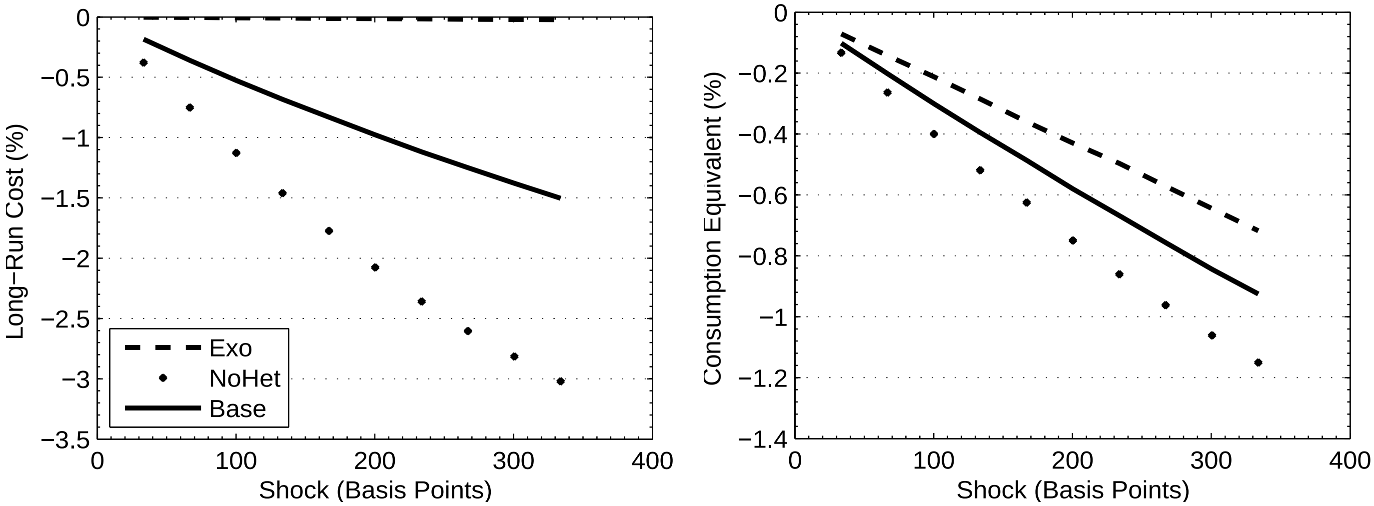
[45] The deviations are calculated by averaging 600 simulations with a horizon of 1200 periods. For each simulation we draw a series of interest rate shocks, drop the first 100 periods to build the stochastic state of the economy at the moment of the shock. The average across simulations of the difference between the path with a one time 33 basis point shock and the original path is used to generate the impulse response functions.



(a) Interest Rate
(b) Entry
(c) Composition
(d) TFP Growth

Figure 3: 33 basis point increase in interest rate.

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 dynamics of the baseline model imply 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 3d 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 using Equation 35. In this particular case, the long-run cost is 0.38% for *NoHet* and 0.18% for the baseline. Therefore, the model with no heterogeneity generates a two times larger long-run cost. We can also illustrate this result by calculating the consumption equivalent welfare cost of the interest rate shock. Figure 4a shows the long-run cost of each model for different shock sizes measured as the permanent distance between the shocked path and the BGP, in percentage terms. Figure 4b shows the welfare costs for different shock sizes, the maximal fraction of BGP consumption that the household would sacrifice to avoid the shock. Note that the long-run cost is a measure that abstracts from the short-run impact of the shock and the preferences of the representative household, while the welfare cost measure includes the effects of the shock at every horizon and uses the inter-temporal preferences of the representative household to quantify the loss.

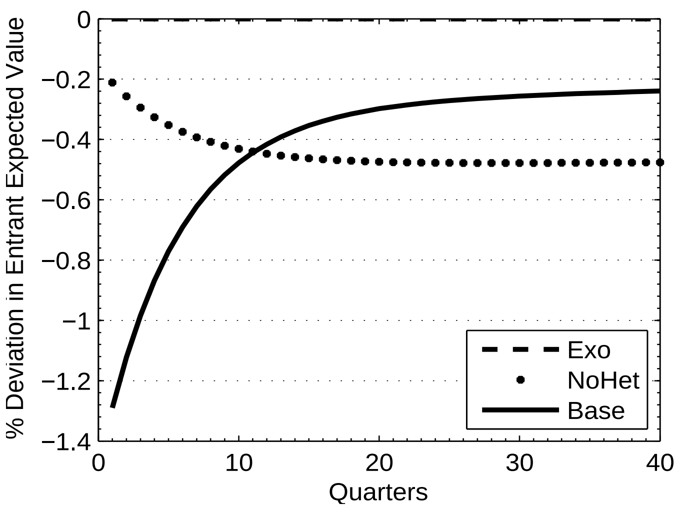


(a) Long-run Cost (b) Consumption Equivalent Welfare Cost

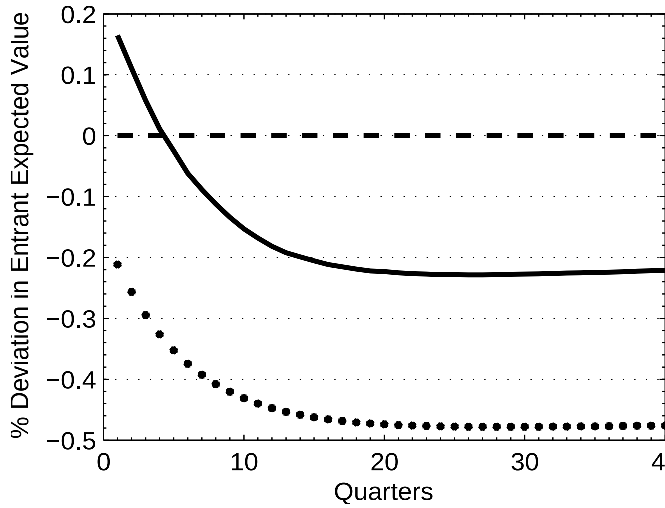
Figure 4: The Impact of Selection.

As expected, in Figure 4a we see that *Exo* is not subject to a long-run cost. Therefore, in Figure 4b, the distance between the consumption equivalent welfare cost of *Exo* and the models with endogenous growth approximates the welfare cost of the long-run loss. When using the baseline model as a benchmark, the long-run cost contributes to 30% of the welfare cost; if *NoHet* is used, the long-run cost explains 45% of the welfare cost. Regardless of the size of the shock, *NoHet* doubles the estimated long-run cost of a sudden stop, increasing the consumption equivalent welfare cost by 30% when compared to the baseline model. For instance, a 330 basis point increase in the interest rate implies, under *NoHet*, a long-run cost of 3% and a welfare cost of 1.15% of consumption, considerably higher than the 1.5% long-run cost and the 0.93% consumption equivalent welfare cost suggested by the baseline model. Therefore, modeling heterogeneity and selection is particularly relevant when studying the absolute effect of large shocks.

In order to understand the role of selection for the financial intermediary's decision problem, Figure 5a 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 five times more on impact than for *NoHet*. In this sense, the *pure* 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 5a, 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.[46]



(a) Expected Entrant Value (Random Selection)



(b) Expected Entrant Value

Figure 5: The Impact of Selection.

Figure 5b 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 the decrease in the value of product lines. The difference in the average value of an entrant displayed in the second panel of Figure 5 illustrates why the financial intermediary decreases project enactment in *NoHet* by a factor more than two times larger than the decrease implied by the baseline model.

