Corporate Taxes and Growth:
The Impact of Financial Selection on Firm Entry*

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April 26, 2020

Abstract

A key engine of long–run economic growth is firm entry. Nevertheless, empirical evidence suggests that higher corporate tax rates are associated with significant decline in firm entry while having only a mild effect on aggregate growth, if any. To rationalize this relationship, we build a general equilibrium endogenous growth model that features heterogeneity in business projects and financial screening. With good ideas being scarce, the ability of financial intermediaries to select promising projects determines the strength of a mass-composition trade-off between firm entry and economic growth: Larger cohorts have a lower average quality, which translates into a lower average productivity growth across those entrants. Accounting for heterogeneity and financial selection allows the model to conciliate the apparently contradictory effects of corporate taxation on firm entry and aggregate growth. Financial selection is key to this relationship: We establish both empirically and numerically that in industries with a more intense financial selection, the effect of corporate taxes on both variables is more muted.

Keywords: Endogenous Growth, Financial Development, Project Heterogeneity, Financial Selection

*The authors wish to thank Ufuk Akcigit, Harold Cole, Dirk Krueger, Jeremy Greenwood, and seminar participants at the SED, IAES, ESEM, Midwest Macro, WFC, EBES, PUC Chile, and Banco Central de Chile for useful comments and suggestions. We also thank Veronika Penciakova for her excellent research assistance. Felipe acknowledges the support of the Robert Summers Fellowship, and CONICYT Chile. The authors are responsible for all remaining imperfections. The views in this paper are solely the responsibilities of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or of any other person associated with the Federal Reserve System. A previous version with the title "Project Heterogeneity and Growth: The Impact of Financial Selection on Firm Entry" appeared as a PIER Working Paper (No. 13-011).

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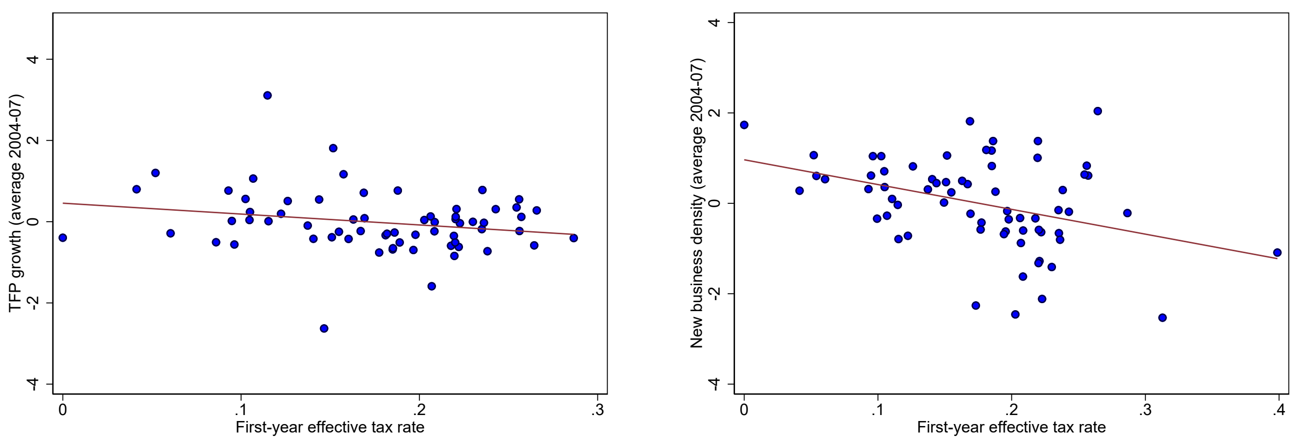
1 Introduction

We study the differential effect of corporate taxation on firm entry and growth. Figure 1 corroborates an important finding in the empirical literature: Higher corporate taxes are strongly detrimental for firm entry, whereas their effect on productivity growth is only weakly negative, if any. This observation seems puzzling, considering that firm entry is a major source of aggregate productivity growth.[1]



(a) Growth

(b) Entry

Figure 1: Effect of Corporate Taxes on TFP Growth and Firm Entry

Notes: For the sake of comparison, both TFP growth rates and the new business density values are normalized and standardized by the respective sample means and standard deviations. Appendix C presents a comparison using output growth.

In this paper, we present a theoretical framework and show that financial selection of heterogeneous firms at the entry stage can reconcile these seemingly contradictory effects of corporate taxation. We argue that financial selection introduces a quantity-quality trade-off: In larger cohorts of entrants, there is a bigger mass of new ideas contributing to productivity growth, but the average contribution of those ideas is lower. This inverse relationship between the size and average productivity contribution of entrant cohorts mitigates the transmission of the effect of taxes on entry to aggregate growth. The strength of this mitigation effect crucially depends on the ability of the financial system to channel funds to the most promising firms. Using cross-country-industry data, we show that stronger exposure to financial selection diminishes the negative effect of taxation on entry and growth, in line with our model's prediction.

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

Our theoretical framework draws on the Schumpeterian creative destruction models of endogenous growth (Grossman and Helpman, 1991; Aghion and Howitt, 1992). In the model, entrepreneurs with a new invention (creativity) have lower production costs, and this productivity advantage allows them to replace the former incumbent (destruction), which is the source of long-run economic growth. In order to understand how mass and composition effects interact with corporate taxation, we modify this framework along two dimensions. First, we introduce *ex ante* project heterogeneity that is translated into *ex post* firm heterogeneity in the intermediate good sector. Second, we introduce a financial system with access to a screening technology. The accuracy of the screening device represents the level of financial development in the economy.

The theoretical model captures several salient features in the data. First, it reflects the fact that long-run economic growth is driven by productivity growth and firm entry is an important determinant of productivity growth (Foster et al., 2001; Bartelsman et al., 2009). In addition, empirical work on firm financing show that entrants and young firms are in need of outside finance to afford their business plans.[2] Together, these facts establish a link between finance and growth: More developed financial systems are able to pool more funds to finance more start-ups, and the higher entry rate generates more creative destruction and thus more growth. However, the financial system does not only pool funds but also plays the crucial role of selecting promising businesses to fund, given the heterogeneity across business ideas with relative scarcity of good ones.[3] As such, financial intermediation affects both the *mass* the *composition* of an entrant cohort, which constitutes the key mechanism embedded in our theoretical framework.

The theoretical investigation of the model demonstrates that increases in corporate taxation have stronger negative effects on firm entry than they do on the long-run growth as a result of the composition effect triggered by financial selection. We corroborate these findings with a numerical experiment in a reasonably calibrated version of the model that illustrates the model's ability to generate these relationships for a wide range of corporate tax levels. The underlying intuition lies in the strength of financial selection. With rising taxes, the set of projects that are enacted becomes smaller as the expected stream of profits from each project shrinks. Nevertheless, when the screening technology is accurate enough, the forgone contribution to economic growth of the marginal entrant that is denied financing remains relatively modest, as the selection process carefully scraps the projects with the least potential. However, with further increases in tax rates, the contribution

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

[3]Silverberg and Verspagen (2007) document that both patent citation and returns to patenting are highly skewed toward relatively few patents. Fracassi et al. (2016) document a loan approval rate of only 18.2% for start-ups, using loan application data for a major venture capital firm in the United States. Moreover, credit allocation is far from being random. In fact, funded start-ups in their sample survive longer and are more profitable than rejected ones.

of the marginal entrant that is left out also rises. Hence, the relative strength of mass effect over composition effect is not constant. This result implies a nonlinear impact of corporate taxation on economic growth. Moreover, additional numerical exercises presented in the Appendix illustrate that these findings also hold in an extended version of the model that captures endogenous innovation decisions of incumbent firms in addition to entry dynamics.

The last section of the paper presents regression results from cross-country and cross-country-industry analyses, which lend support to the proposed mechanism. First, we formalize the relationship from Figure 1. Exploiting industry variation, we then show how the mass-composition trade-off depends on the intensity of firm selection. In particular, our results suggest that the dampening of the negative effect of corporate taxes on firm entry and aggregate growth is stronger in industries that are more exposed to financial selection. In line with the numerical analysis of the model, this result reflects the role of adjustments in the composition margin, which strengthens with better financial selection of firms at entry.

Related Literature The screening role of the financial system in our model links it to a literature that can be traced back to Bagehot (1878) and Schumpeter (1934), but a more formal exposition of financial selection can be found in Boyd and Prescott (1986). The handbook chapter by Levine (2005) eloquently explains that one characteristic of financial development is the *improvement in the production of ex ante information about possible investments*, consistent with the role of financial system in our framework. Keys et al. (2010) study empirically the importance of financial selection, documenting that the lower screening intensity in the sub-prime crisis generated between 10% and 25% more defaults.

Many studies have investigated the theoretical underpinnings of the relationship between finance and growth. For instance, Greenwood and Jovanovic (1990) present an externality-driven endogenous growth model inspired by Romer (1986) with a financial sector. Bose and Cothren (1996) also use a first-generation endogenous growth model to study how improvements in the screening technology of the financial system affect the growth rate of the economy. An early innovation-based endogenous growth model with heterogeneity and financial selection is proposed by King and Levine (1993). They introduce heterogeneity through project management capabilities of agents in a Aghion and Howitt (1992) model, with the financial system pooling resources and identifying capable individuals in order to put them in charge of innovative projects. More recent advances on this finance-growth nexus include Greenwood et al. (2010), Levine (2005), Cole et al. (2016), and Levine and Warusawitharana (2019). From the modeling perspective, our work is closer to Ateş and Saffie (2016), which use a quantitative endogenous growth model with financing frictions and external finance to analyze permanent effects of sudden stops. Departing from that model, in this paper we develop a framework with imperfect financial selection and use it to derive novel analytical predictions. Our main focus here is the role of the selection quality in shaping the response of firm entry and aggregate growth to corporate tax changes.

Our analysis of corporate taxes links our paper to a large body of work on the effect of taxation on economic activity. Easterly and Rebelo (1993) and Piketty et al. (2014) find no robust relationship between economic growth and taxation, while the findings of Romer and Romer (2010) using narrative records suggest the contrary when short-term growth is concerned. Also, Romer and Romer (2014) find a limited effect of marginal income tax changes on taxable income using data from the inter-war period in the United States, while they argue that the effect on business formation is more pronounced. This result resonates with the strong negative effect of corporate taxation on entrepreneurship in Rin et al. (2011). Ferraro et al. (2017) contributes to this literature with a quantitative investigation, which analyzes the effect of different types of taxes on economic activity on aggregate productivity. Closer to our study, Jaimovich and Rebelo (2017) build on the non-Schumpeterian innovation tradition of Romer (1990), which they complement with heterogeneous agents as in Lucas (1978) to study the nonlinear relationship between taxation and long-run growth. While the interplay between taxation, heterogeneity of ideas, and self-selection into entrepreneurship in Jaimovich and Rebelo (2017) generates similar patterns to those found in our work, our study emphasizes the important role of financial selection in this relationship, which we show is corroborated by new empirical evidence.

This paper contributes to the literature on two grounds. First, it shows theoretically how financial selection, through its effect on the entry decisions of heterogeneous firms, could reconcile the incommensurate effects of corporate taxation on firm entry and long-run growth. This result hinges on the endogenous mass-composition trade-off arising in the model, which generates a non-monotonic and non-linear relationship between entry and growth rates. Second, our theory suggests that the strength of this mechanism depends positively on the quality of financial selection, and we provide new empirical evidence that corroborates this theoretical prediction.

The paper is structured as follows. Section 2 presents the model economy. Section 3 discusses the main analytic results, the numerical illustration of the mass and composition effect, and the role of financial selection. Section 4 shows evidence from the data supporting the main predictions of the model, and Section 5 concludes.