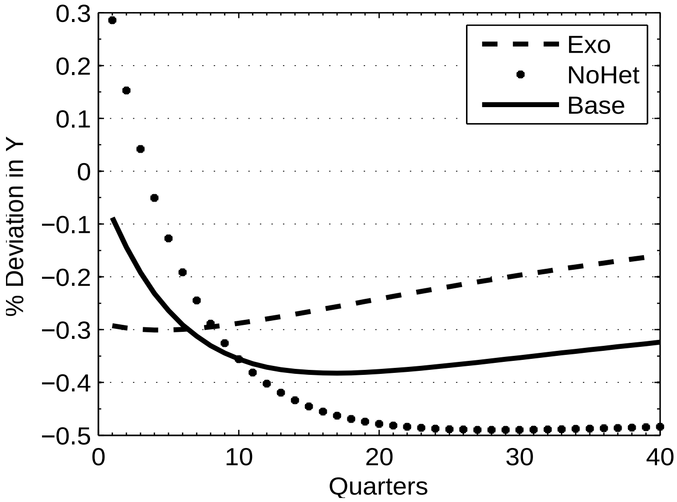
Having characterized the source and magnitude of the long-run cost, we focus our attention on the response of output. Figure 6a shows the response of output for the three models. Following equation (26), we can distinguish the following three components of output:

$$Y(s^t) = \underbrace{\left(A(s^t)\right)^{\alpha}}_{\text{A Component}} \underbrace{\left[\left(L^H(s^t)\right)^{\mu(s^t)} \left(L^L(s^t)\right)^{1-\mu(s^t)}\right]^{\alpha}}_{\text{L Component}} \underbrace{\left(K(s^{t-1})\right)^{1-\alpha}}_{\text{K Component}} \tag{36}$$

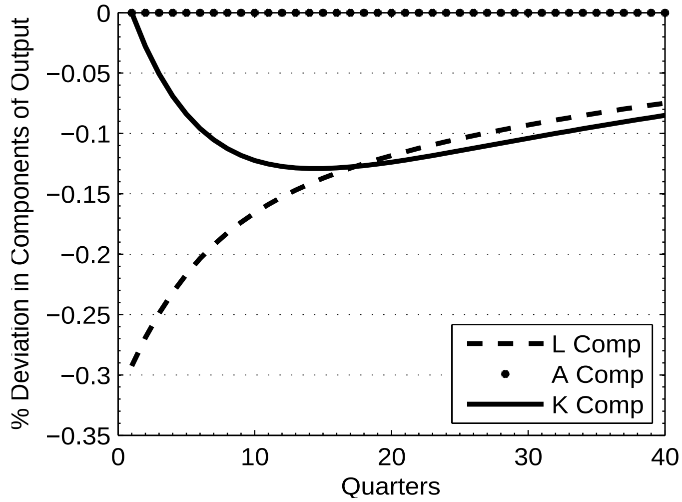
Figures 6b, 6c, and 6d display the evolution of those three components for each model.

The most striking fact in Figure 6a is the positive contemporaneous response of output under *NoHet*.

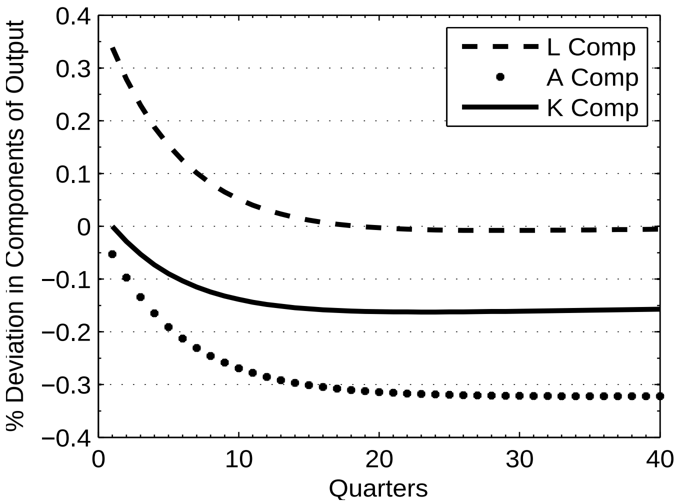
[46]Note that the analysis from the cost side does not reverse this partial equilibrium intuition; as seen in Figure 7d, the marginal cost of enacting a project decreases more for *NoHet*.



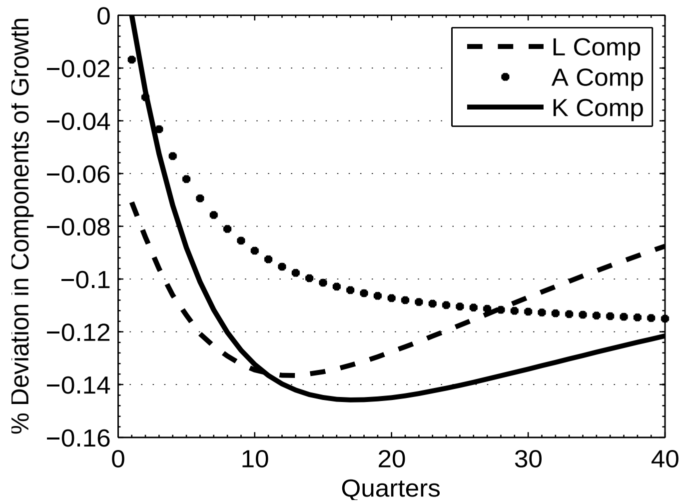
(a) Output



(b) Exo Components



(c) NoHet Components



(d) Baseline Components

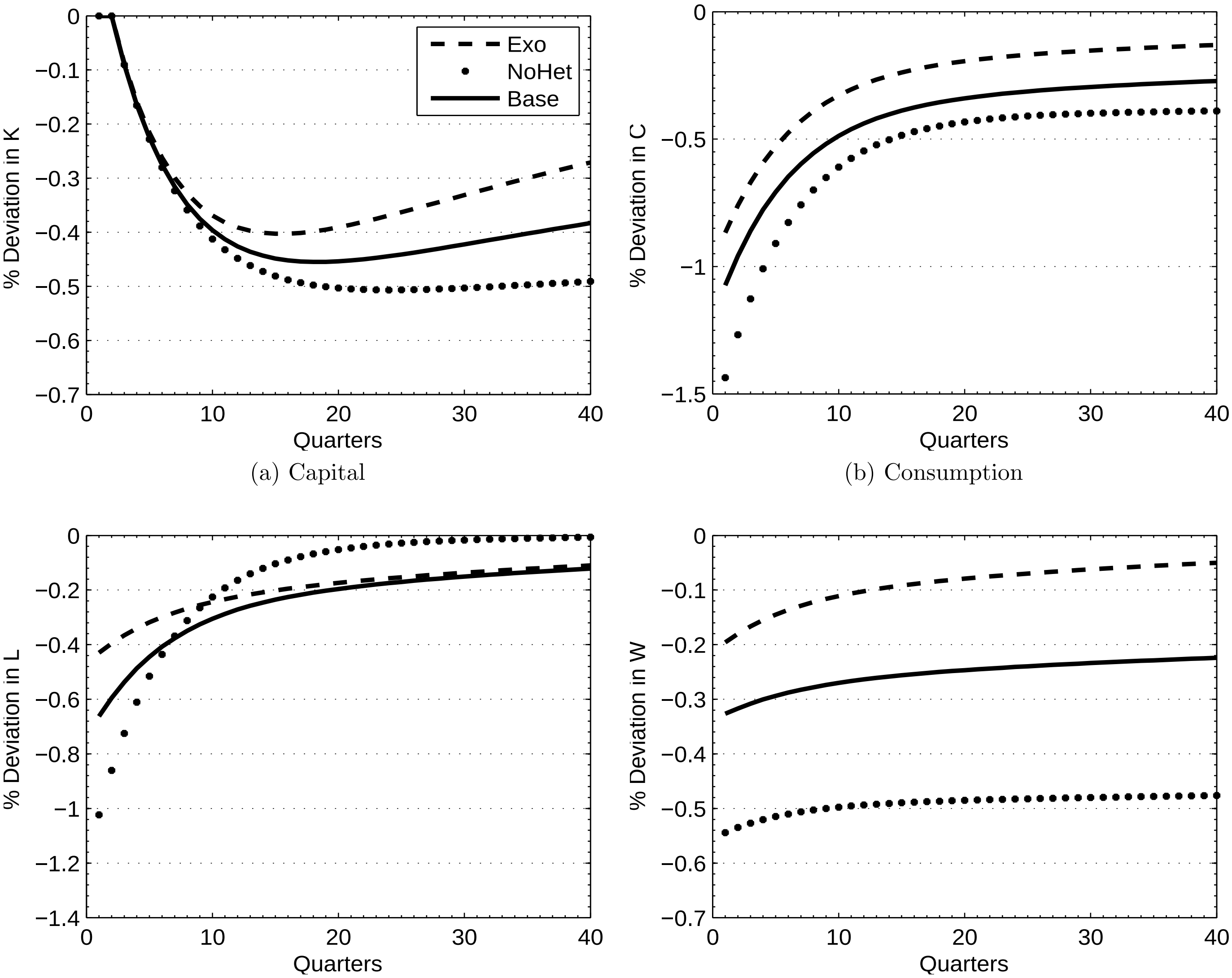
Figure 6: The Sources of Output.