2 Model

This section presents a simple extension of the quality-ladder models (Grossman and Helpman, 1991; Aghion and Howitt, 1992).[4] A continuum of differentiated intermediate goods (varieties), indexed by $j \in [0,1]$, are used to produce a unique final good. In each variety, the producer with the lower marginal cost monopolizes production. Productivity growth is endogenous, and productivity increases when a new firm (entrant) captures a product line by innovating over the former leader (incumbent firm). We extend this framework to allow for project heterogeneity and financial selection. A representative financial intermediary owns a unit mass of projects, indexed by $e \in [0,1]$, and collects deposits from the representative household to enact a portion of them. Successfully enacted projects give rise to new firms. Two ingredients are critical for a mass-composition trade-off to arise. First, we allow for heterogeneity at the project and at the firm level. Firms are heterogeneous in their cost advantage with respect to the closest competitor. In particular, there are two types of firms: H (high) and L (low). Type-H firms enjoy a larger cost advantage than type-L firms. Projects are heterogeneous in their idiosyncratic probability of generating a type-H firm. Second, we model financial selection by allowing the financial intermediary to access an imperfect screening device to assess the idiosyncratic probability that characterizes each project.

2.1 The Representative Household

The representative household lends assets $A(t)$ to the financial intermediary at the interest rate $r(t)$ and receives the profits of the financial intermediary $\Pi(t)$ as well as the revenue generated by corporate taxation $T(t)$, which the government levies on intermediate good producers. Time is continuous. The household supplies L units of labor inelastically, receives log-utility from consumption of final good, and discounts future utility at the rate of time preference υ. Given functions for wages, interest rates, profits, lump sum transfers of tax revenue $\{w(t)\,, r(t)\,, \Pi(t)\,, T(t)\}$, and initial asset holding $A(0)$, the representative household chooses functions of optimal consumption and assets allocation $\{C(t)\,, A(t)\}$ to solve

$$\max_{C(t)\,, A(t) \geq 0} \int_0^\infty e^{-\upsilon t} \log C(t) dt \qquad sbj.to \tag{1}$$

$$C(t) + \dot{A}(t) = w(t)L + r(t)A(t) + \Pi(t) + T(t). \tag{2}$$

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

As indicated by equation (2), the final good is the numeraire. The Euler equation follows as

$$\frac{\dot{C}(t)}{C(t)} \equiv g(t) = r(t) - \upsilon. \tag{3}$$

2.2 Final Good Sector

The representative final good producer combines intermediate inputs to produce the final good according to the following constant return to scale technology,

$$\ln Y(t) = \int_0^1 \ln x_j^D(t) dj,$$

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

$$\max_{\left\{\left\{x_j^D(t)\right\}_{j\in[0,1]}\right\}\geq 0} \left\{ exp\left(\int_0^1 \ln x_j^D(t) dj\right) - \int_0^1 x_j^D(t) p_j(t) dj \right\}. \tag{4}$$

The solution to this problem yields the following demand schedule for intermediate goods:

$$x_j^D(t) = \frac{Y(t)}{p_j(t)}. \tag{5}$$

2.3 Intermediate Good Sector: Heterogeneous Firms

There is a continuum of firms producing a unit mass of intermediate goods indexed by j. The output of variety j is denoted by $x_j(t)$. Production technology of each variety is linear in labor $l_j(t)$ with constant marginal productivity $q_j(t)$, thus

$$x_j(t) = l_j(t) q_j(t). \tag{6}$$

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

$$q_j(t+\Delta t) = \mathbb{I}_j(t) q_j(t)\left(1+\sigma^d\right) + \left(1-\mathbb{I}_j(t)\right) q_j(t); \quad d \in \{L, H\}, \tag{7}$$

where $\mathbb{I}_j(t)$ is an indicator function that equals 1 if a new firm improves the production technology in product line j at instant t, and 0 otherwise. Moreover, σ^d is the heterogeneous step size of the innovation carried by the entrant firm, with $\sigma^H > \sigma^L > 0$. This ranking implies that type-H entrants improve the productivity of labor more than type-L entrants. Therefore, incumbent firms are heterogeneous in their cost advantage. Henceforth, the time index t will be omitted unless it creates confusion.

Within each variety, the new firm and the incumbent play a Bertrand monopolistic competition game. This setup implies that the competitor with the lower marginal cost dominates the market by following a limit pricing rule, i.e., she sets her price, p_j equal to the marginal cost of the closest follower. Denoting the efficiency of the closest follower by $\tilde{q}_j$, we have

$$p_j = \frac{w}{\tilde{q}_j}. \tag{8}$$

In any product line j, the last entrant firm of type d replaces the former leader and becomes the incumbent, reaping profits π_j^d at time t. Profits are subject to tax rate τ. A firm owner collects after-tax profits at a given point in time. The firm will continue to produce over the following time interval only if it is not replaced by a new entrant. If a mass $M_{t+\Delta t}$ of projects is enacted between t and $t + \Delta t$, and each is successful with fixed probability λ, the existing firm will continue to produce with probability $1 - \lambda M_{t+\Delta t}\Delta t$. Then, given the interest rate r, the value V_j^d of owning the product line j at time t for a type d leader is given by

$$rV_j^d - \dot{V}_j^d = (1 - \tau)\pi_j^d - \lambda M V_j^d. \tag{9}$$

In this framework, incumbents are systematically replaced by more efficient entrants. This process captures Schumpeterian creative destruction and is the engine of economic growth in the model. For tractability we abstract from incumbent's dynamics. Appendix E extends the model to include innovation by incumbents as in Klette and Kortum (2004) and shows that mass and composition effects are also present in that framework.

2.4 Heterogeneous Projects

At every instant there is a continuum of projects indexed by $e \in [0, 1]$. There is a fixed cost of enacting a project of κ units of labor. An enacted project generates a new entrant with probability

λ.[5] Akin to Ateş and Saffie (2016), heterogeneity and scarcity are modeled in a way that this *ex ante* project heterogeneity is related to the *ex post* firm heterogeneity. In particular, projects are heterogeneous in their expected cost reduction, and promising ones are scarce. Every project has an unobservable idiosyncratic probability $\theta(e) = e^{\nu}$ of generating a drastic improvement on productivity, characterized by σ^H. As shown in Figure 2, the higher the index e is, the more likely it is for project e to generate a type-H innovation, and hence, the higher is the expected cost reduction. Thus, *e* is more than an index; it is a ranking among projects with respect to their idiosyncratic $\theta(e)$.

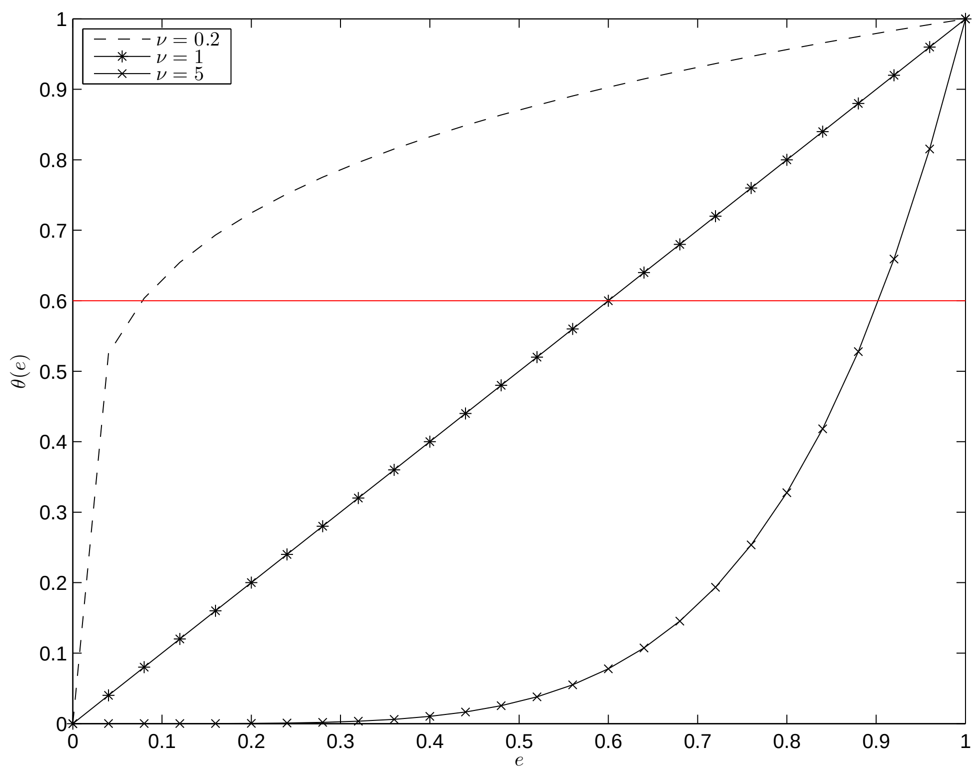


Figure 2: Project Heterogeneity

In this setting, ν governs the underlying scarcity of potential type-H firms in the economy. Figure 2 shows that for any $\bar{\theta} \in [0, 1]$, the higher the value of ν, the fewer projects with probability $\theta(e) > \bar{\theta}$ of generating a type-H firm. For example, when $\bar{\theta} = 0.6$, if $\nu = 0.2$, there is a mass 0.9 of projects that deliver a type-H firm with probability higher than 0.6, whereas when $\nu = 5$, only a mass 0.1 is above that level. Hence, ν is a measure of the shortage of projects that are likely to produce type-H firms. Lemma 1 translates the ranking of projects into a probability distribution for θ; the proof is provided in Appendix A.1.

[5] The parameter λ is not crucial for the theory. It is useful for scaling proposes in the numerical illustration. Entry is undirected in the sense that new firms land on random varieties. Because in equilibrium every entrant is indifferent, this assumption is not restrictive.

Lemma 1. *The probability distribution $f(\theta)$ is characterized by*

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

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

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

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

The empirical literature shows that good projects are scarce, indicating that $\nu > 1$.[6] The fraction of type-H firms when enacting a set $M \in (0,1]$ of projects is given by

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

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

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

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

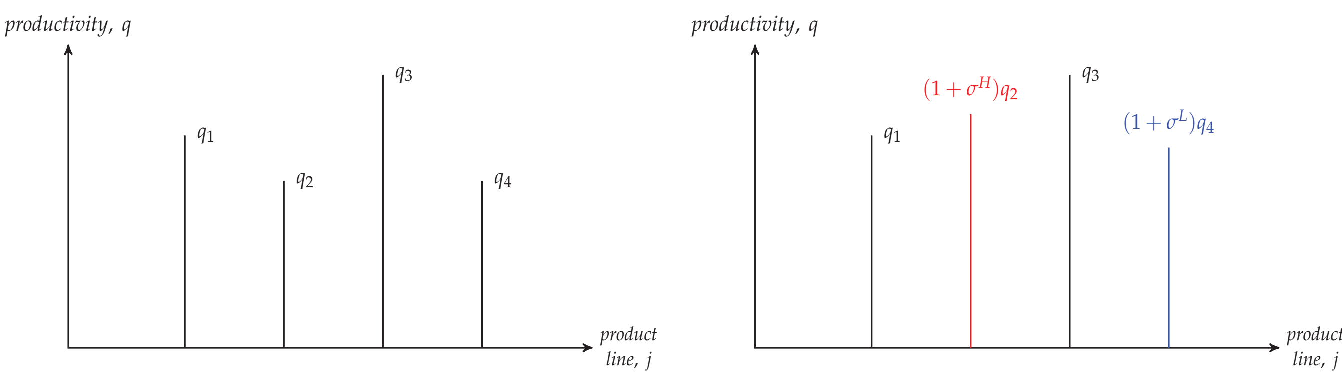
The fraction of type-H firms in the entrant cohort determines the evolution of productivity at the product line level. In fact, Equation (10) characterizes the evolution of productivity in product line j in an infinitesimal interval of time.