This counter-factual response is explained by the relative changes of labor supply with respect to entry-driven labor demand. In fact, the radical decrease in entry in *NoHet* releases much more labor than the quantity that is absorbed by the contraction in labor supply. As a result, the use of labor in the intermediate good production rises in the short run, generating an increase in production. Note that the L component in Figure 6c increases by more than 0.3%, reversing the decrease in the other two components in the short run. 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. This short-run mitigating effect of labor is considerably weaker in the baseline model because the reduction in the labor demand for project enaction is much lower. The effect is in line with economic intuition, as the interest rate shock mostly affects the entry margin and current output is produced by incumbents. In this sense, the reallocation of labor from entry to intermediate production implies a lower short-run effect, but more severe medium and long-run effects due to the permanent productivity loss. In fact, because 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 lower in the long run. In the medium-run horizon, the baseline model exhibits an amplitude that is roughly 30% larger than that of *Exo*. Moreover, medium-run persistence is also higher, as can be seen from the delay in the lower point of the path in Figure 6a.

Comparing the sources of output in both models, we can identify the drivers of both effects. First, the gradual decrease of the A component, absent in *Exo*, has a first order effect on the depth of the crisis. The amplification is also 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 aggregate productivity.[47] Second, the persistence is mostly 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. The lack of a strong recovery in capital due to the permanent TFP loss also contributes to the medium-run persistence of the crisis. In contrast, investment and labor recover quickly in *Exo* to catch up with the TFP level in the economy; therefore, *Exo* features a full neoclassical recovery, not only in labor, but also in physical capital. To complete the macroeconomic picture triggered by this episode, Figure 7 presents the deviations of capital, consumption, total hours, and wages for the three models.

Figure 7c shows the response of total hours in the three models. On impact, the model with exogenous growth has the lower decrease in labor (-0.4%), while labor decreases 50% more in the baseline model, and the model with no heterogeneity shows an even larger decrease (-1%). Two reasons lay behind this amplification. First, the decrease in labor productivity in the models with endogenous growth amplifies the decrease in efficiency-adjusted wages and so, given GHH preferences, unambiguously reduces the labor supply of the household. Second, without entry, interest rates mostly affect labor by the working capital channel; in the presence of entry, the financial intermediary acts as a second channel that links interest rates to the labor market and the real economy. 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 doubles the estimation of this cost. The baseline model also generates persistence and amplification of interest rate shocks, while the model with no heterogeneity can deliver counter-factual predictions due to the violent behavior of entry.

[47]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.



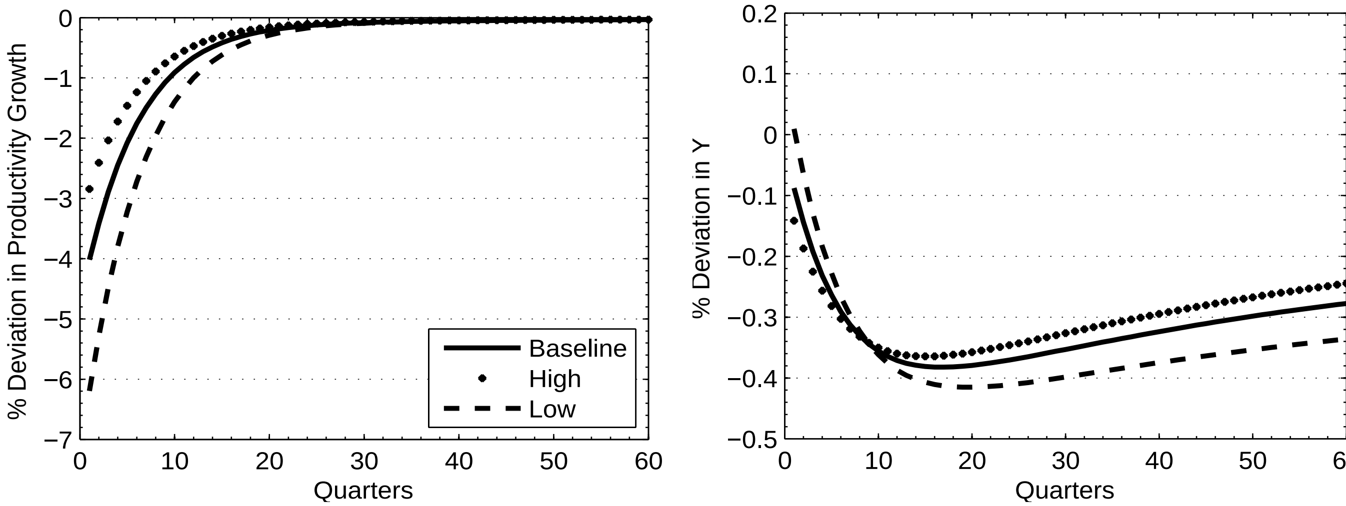
(a) Capital (b) Consumption

(c) Total Hours (d) Wages

Figure 7: Macroeconomic Aggregates.

Finally, it is interesting to explore how different accuracy levels of the financial system shape the long-run cost of a crisis and its medium-run characteristics. Figure 8 compares the deviation of productivity and output of the baseline calibration with two alternative calibrations: one where the fraction of entrants with types below the threshold is 5% along the balanced growth path (instead of the original 15% target that resulted in the calibration at $\rho = 0.71$), and one where that fraction is 25%. This corresponds to a high accuracy calibration with $\rho = 0.91$ and a low accuracy calibration with $\rho = 0.49$.[48]

[48]Because the long-run growth rate changes with both calibrations, we also modify β to guarantee that no bond holding costs are incurred in the long run. In particular, in the original calibration $\beta = 0.9975$, for the high accuracy β increases to 0.9977, and in the low accuracy it decreases to 0.9973.



(a) TFP Growth (b) Output

Figure 8: Financial Development.

In line with economic intuition, Figure 8a shows that the long-run cost of a sudden stop decreases with the accuracy of the financial system. In fact, the better the selection, the stronger the composition effect, and, hence, the less detrimental the decrease in entry. Moreover, Figure 8b shows that economies with better selection technology suffer more in the short run, but endure the crisis much better in the medium run. this is because output not only drops less, but also recovers faster and is subject to a lower long-run loss. This result is in line with Cerra and Saxena (2008)'s findings, where the level of development shapes the magnitude and persistence of extreme crises. Moreover, note that more financially developed economies exhibit less volatile trends in response to interest rate shocks. This sheds some light on the drivers of the relative importance of trend shock documented across developed and developing countries by Aguiar and Gopinath (2007). As a final remark, the long-run cost decreases from 0.18% in the baseline to 0.15% in the high accuracy case, but it increases to 0.25% in the low accuracy case. This suggests that the benefits of policy interventions aiming to foster financial development are subject to decreasing returns.

6 Concluding Remarks

In this paper, 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 entrants 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 sum, although *fewer* firms are born during the crisis, they are *better*.

The model is able to convey some interesting insights about the role of firm entry during a financial crisis. For instance, in the quantitative section, we explore the long-run cost of a sudden stop driven by the endogenous changes in TFP growth that the crisis triggers. An increase in the interest rate has a permanent effect on output, investment and consumption. Not accounting for heterogeneity and selection doubles the estimation of this long-run cost, which has non-trivial welfare consequences, as the consumption equivalent welfare cost increases by 30%. As governments often use forgone entry as an excuse for policy, a correct assessment of that cost is critical. This model provides a tractable framework where those policies can be analyzed.

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 medium-run and long-run impact of a financial crisis, but suffering a larger contemporaneous output decrease. 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 potentially desirable, not only from a balanced growth path perspective, but also as a buffer against large crises. This paper provides a framework where the long-run macroeconomic consequences of banking competition can be quantified.

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. Note that interest rate shocks are particularly suited for this task, as they decrease the benefit of entry and increase the cost faced by entrants. However, traditional stationary adverse TFP shocks reduce both the cost and benefits of entry, having a minor impact on the TFP accumulation process. In this sense, not every stationary shock produces a sizable long-run TFP cost. Future research is needed to continue closing the gap between the quantitative firm dynamics-innovation literature and the stochastic open economy models. This is not only relevant for developing countries, where the distinction between short-run fluctuations and medium to long-run trends seems rather arbitrary, but also for developed economies. Indeed, the Great Recession challenged traditional macroeconomic models by exhibiting persistent effects in aggregate productivity, diminishing potential output even at long horizons.