[6] Silverberg and Verspagen (2007) use patent data to study the skewness of the patent quality distribution proxied by citations. They find that both the distribution of citations and the return to patents are highly skewed, and that the tail index is roughly constant over time. Other firm-related variables are also documented in the literature to have *fat tails*. For instance, Moskowitz and Vissing-Jorgensen (2002) find large skewness on entrepreneurial returns. Axtell (2001) shows that the size distribution of U.S. firms closely mimics a Zipf distribution, where the probability of a firm having more than n employees is inversely proportional to n. Scherer (1998) uses German patent data to show the skewness of the distribution of profits and technological innovation.

$$q_j(t+\Delta t) = \begin{cases} \left(1+\sigma^H\right) q_j(t) & \text{w.p. } \tilde{\mu}^H(t)\,\lambda M(t)\,\Delta t \\ \left(1+\sigma^L\right) q_j(t) & \text{w.p. } \left(1-\tilde{\mu}^H(t)\right)\lambda M(t)\,\Delta t \\ q_j(t) & \text{w.p. } 1-\ \lambda M(t)\,\Delta t \end{cases}. \tag{10}$$

When a mass of $M(t)$ projects is enacted, undirected entry implies that a product line may be hit with probability $\lambda M(t)\,\Delta t$. With probability $\tilde{\mu}^H(t)$ the new firm has type H, in which case the productivity of variety j increases to $\left(1+\sigma^H\right) q_j(t)$. With complementary probability, the product line is hit by a type L entrant reaching a productivity level of $\left(1+\sigma^L\right) q_j(t)$. With probability $1-\lambda M(t)\,\Delta t$, product line j is not affected by entry so that the current incumbent continues to operate with the same productivity.

Figure 3 illustrates the changes in efficiency levels of product lines as the result of firm entry. Figure 3a shows the productivity levels of four specific varieties. Notice that the productivity in the second and fourth lines are the same. Figure 3b shows the evolution of the levels after entry takes place. The incumbent in the second line is replaced by a type-H entrant, whereas the incumbent in the fourth line is replaced by a type-L entrant. Because the proportional increase in the efficiency is larger with a high step size, the efficiency of the second incumbent surpasses the one of the fourth in the next instant.



(a) Product Lines (b) Efficiency Improvement

Figure 3: Evolution of Product Lines

2.5 The Representative Financial Intermediary

The second key innovation of this model is the introduction of a financial system that screens and selects the most promising projects. The representative financial intermediary has access to a unit mass of projects every period. It collects deposits from households, selects which projects to invest in according to their expected value, and pays back to the household the profits generated by these projects. Note that, if $V_j^H > V_j^L, \forall j$, the financial intermediary strictly prefers to enact projects with higher e. In particular, if e was observable, a financial intermediary willing to finance M projects would enact only the projects with $e \in [1-M, 1]$. However, e is unobservable. Nevertheless, the financial intermediary has access to a costless, yet imperfect, screening technology that delivers a stochastic signal $\tilde{e}$ defined by

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

The parameter $\rho \in [0,1]$ characterizes the accuracy of the screening, a reflection of the financial development of the economy, with $\rho = 1$ implying the perfect screening case. Define the expected value of successfully enacting a project with step size d as $V^d = \mathbb{E}_j\left[V_j^d\right]$. Proposition 1 shows that when the expected return of creating a type-H firm is higher than the one of creating a type-L firm, the optimal strategy is to set a cut-off for the signal. The proof is provided in Appendix A.2.

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

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

$$\begin{aligned} \tilde{\mu}^H(\bar{e}) &= \frac{1}{\lambda M}\int_0^1 \lambda \times prob(\tilde{e} \geq \bar{e}|e) \times \theta(e)\, de \\ &= \frac{1}{1-\bar{e}}\left[\int_0^{\bar{e}} (1-\rho)(1-\bar{e})\, e^{\nu} de + \int_{\bar{e}}^1 \left\{(1-\rho)(1-\bar{e}) + \rho\right\} e^{\nu} de\right] \\ &= \frac{1}{\nu+1}\left[1 - \rho + \frac{\rho}{1-\bar{e}}\left(1 - \bar{e}^{1+\nu}\right)\right]. \end{aligned} \tag{11}$$

Note that for any cut-off $\bar{e}$, the composition increases with the level of financial technology ρ and decreases with the scarcity of high type projects ν. Moreover, in terms of the resulting composition, financial selection performs at least as well as the random selection of projects. We summarize these properties in Proposition 2.[7]

Proposition 2. *The proportion of high type entrants $\tilde{\mu}^H$ exhibits the following features:*

[7] The proof is straightforward and therefore omitted.

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

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

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

The financial intermediary collects deposits $D(t)$ from the representative household in order to enact a mass $M = \frac{D}{w\kappa}$ of projects every period. Proposition 2 implies that the financial intermediary will always use its screening device.[8] Then, given $\{V^H, V^L, r, w\}$ the financial intermediary chooses $\{\bar{e}, D\}$ in order to solve

$$\max_{\{D,\bar{e}\}} \left\{ \frac{\lambda D}{w\kappa} \left[\tilde{\mu}^H(\bar{e})V^H + (1-\tilde{\mu}^H(\bar{e}))V^L\right] - D(1+r) \right.$$
$$\left. -\xi_1\left(1-\bar{e}-\frac{D}{w\kappa}\right) - \xi_2\left(\frac{D}{w\kappa}-1\right) + \frac{\xi_3}{w\kappa}D \right\} \tag{12}$$

where $\{\xi_1, \xi_2, \xi_3\}$ are Lagrange multipliers that control for the range of $\bar{e}$, and the equality of the households' deposits to the demand by the intermediary. Note that the term that multiplies the expression in brackets in the first line is the mass of projects that are enacted and turn out to be successful. The bracketed term is the expected return of the portfolio with composition $\tilde{\mu}^H(\bar{e})$. The intermediary needs to pay back D plus the interest. Because the objective function is strictly concave, the first order conditions are sufficient for optimality. In line with Proposition 2, a financial intermediary with $\rho > 0$ faces a trade-off between mass and composition of the enacted pool. Now, we examine the optimal decisions of the intermediary. First-order conditions regarding $\{D, \bar{e}\}$, respectively, yield

$$\frac{\lambda}{w\kappa}\left[\tilde{\mu}^H(\bar{e})V^H + (1-\tilde{\mu}^H(\bar{e}))V^L\right] - (1+r) + \frac{\xi_1}{w\kappa} - \frac{\xi_2}{w\kappa} + \frac{\xi_3}{w\kappa} = 0$$
$$\frac{\lambda D}{w\kappa}\left(\frac{V^H - V^L}{\nu+1}\right)\left[\frac{\rho}{1-\bar{e}}\left(\frac{1-\bar{e}^{\nu+1}}{1-\bar{e}} - (\nu+1)\bar{e}^{\nu}\right)\right] + \xi_1 = 0.$$

Note that if $\rho > 0$, then $\xi_1 < 0$ which in turn implies a positive wedge between the marginal revenue the intermediary generates and the marginal payment it needs to make to households. Therefore, the screening technology allows the intermediary to make positive profits. Furthermore,

[8] When a fixed cost is included, the partial solution exhibits a kink. In general equilibrium there is a region where the equilibrium implies not screening, another region where it always implies screening, and a third region characterized by nonexistence. An increasing and convex variable cost does not alter the results.

the unique interior solution ($\xi_2 = \xi_3 = 0$) is characterized by

$$\rho \bar{e}^{\nu} = \frac{\frac{w\kappa}{\lambda}(1+r) - V^L}{(V^H - V^L)} - \frac{1-\rho}{(\nu+1)}. \tag{13}$$

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

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

2.6 Equilibrium

Having introduced the basic components of the model, we can examine its equilibrium and balanced growth path (BGP). First, we define and characterize the equilibrium conditions, then we state the existence and uniqueness of a balanced growth path and characterize it analytically.[9]

Definition 1 (Equilibrium)**.** *A competitive equilibrium for this economy consists of quantities* $\left\{C(t),\ Y(t),\ A(t),\ \{x_j^S(t),\ x_j^D(t)\}_{j\in[0,1]},\ \{l_j^d(t)\}_{j\in[0,1]},\ D(t),\ \bar{e}(t)\right\}$*, government policy* $\{\tau, T(t)\}$*, values* $\{V_j^H(t),\ V_j^L(t)\}_{j\in[0,1]}$*, prices* $\left\{w(t),\ r(t),\ \{p_j(t)\}_{j\in[0,1]}\right\}$*, financial intermediary profits* $\Pi(t)$*, intermediate good producer's profits* $\pi_j^d(t)$*, entrants and incumbents compositions* $\{\tilde{\mu}^H(t),\ \mu(t)\}$ *and initial conditions* $\left\{A(0),\ \{q_j(0)\}_{j\in[0,1]},\ \mu^H(0)\right\}$ *such that:*

1. *Given* $\{w(t),\ r(t),\ T(t),\ \Pi(t)\}$*, household chooses* $\{C(t),\ A(t)\}$ *to solve* (1) *subject to* (2).
2. *Given* $\{p_j(t)\}$*, final good producer chooses* $\{x_j^D(t)\}_{j\in[0,1]}$ *to solve* (4) *every t.*
3. *Given* $w(t)$*, and* $q_j(t)$ *intermediate producer of good j with type d sets* $p_j(t)$ *according to* (8)*, and earns profits* $\pi_j^d(t)$*, for every t that she remains the leader in product line j.*
4. *Given* $\{V^H(t),\ V^L(t),\ r(t),\ w(t)\}$*, financial intermediary chooses* $\{D(t),\ \bar{e}(t)\}$ *to solve* (12) *every t..*

[9] The system of equations that characterizes the equilibrium is presented in Appendix A.4.

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

$$\int_0^1 l_j^d(t)dj + (1-\bar{e}(t))\kappa = L \tag{14}$$

$$A(t) = D(t) = (1-\bar{e}(t))w(t)\kappa \tag{15}$$

$$x_j^S(t) = x_j^D(t) \quad \Rightarrow \quad l_j(t)q_j(t) = \frac{Y(t)}{p_j(t)} \tag{16}$$

$$C(t) = Y(t) = e^{\int_0^1 \ln x_j(t)dj} \tag{17}$$

6. $V_j^d(t)$ *evolves accordingly to* (9), $q_j(t)$ *evolves accordingly to* (7), *and government budget is balanced every period.*

7. *The entrant's composition* $\tilde{\mu}^H(t)$ *is determined by* (11), *and the composition of the product line* $\mu^H(t)$ *evolves according to*

$$\dot{\mu}^H(t) = \lambda(1-\bar{e})\left(\tilde{\mu}^H(t) - \mu^H(t)\right).$$

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

Proposition 3. *The following apply in equilibrium:*

1. $\forall j \in [0,1]$ *and* $\forall d \in \{L,H\}$ *we have: i)* $\pi_j^d = \pi^d$*, ii)* $l_j^d = l^d$*, and iii)* $V_j^d = V^d$*.*

2. *If* $\sigma^H > \sigma^L$ *we have: i)* $\pi^H > \pi^L$*, ii)* $l^H < l^L$*, and iii)* $V^H > V^L$*.*

Proposition 3 shows that in equilibrium $V_t^H > V_t^L$, and hence, the financial intermediary uses a cut-off strategy when selecting projects. Note that more efficient leaders needs less labor to serve the demand of their variety. For concreteness, imagine a type-H leader with a follower of productivity level $\tilde{q}$. This leader will charge the same price as a type-L leader who is also followed by someone with efficiency $\tilde{q}$. Therefore, both are selling the same quantity; nevertheless, the more efficient leader needs less labor to produce that quantity and hence earns more profits. Having characterized the equilibrium, we can define the balanced growth path.