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Appendices

A 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.

A.1 Normalized Model: System of Equations

A.1.1 Final Good Producer

$$
\begin{aligned}
y(s^t) &= \left((L^H(s^t))^{\mu(s^t)}(L^L(s^t))^{1-\mu(s^t)}\right)^{\alpha}\left(\frac{k(s^{t-1})}{1+a(s^{t-1},s_t)}\right)^{1-\alpha} && (37)\\
x_j(s^t) &= \frac{\alpha y(s^t)}{p_j(s^t)\left(1+\eta(R(s^t)-1)\right)}. && (38)\\
k(s^{t-1}) &= \frac{(1-\alpha)y(s^t)}{r(s^t)}\left(1+a(s^{t-1},s_t)\right) && (39)
\end{aligned}
$$

A.1.2 Intermediate Good Producer

$$
\begin{aligned}
L^d(s^t) &= \frac{\alpha y(s^t)}{w(s^t)(1+\sigma^d)\left(1+\eta\left(R(s^t)-1\right)\right)} \Rightarrow \frac{L^H(s^t)}{L^L(s^t)} = \frac{1+\sigma^L}{1+\sigma^H} && (40)\\
\pi_j^d(s^t) &= \frac{\alpha\sigma^d}{(1+\sigma^d)\left(1+\eta(R(s^t)-1)\right)}y(s^t) && (41)\\
v^d(s^t) &= (1-\tau)\pi^d(s^t) + E\left[m(s^t,s_{t+1})\left(1-\lambda M(s^t,s_{t+1})\right)v^d(s^t,s_{t+1})|s^t\right] && (42)
\end{aligned}
$$

A.1.3 Financial Intermediary and Composition

$$\tilde{\mu}(\bar{z}(s^t)) = \tilde{\mu}^H(\bar{z})(s^t) = \frac{1}{\nu+1}\left[1-\rho+\rho\frac{1-(\bar{z}(s^t))^{\nu+1}}{1-\bar{z}(s^t)}\right] \tag{43}$$

$$\rho(\bar{z}_t(s^t))^\nu = \frac{\frac{w(s^t)\kappa}{\lambda}(R(s^t))-v^L(s^t)}{(v^H(s^t)-v^L(s^t))} - \frac{1-\rho}{(\nu+1)} \tag{44}$$

$$\mu(s^t) = \mu(s^{t-1}) + \lambda(1-\bar{z}(s^t))\left(\tilde{\mu}(\bar{z}(s^t)) - \mu(s^{t-1})\right) \tag{45}$$

A.1.4 Representative Household

$$1 = E\left[m(s^t, s_{t+1})|s^t\right] R(s^t) - \psi\left(\frac{b(s^t)}{y(s^t)} - \bar{b}\right) \tag{46}$$

$$E\left[m(s^t,s_{t+1})\frac{r(s^t,s_{t+1})+(1-\delta)-\frac{\phi}{2}\left([1+g_{bgp}]^2-\left[\frac{k(s^t,s_{t+1})}{k(s^t)}(1+a(s^t,s_{t+1}))\right]^2\right)}{1+\phi\left[\frac{k(s^t)}{k(s^{t-1})}(1+a(s^{t-1},s_t))-(1+g_{bgp})\right]}|s^t\right] = 1 \tag{47}$$

$$L(s^t) = \left(\frac{w(s^t)}{\Theta_l\chi}\right)^{\frac{1}{\chi-1}} \tag{48}$$

with:

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

A.1.5 Open Economy Variables

$$\ln\left(\frac{R(s^t)}{\bar{R}}\right) = \rho_r \ln\left(\frac{R(s^{t-1})}{\bar{R}}\right) + \sigma_r\epsilon_t \quad \text{where} \quad \epsilon_t \overset{iid}{\sim} N(0,1) \tag{49}$$

$$nx(s^t) = y(s^t) - c(s^t) - i(s^t) - \frac{\psi}{2}y(s^t)\left(\frac{b(s^t)}{y(s^t)} - \bar{b}\right)^2 \tag{50}$$

$$d(s^t) = \frac{b(s^{t-1})}{1+a(s^{t-1},s_t)} - \eta\frac{\alpha y(s^t)}{1+\eta(R(s^t)-1)} - (1-\bar{z}(s^t))\kappa w(s^t) \tag{51}$$

A.1.6 Labor Market Clearing

$$\left(\frac{w(s^t)}{\Theta_l \chi}\right)^{\frac{1}{\chi-1}} = \frac{\alpha y(s^t)\left(\mu(s^t)+(1-\mu(s^t))\frac{1+\sigma^H}{1+\sigma^L}\right)}{w(s^t)(1+\sigma^H)\left(1+\eta\left(R(s^t)-1\right)\right)} + (1-\bar{z}(s^t))\kappa \tag{52}$$

A.1.7 Output Growth

$$\begin{aligned}\ln(1+g(s^{t-1},s_t)) &= \alpha\int_0^1 \ln\left(\frac{L_j(s^t)}{L_j(s^{t-1})}\right)+\ln\left(\frac{q_j(s^t)}{q_j(s^{t-1})}\right)dj + \\ &\quad (1-\alpha)\ln\left(\frac{K(s^{t-1})}{K(s^{t-2})}\right)\end{aligned} \tag{53}$$

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:

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

A.2 Balanced Growth Path

First note that the three components of equation (53) 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 (47), we get:

$$\frac{(1+a(\bar{z}))^{\gamma}}{\beta} \quad = \quad 1+r-\delta \tag{54}$$

From equation (40), we get:

$$L^{d}(y,w) \quad = \quad \frac{\alpha y}{w(1+\sigma^{d})\left(1+\eta\left(\bar{R}-1\right)\right)} \tag{55}$$

And we characterize $k(y,\bar{z})$ using (39) and (54):

$$k(y,\bar{z}) = \frac{(1-\alpha)\left(1+a(\bar{z})\right)}{\frac{(1+a(\bar{z}))^{\gamma}}{\beta}-1+\delta}y \tag{56}$$

Replacing equations (56), and (55) in equation (37), we write $w(\bar{z})$ as:

$$w(\bar{z}) \quad = \quad \left(\frac{\alpha\left(1+a(\bar{z})\right)^{\frac{1}{\lambda(\bar{z}-1)}}}{\left(1+\eta\left(\bar{R}-1\right)\right)}\right)\left(\frac{(1-\alpha)}{\frac{(1+a(\bar{z}))^{\gamma}}{\beta}-1+\delta}\right)^{\frac{1-\alpha}{\alpha}} \tag{57}$$

We characterize $y(\bar{z})$ using (52):

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

Given $y(\bar{z})$, we write $L^{d}(\bar{z})$ and $k(\bar{z})$ using equations (56) and (55). Moreover, as normalized profits are constant over the BGP, we write $v^{d}(\bar{z})$ as:

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

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

$$\rho(\bar{z})^{\nu} = \frac{\frac{w(\bar{z})\kappa}{\lambda}(\bar{R})-v^{L}(\bar{z})}{(v^{H}(\bar{z})-v^{L}(\bar{z}))}-\frac{1-\rho}{(\nu+1)} \tag{58}$$

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 (46):

$$\frac{\bar{R}}{1+\psi\left(\frac{b(\bar{z})}{y(\bar{z})}-\bar{b}\right)} = \frac{(1+a(\bar{z}))^{\gamma}}{\beta} \Rightarrow b(\bar{z}) = \left(\frac{\frac{\beta\bar{R}}{(1+a(\bar{z}))^{\gamma}}-1}{\psi}+\bar{b}\right)y(\bar{z}) \tag{59}$$

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 setting $\bar{b}=\frac{b(\bar{z})}{y(\bar{z})}$, so that no cost is paid along the BGP, implies $\beta\bar{R}=(1+a(\bar{z}))^{\gamma}$.