Definition 2 (BGP). *The economy is in a Balanced Growth Path at time T if it is in such an equilibrium that,* $\forall t > T$*, the endogenous aggregate variables* $\{C(t), Q(t), Y(t), A(t)\}$*, where* $Q(t) = \exp\left(\int_0^1 \ln q_j(t)\, dj\right)$ *is the average efficiency level of the economy, grow at a constant rate,* *and the threshold $\bar{e}(t)$ is constant.*

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

Theorem 1 (Existence and Uniqueness)**.** *The condition $\frac{\kappa}{L} \in [a, b]$, where $\{a, b\}$ are constants that depend on model parameters, is sufficient for the existence and uniqueness of an interior BGP for this economy.*

To sum up, this section introduced a long-run endogenous growth model that features project heterogeneity and financial selection. In this economy, good ideas are scarce and the ability of the financial intermediary to select the most promising ones is limited. These features induce a trade-off between mass and composition, as the larger the entrant cohort is, the lower the fraction of drastic innovations in the economy becomes. The next section focuses on how changes in corporate tax levels affect this margin and the long-run growth.

3 Taxes, Firm Entry, and Growth

In this section we characterize the long-run growth rate of the economy and theoretically show that mass and composition effects govern the pass-through of taxes to firm entry and aggregate growth. We also introduce a numerical example that illustrates how the degree of financial selection quality affects the strength of this pass-through.

3.1 Mass and Composition Effects

Appendix A.5 derives the following expression for output growth, which is driven by improvements in labor productivity, along the balanced growth path:

$$g(\bar{e}) = \lambda(1 - \bar{e}) \times \ln\left[(1 + \sigma^H)^{\mu^H(\bar{e})}(1 + \sigma^L)^{1-\mu^H(\bar{e})}\right]. \tag{18}$$

The economic intuition of equation (18) is clear: The long-run growth of this economy is the geometric mean of the efficiency improvement weighted by the composition of the cohort and scaled by the mass of entrants. The trade-off between mass and composition is manifested in this term. A lower standard $\bar{e}$ implies a larger pool of entrants, which increases the exponent of this term but also decreases the base through the indirect effect on composition $\mu^H(\bar{e})$. The interaction of these two margins determines the long-run growth $g(\bar{e})$.

To understand the source of the trade-off, it is useful to consider two alternative cases that the intermediary could face when investing in projects: an economy with no accuracy ($\rho = 0$) where project initialization is random, and a model with no heterogeneity ($\sigma^H = \sigma^L$) where selection is useless. In both of these cases, the expected step size of the marginal enacted project is constant with respect to the total enacted mass, destroying the trade-off between the enacted mass and its composition. In contrast, the full model is characterized by the decreasing expected step size of the marginal entrants with respect to the total entry; this tension introduces a trade-off between mass and composition in the economy. Because $\bar{e}$ is an endogenous variable, the role of mass and composition in shaping the response to taxation must be derived in general equilibrium. Proposition 4 shows the general equilibrium comparative statics to changes in the corporate tax rate τ.[10]

Proposition 4. *An economy with higher corporate tax rate τ has higher lending standards and less entry but better composition in equilibrium. Long-run growth decreases with τ:*

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

Proposition 4 shows that economies with higher corporate taxes (τ) have lower entry rates and lower long-run growth but better composition. The result that the changes in growth and entry share the same sign implies that the mass effect generated by the change in taxes dominates the composition effect. However, the fact that the change in composition has a positive sign means that it mitigates the effect of a change in entry on the growth rate, leading to a milder pass-through between entry and growth, as seen in Figure 1. The composition effect introduces nonlinearities on the relationship between credit availability and growth. In fact, in the absence of selection or heterogeneity project enaction has a constant contribution to growth. Therefore, the relationship between entry (or total credit) and growth is linear. The model presented here breaks that linearity, introducing a nontrivial relationship between entry and growth shaped by the interaction between heterogeneity, scarcity, and financial selection that characterizes the economy. The next subsection illustrates this nonlinearity with a numerical example and highlights the central role played by the accuracy of the screening technology of the financial intermediary in determining its strength.[11]

[10] The proof is provided in Appendix A.6. A similar proposition can be derived for the entry cost κ. The effect of ρ can be proved to be non-monotonic. See the working paper Ateş and Saffie (2013) for details.

[11] Similarly, an economy with higher enacting cost κ also has higher lending standards and less entry but better composition in equilibrium. The empirical findings in Section 4 also support this prediction. For a formal description and proof, see Appendix A.7.

3.2 Numerical Example

To illustrate how financial selection can explain that taxation is more detrimental for firm entry than for economic growth, we parametrize the model using values listed in Table 1. The parameters are chosen in a way that, despite the simplicity of the model, the economy is consistent with the data of the sample of developed countries that we study in Section 4.

Table 1: Parameter Values

L	λ	σ^L	σ^H	ρ	κ	υ	ν	τ
1	0.25	9.5%	45%	0.9	0.12	1.5%	5	35%

The size of the labor force is normalized to 1. The value of λ implies that one of every four projects are able to generate an actual entrant. Type-H firms increase productivity 55%, while type-L firms generate a 10.5% increase in productivity. Given the scarcity parameter ν, the underlying heterogeneity of projects suggests that one of every six projects is expected to generate a type-H firm, implying a highly skewed distribution for the probability of generating a drastic innovation. Although we explore several values, the baseline number for ρ implies that 90% of the projects are successfully screened by the financial intermediary. In line with the average statutory corporate tax for high-income economies presented by Djankov et al. (2010), we set τ to 35%. We set the discount rate of 1.5%, implying a 3.7% interest rate along the balanced growth path.

The calibrated model delivers a cut-off value $\bar{e}$ of 50%. In turn, the resulting composition in the intermediate good sector ($\mu = 31\%$) is twice the one that would prevail under random selection. The implied entry rate is 12.5%, close to the average firm entry rate observed in the United States since late 1970s, and in the empirical range for other advanced economies. Aggregate growth is 2.2%, also consistent with the real output growth of advanced economies, especially since the 1980s. The value of κ implies that the cost of starting a business is 11% of per capita income, which is in line with the Doing Business database of the World Bank that reports a business start-up cost of 9% for OECD member countries in as late as 2005. Finally, the average and the standard deviation of markups are consistent with the empirical estimation for developed economies (Dobbelaere and Mairesse, 2005; Christopoulou and Vermeulen, 2008).