A.3 Existence and Uniqueness

A.3.1 Uniqueness of an Interior Solution

Recall that $\chi>1$ and $\gamma>1$. Let's first find an expression for the right hand side of (58). Let's work term by term, first noting that:

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

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:

$$\frac{\frac{w(\bar{z})\kappa}{\lambda}}{v^{H}(\bar{z})-v^{L}(\bar{z})} = \frac{\kappa}{\lambda(1-\tau)}\frac{\left(1-(1-\lambda(1-\bar{z}))\,\beta(1+a(\bar{z}))^{1-\gamma}\right)\left(\frac{1+\sigma^{H}}{\sigma^{H}-\sigma^{L}}-\mu(\bar{z})\right)}{\left(\left(\frac{w(\bar{z})}{\Theta_{l}\chi}\right)^{\frac{1}{\chi-1}}-(1-\bar{z})\kappa\right)} \tag{60}$$

Then, the right hand side of equation (58) is decreasing in $\bar{z}$ if and only if equation (60) also decreases in $\bar{z}$. Taking the natural logarithm of equation (60) and dropping the constant, we define the following function:

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

Some preliminary derivatives are given by:

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

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.

A.3.2 Existence and Uniqueness of an Interior Solution

We need to find conditions such that equation (58) 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:

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

For the $\bar{z} = 1$ case, we have:

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

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 Macroeconomic Data

In this section, we present the sources of the macroeconomic data used in this paper and the behavior of the aggregated time series during the crisis. We first present a general description of the Chilean economy from the *World Bank Database*, in Table 6.

	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 6: 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 paper. 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 the world's exports and 0.41% of the world's imports. Chile is also the 7^{th} freest economy in the world (2013 *International Economic Freedom Ranking*).

The main source of data for the macroeconomic analysis in Section 4 is the International Financial Statistics (IFS) database from the International Monetary Fund (IMF). From that source, 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 (22878BJ DZF...), direct investment abroad (22878BDDZF...), 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 Instituto Nacional de Estadística (INE, National institute of Statistics) of Chile and hours worked per week from the *Encuesta de Ocupación y Desocupación* from the Economics 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 X-12 procedure of the US Census. We follow the procedure of Bergoeing et al. (2002) to build real aggregate macroeconomic variables.[49]

Figure 9 shows the evolution of the annualized real lending interest rate between 1996 and 2005,

[49]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.

where the grey area spanning the period between 1998:II and 2000:III highlights the crisis period. Figure 10 explores some of the macroeconomic consequences of the Russian default in the Chilean economy.[50]Figure 10a shows a drop of more than 30% in real investment over just one quarter. In that same period, Figure 10b points to a drop of more than 6% in hours worked. Figures 10c and 10d show that both output and consumption decreased by 5% and took more than a year to return to the pre-crisis level.

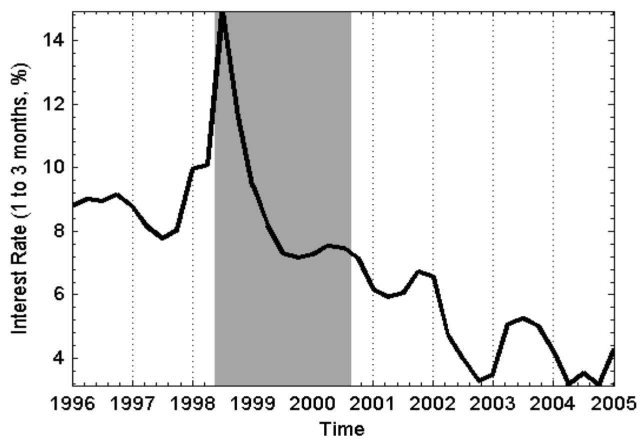
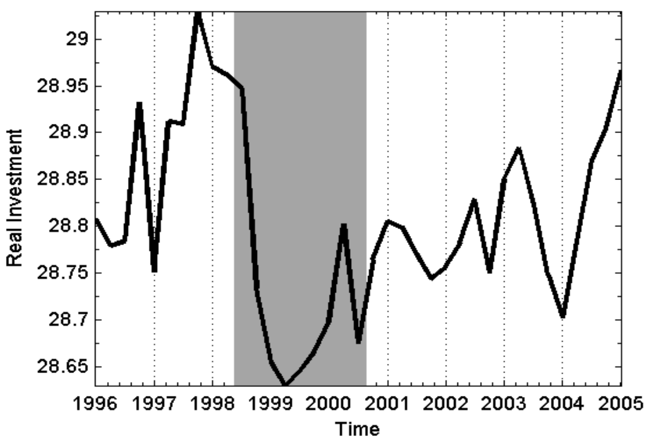
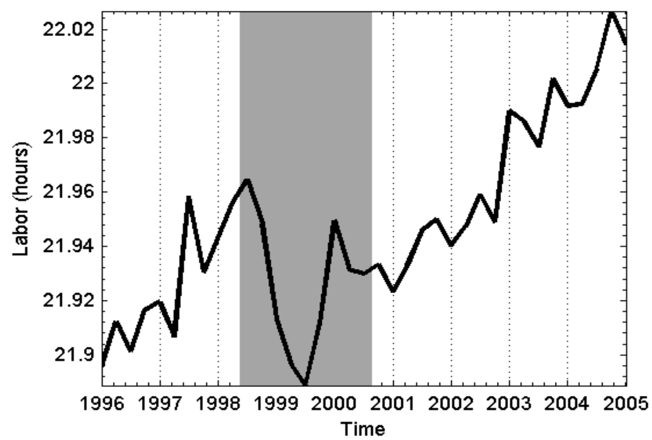


Figure 9: The Chilean Sudden Stop

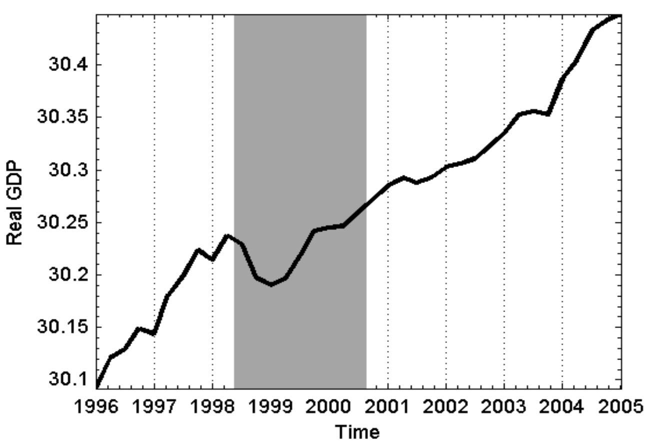
[50]The data of Figure 10 is seasonally adjusted, in real terms, and in logarithms.



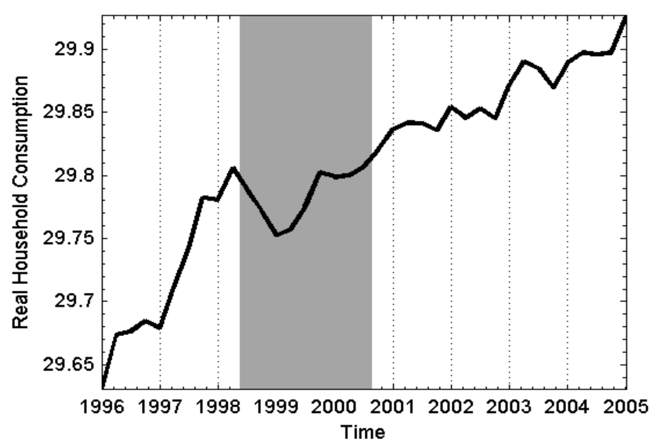
(a) Real Investment (↓ 30%)



(b) Total Hours (↓ 6%)



(c) Real GDP (↓ 5%)



(d) Household Consumption (↓ 5%)

Figure 10: Macroeconomic Impact of the Crisis.

C ENIA and Empirical Analysis

The Encuesta Nacional Industrial Anual (ENIA, Annual National Industrial Survey) conducted the by the INE covers all manufacturing plants in Chile with more than 10 workers. Our version extends from 1995 to 2007.

C.1 Data Cleaning

We eliminate observations with one or more of the following inconsistencies, with original variable names provided in parenthesis: negative electricity consumption (*elecons*), worked days less than or equal to 0 (*diatra*), gross value of the production less than value added (*vpn*<*va*), value added less than 0 (*va*), remuneration of workers equal to 0 (*rempag*), size equal to 0 (*tamano*), ISIC code less than 3000 (bad coding in *sector*), and sales income less than income from exports (*ingtot*<*ingexp*). Finally, as mentioned in the text, we dropped industries 314 (Tobacco), 323 (Leather), 353 (Oil and Gas 1), 354 (Oil and Gas 2), 361 (Pottery), 362 (Glass), 371 (Metals 1), 372 (Metals 2) and 385 (other) due to an insufficient number of observations or inadequate entry dynamics. To minimize problems due to the 10 workers threshold, we count as the first observation of a firm the first time it appears in the data with 11 or more workers. The restricted sample still contains more than 90% of the original observations and total workers in the sample.

C.2 Variable Construction and Other Controls

We 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 $t-1$. The revenue (*ingtot-revval-reviva*) used to calculate the profitability measures and the Herfindahl-Hirschman concentration Index (HHI) excludes non-manufactured products (re-selling products and their tax shield); the costs include wages and exclude the costs and taxes associated to non-manufactured products (*costot-mrevval-mreviva+rempag*). The production used to build the labor productivity proxy used in Table 2 includes the changes in inventories as a fraction of the sales of manufactured products (*vpf-provap+provaf-acavap+acavaf*). We define capital as the end-of-period value of land, machinery, buildings and vehicles (*salter+saledi+salmaq+salveh*). We use the net increase in physical capital (*abaf*) to build the capital accumulation variable used in Table 2. We deflate monetary variables using the industry level deflators provided by the INE. The index of manufacturing production (22866EY.ZF...), the unemployment rate (22867R..ZF...), and the producer price and wholesale price index (PPI/WPI, 22863...ZF...) are taken from the IFS database. The labor cost index is from the Chilean Central Bank.

C.3 Descriptive Tables

The following table presents the mean, standard deviation, number of observations, and the 25^{th}, 50^{th}, and 75^{th} percentiles of the key variables used in the empirical analysis and for calibration purposes. For firm level observations, top and bottom 1% have been removed to control for outliers. Firms born prior to 1996 are excluded from the tables and regressions, because we cannot infer their cohort. Firms born in 2007 are also excluded because we observe them only at age 0. Note that the raw data reflects the main message of the empirical section. In fact, the simple average industry level entry rate is 11% before the crisis, 7% during the crisis, and 9% after the crisis. Moreover, the average lifetime profitability of the cohorts born during the crisis is also higher in the raw data.

Variable	Mean	Std. Dev.	N	P25	P50	P75
Profitability	0.231	0.209	17868	.126	.242	.359
Labor productivity proxy (log)	4.68	1.042	16945	4.092	4.613	5.237
Capital accumulation rate	0.128	0.243	17179	0	.021	.164
Electricity consumption (log)	-0.666	1.769	17874	-1.843	-.88	.32
Total workers	58.998	131.307	18234	16	24	49
Capital (log)	6.467	2.013	17347	5.199	6.439	7.715
Workers at entry	52.002	12.991	4089	42.817	48.031	57.319
Capital at entry (log)	6.29	0.259	4089	6.08	6.212	6.543
Average exit age	2.407	2.536	2241	0	2	4
HHI	0.057	0.103	220	.011	.021	.054
Average industry level entry	0.086	0.052	220	.051	.076	.112
Fraction dying at age= 0	0.172	0.15	220	.077	.15	.25
Cohort size	371.727	166.339	11	252	302	454
Fraction of the cohort not dying in the sample	0.474	0.163	11	.312	.434	.635
Unemployment rate	0.076	0.013	12	.072	.077	.082
PPI/WPI	84.113	17.932	12	66.015	84.065	97.445
Labor cost index	92.697	5.916	12	88.535	92.86	97.545
Manufacturing production (log)	4.465	0.121	12	4.38	4.409	4.579

Table 7: Summary Statistics: All Cohorts.

C.5 Hausman and Taylor (1981)

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).

Variable	Mean	Std. Dev.	N	P25	P50	P75
Profitability	0.23	0.203	6794	.127	.243	.357
Labor productivity proxy (log)	4.521	0.986	6552	3.984	4.453	5.049
Capital accumulation rate	0.106	0.219	6497	0	.012	.13
Electricity consumption (log)	-0.783	1.684	6729	-1.918	-1	.125
Total workers	55.902	135.665	6863	16	23	45
Capital (log)	6.416	1.926	6577	5.21	6.423	7.563
Workers at entry	47.589	6.817	1170	42.817	42.817	57.319
Capital at entry (log)	6.203	0.177	1170	6.08	6.08	6.456
Average exit age	3.426	3.089	843	1	3	6
HHI	0.03	0.045	40	.009	.016	.034
Average industry level entry	0.113	0.069	40	.076	.102	.127
Fraction dying at age= 0	0.151	0.093	40	.096	.148	.186
Cohort size	585	282.843	2	385	585	785
Fraction of the cohort not dying in the sample	0.288	0.034	2	.264	.288	.312
Unemployment rate	0.054	0.001	2	.053	.054	.054
PPI/WPI	62.63	0.721	2	62.12	62.63	63.14
Labor cost index	83.895	1.478	2	82.85	83.895	84.94
Manufacturing production (log)	4.36	0.034	2	4.336	4.36	4.384

Table 8: Summary Statistics: Before Crisis Cohorts.

Variable	Mean	Std. Dev.	N	P25	P50	P75
Profitability	0.239	0.214	4169	.132	.247	.366
Labor productivity proxy (log)	4.768	1.044	4029	4.136	4.67	5.345
Capital accumulation rate	0.115	0.228	3976	0	.011	.142
Electricity consumption (log)	-0.698	1.83	4188	-1.91	-.878	.36
Total workers	58.532	129.278	4306	15	24	48
Capital (log)	6.388	2.12	4021	5.121	6.341	7.772
Workers at entry	48.737	2.733	839	44.667	49.798	51.211
Capital at entry (log)	6.03	0.167	839	5.782	6.089	6.181
Average exit age	2.647	2.333	529	0	2	5
HHI	0.064	0.11	60	.012	.023	.062
Average industry level entry	0.067	0.035	60	.041	.061	.078
Fraction dying at age= 0	0.152	0.123	60	.063	.162	.223
Cohort size	279.667	25.423	3	252	285	302
Fraction of the cohort not dying in the sample	0.366	0.064	3			
Unemployment rate	0.081	0.009	3	.072	.083	.089
PPI/WPI	69.147	5.677	3	64.34	67.69	75.41
Labor cost index	89.207	1.726	3	87.26	89.81	90.55
Manufacturing production (log)	4.368	0.021	3	4.344	4.379	4.382

Table 9: Summary Statistics: Crisis Cohorts.

Variable	Mean	Std. Dev.	N	P25	P50	P75
Profitability	0.226	0.211	6905	.122	.237	.356
Labor productivity proxy (log)	4.787	1.076	6364	4.201	4.735	5.381
Capital accumulation rate	0.158	0.269	6706	0	.04	.22
Electricity consumption (log)	-0.534	1.803	6957	-1.72	-.762	.485
Total workers	62.289	128.134	7065	17	27	55
Capital (log)	6.563	2.027	6749	5.241	6.505	7.856
Workers at entry	55.802	16.522	2080	43.55	48.031	69.957
Capital at entry (log)	6.443	0.22	2080	6.219	6.543	6.598
Average exit age	1.274	1.304	869	0	1	2
HHI	0.082	0.158	120	.011	.026	.079
Average industry level entry	0.086	0.048	120	.054	.076	.114
Fraction dying at age= 0	0.189	0.174	120	.064	.146	.286
Cohort size	346.667	122.662	6	221	352.5	454
Fraction of the cohort not dying in the sample	0.589	0.12	6	.497	.597	.678
Unemployment rate	0.08	0.009	7	.074	.078	.08
PPI/WPI	96.666	11.359	7	86.84	94.89	106.97
Labor cost index	96.707	3.483	7	93.88	96.61	100.26
Manufacturing production (log)	4.537	0.11	7	4.418	4.552	4.637

Table 10: Summary Statistics: Post Crisis Cohorts.

Third, an estimator for the variance of the unobserved fixed effect component can be built as $\hat{\sigma}_{\mu}^2 = \tilde{\sigma}^2 - \frac{\hat{\sigma}_u^2}{T}$, 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 (32), 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.

D Cox Estimation

This section shows that the higher profitability of the cohorts born during the sudden stop is not due to *ex-post* selection. In particular, we perform the following stratified proportional hazard estimation in order to show that firms born during the crisis are not more likely to die at any horizon.

$$\begin{aligned} h_{r,c}(t|\boldsymbol{X}_i) &= h_{0,r,c}(t)\exp\left[\beta_1 \ln(L_{i,t}) + \beta_2 \ln(L_{i,0}) + \beta_3 \ln(elec_{i,t}) + \beta_4 \ln(elec_{i,0}) \right. \\ &\quad \left. + \beta_5 \ln(K_{i,t}) + \beta_6 \ln(K_{i,0}) + \beta_7 \bar{P}_{j,t} + \beta_8 HHI_{j,0} + \gamma_j \right] \end{aligned}$$

C.4 Industry Level Entry Rates

Cohorts	311	312	313	321	322	324	331	332	341	342
96 – 97	11.6%	13.4%	11.3%	9.6%	15.5%	7.1%	10.1%	18.2%	12.7%	7.0%
98 – 99	5.3%	3.6%	7.7%	3.6%	6.1%	5.1%	6.8%	7.7%	5.3%	5.2%
00 – 01	4.2%	6.3%	9.1%	4.1%	5.5%	4.1%	6.3%	11.2%	6.9%	8.1%
02 – 03	10.2%	10.0%	12.6%	6.9%	12.9%	5.7%	13.7%	13.1%	9.0%	20.2%
04 – 05	7.3%	8.5%	19.7%	6.3%	5.7%	3.0%	6.9%	12.3%	8.2%	6.4%

Cohorts	351	352	355	356	369	381	382	383	384	390
96 – 97	9.7%	10.3%	5.5%	8.0%	11.7%	13.1%	10.8%	9.2%	9.5%	22.2%
98 – 99	8.9%	5.0%	7.0%	4.9%	13.1%	4.4%	5.3%	6.0%	4.5%	4.7%
00 – 01	7.1%	5.1%	2.5%	5.2%	9.9%	8.8%	7.8%	8.7%	3.6%	10.5%
02 – 03	7.4%	10.7%	8.9%	12.8%	7.1%	13.6%	17.3%	13.9%	9.7%	7.5%
04 – 05	14.8%	5.8%	8.8%	8.6%	8.4%	9.8%	11.4%	7.0%	10.4%	8.9%

Table 11: Two year average entry rates by industry.

The two strata are geographical region (r) and time period (c). This means that the baseline hazard $h_{r,c}$ 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 4. 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. The following table shows the estimates of the common covariates.

	_t
$\ln(L_{i,t})$	-0.547***
	(0.0708)
$\ln(L_{i,0})$	0.445***
	(0.0709)
$\ln(elec_{i,t})$	-0.0783***
	(0.0262)
$\ln(elec_{i,0})$	0.0543**
	(0.0252)
$\ln(K_{i,t})$	-0.0237
	(0.0246)
$\ln(K_{i,0})$	-0.0373
	(0.0237)
$\bar{P}_{j,t}$	0.0403
	(0.187)
$\text{HHI}_{j,t}$	-0.0796
	(0.356)
Industry control	Yes
Observations	16554
Plants	3778
Exits	2024

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Proportional Hazard

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 (for number of workers and electricity consumption). The specification controls for the industry cycle (using the average varying profitability of the industry $\bar{P}_{j,t}$) and industry specific effects. Figure 11 plots the survival 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.

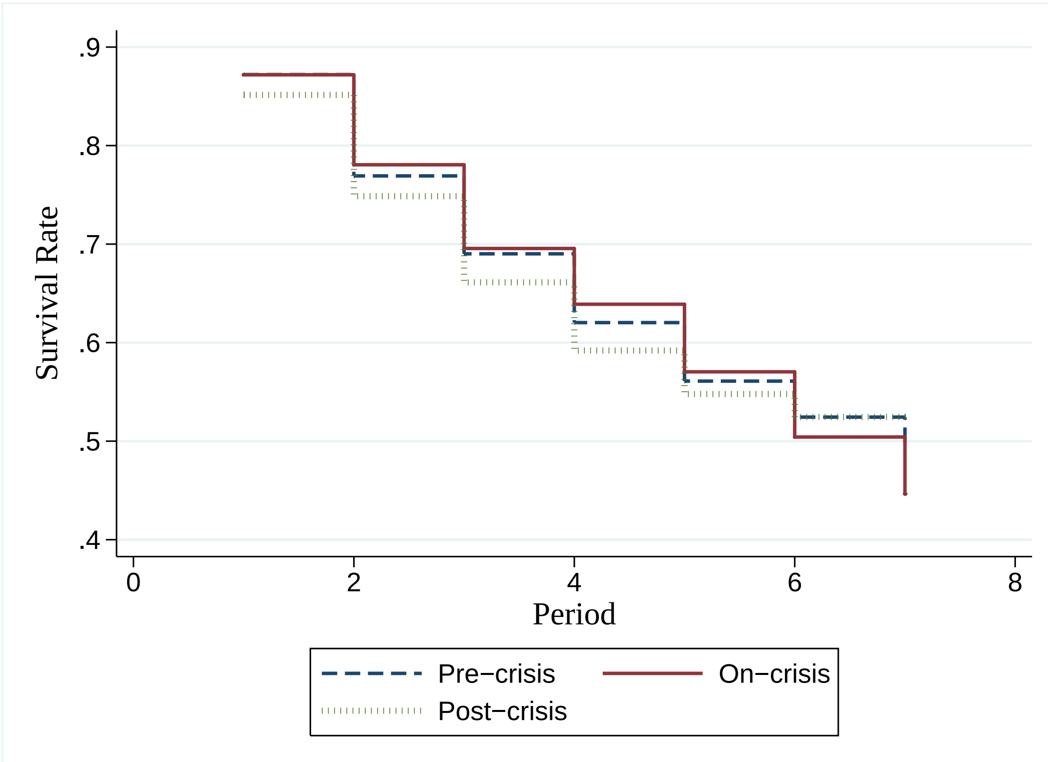
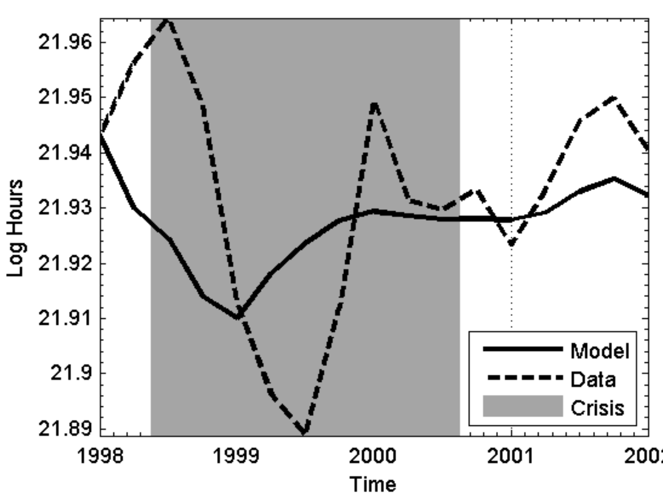


Figure 11: Survival Rates, Cox Proportional Hazard Model

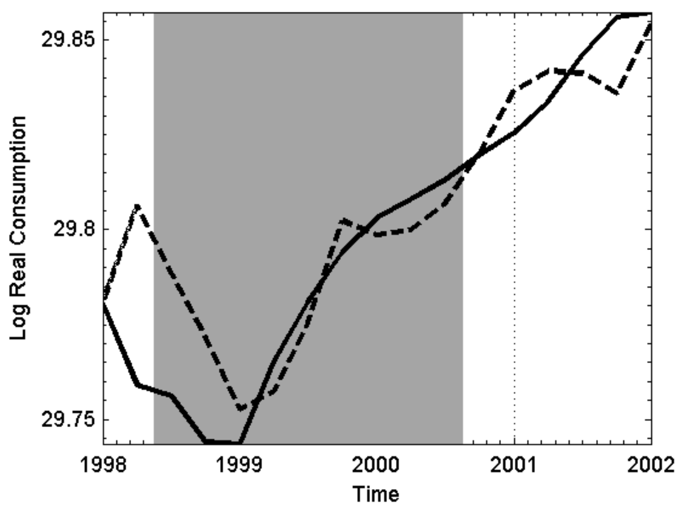
Note that firms born during the crisis do not exit more than other cohorts. Moreover, they even seem stronger in this dimension, in that, until year 6, they have a higher predicted survival probability than firms born either before or after the episode. Hence, *ex-post* selection does not explain the higher profitability of cohorts born during the sudden stop.

E Macroeconomic Aggregates: Model and Data

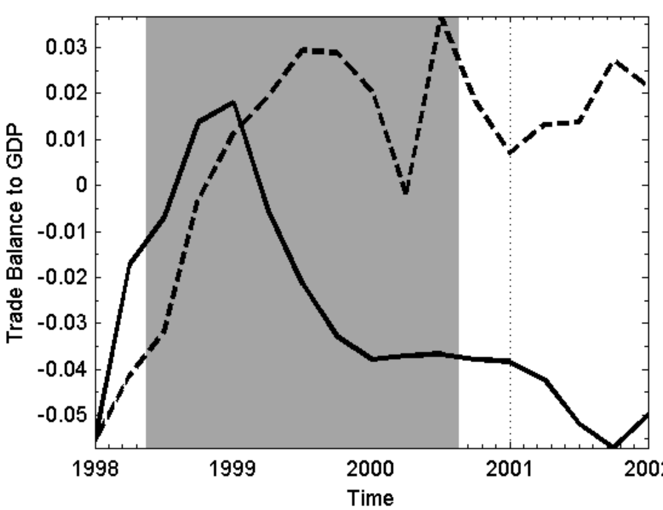
Figure 12 compares the model generated series for the logarithm of total hours, the logarithm of household consumption, trade balance divided by GDP, and the logarithm of investment with the actual series. The model is assumed to be on its BGP on 1998:I and the levels are adjusted so that model and data coincide at that date.



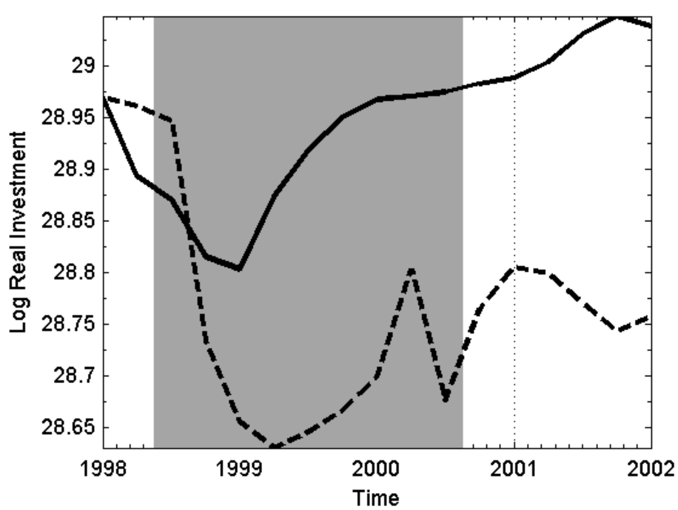
(a) Total Hours (log)



(b) Household Consumption (log)



(c) Trade Balance over GDP



(d) Investment (log)

Figure 12: Model Macro Performance

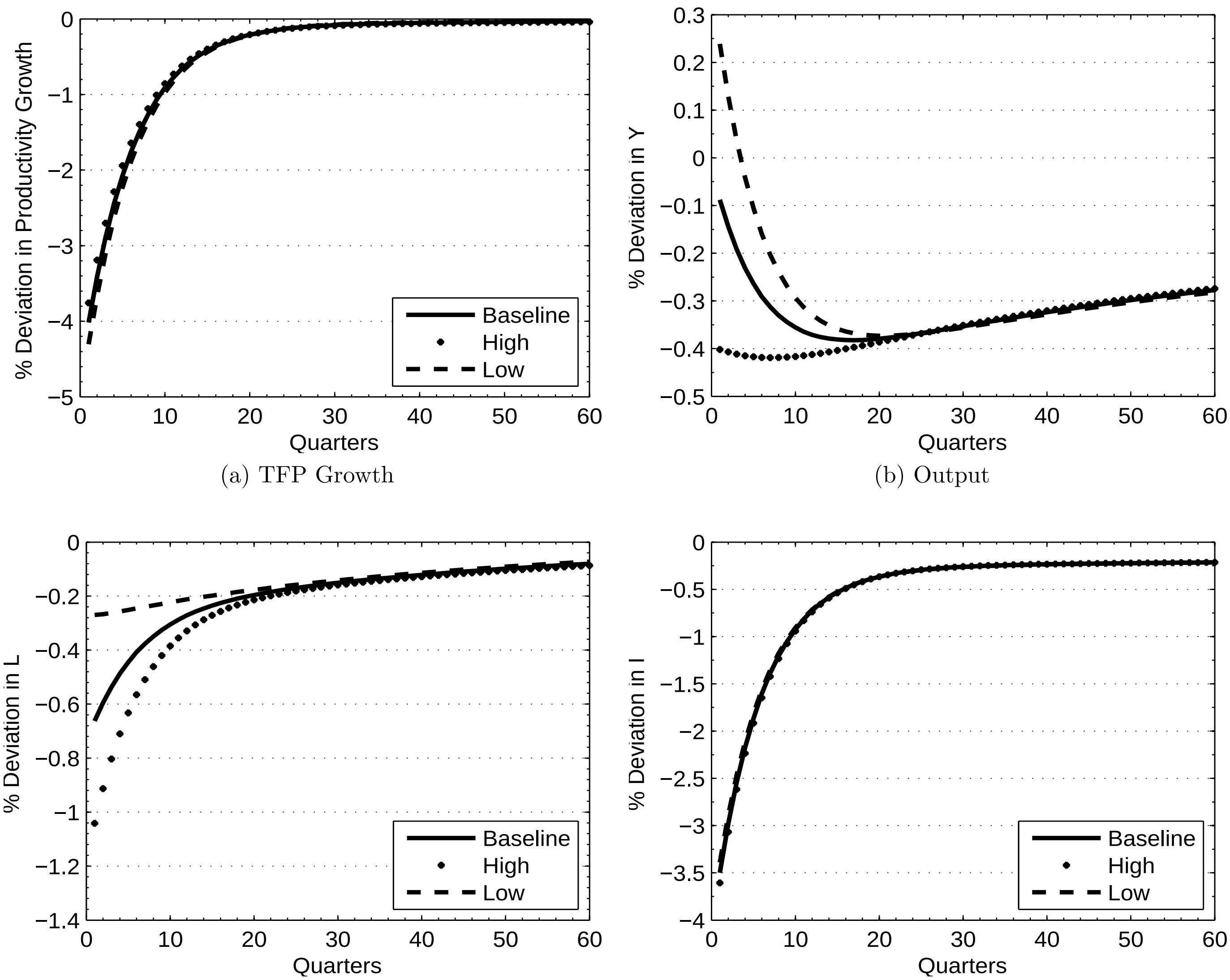
Abstracting from the timing, if we evaluate the model on the magnitude of the contemporaneous response we see that the model captures 60% of the decrease in hours, overshoots by 1% the decrease in consumption, captures almost 90% of the reversal on trade balance, and predicts 50% of the contraction in investment. The recovery of the model is significantly faster than in the data. In fact, as Figure 9 shows, the interest rate recovers quickly. This suggest that the financial conditions faced by the firms are not fully reflected by the interest rate data.

F The Working Capital Channel

This section studies the role of working capital friction in the model. In particular, Figure 13 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 ($\eta = 2$).[51]

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 through a labor channel. As shown in Figure 13c, labor decreases almost 50% more on impact when comparing the high η case with the baseline. Also note that Figure 13d 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 paper, Figure 13a does not display strong differences in terms of TFP growth. Moreover, Figure 13b can be used to assess the long-run effect of η. 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, the more the reduction in labor is directed to intermediate good production, and the less is absorbed by the financial intermediary. Hence, the higher the working capital friction, the lower the effect on entry, and, thus, the lower the long run cost of the crisis. Quantitatively, the long-run loss changes are on the order of 0.001%, thus this parameter does not play a role in the main mechanism of the paper. The reason is simple: η affects the benefit of entry (decreases values) and the cost of entry (decreases wages) in virtually the same magnitude, so the entry margin is practically unaffected. As in Neumeyer and Perri (2005), this parameter is useful in matching the immediate impact of a crisis.

[51] In order to avoid bond holding costs in the long run, we also re-calibrate β. The low value of η is associated with a higher β (0.9977). Higher η implies less long-run growth and therefore a lower β (0.9972).



(a) TFP Growth (b) Output

(c) Labor (d) Investment

Figure 13: The Role of Working Capital