Having calibrated the model, we analyze how Figure 4 shows the long-run responses of entry, composition, growth, and measure of entry elasticity of growth to changes in corporate taxation for several values of ρ. Figure 4d displays the entry elasticity of growth, defined as the ratio of the percentage change in growth to the percentage change in entry generated by a 1 percentage point increase in taxation. In particular, an elasticity smaller than one in absolute value implies that marginal increases in taxation have larger absolute marginal effects on entry than on growth.

In other words, growth responds to taxation less than entry does.[12] In line with Proposition 4, increases in marginal taxation reduce both entry and growth but improve the composition of the economy.

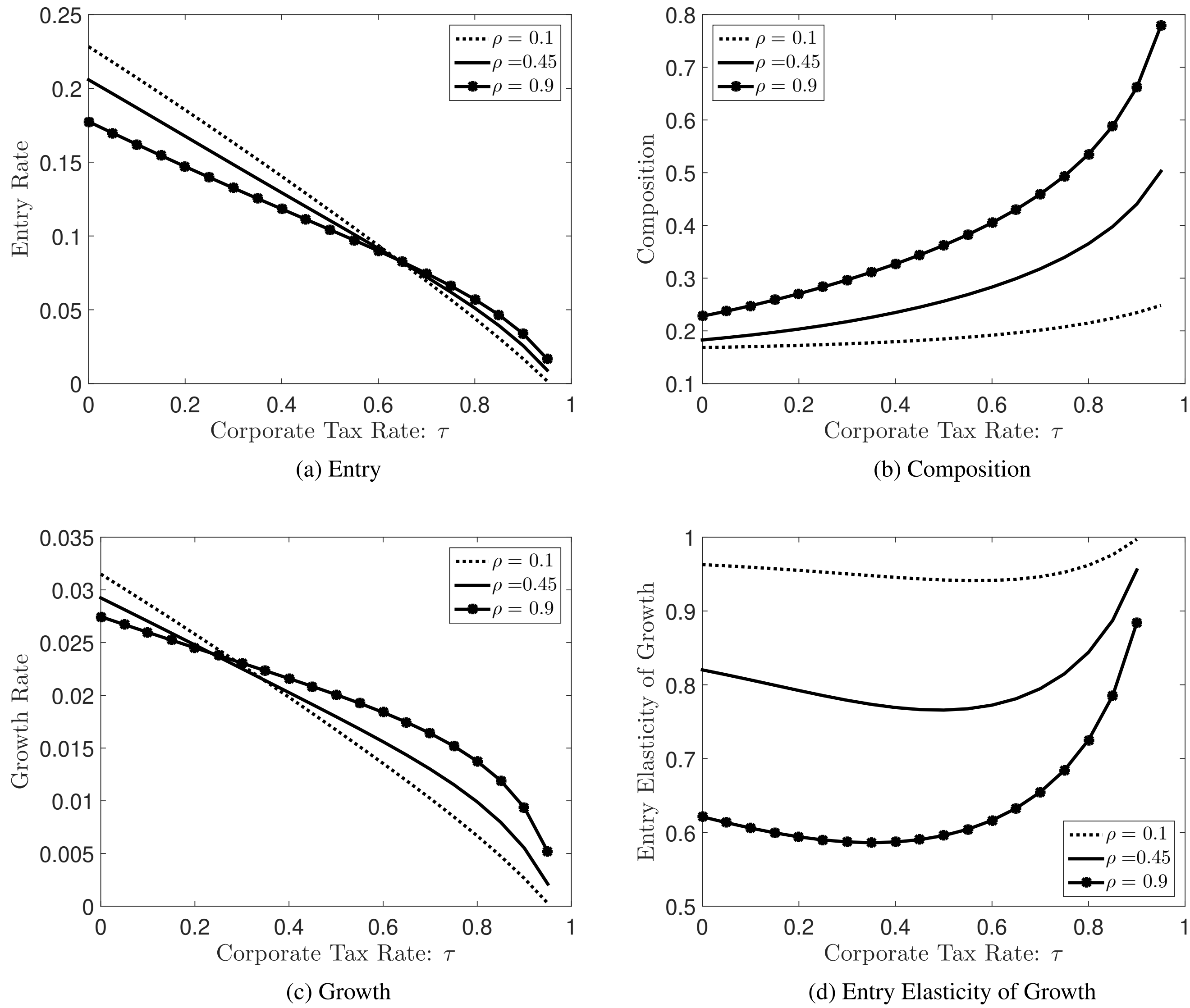


Figure 4: The Effect of Corporate Taxation on Aggregate Variables

As a benchmark, we first focus on the responses of the model when $\rho = 0.9$ (solid circled line). As Figures 4a and 4c show, the response of long-run entry and growth to changes in taxation are both highly nonlinear, yet the growth rate exhibits the strongest nonlinearity. This asymmetry in

[12] A log linear approximation of Equation 18 around the steady state shows that abstracting from changes in composition, the percentage change in growth (dg/g) is equal to a proportional change in entry as (dM/M). Therefore, the weaker-than-unit elasticity of growth to entry points to a strong dampening impact of changes in the composition margin.

the response to taxation is summarized in Figure 4d: For a wide range of tax rates, the percentage decline in the growth rate caused by a 1 percentage point increase in taxation is only 60% of the corresponding percentage decline in the entry rate. The reason for this difference is the strength of the composition effect. As seen in Figure 4b, the decrease in entry induced by higher corporate taxation implies tighter lending standards and, hence, a higher composition. In fact, financial selection implies that the contribution of the marginal entrant to growth is decreasing in entry. Therefore, the initial reductions in entry triggered by higher corporate taxation do not impose an important cost in terms of growth on this economy, which has a fairly high level of financial development. Only when the level of taxation reaches extremely high levels, with low entry rates, do the sacrificed entrants challenge the long-run growth of the economy, thus reconciling the differential effect of taxes on firm entry and growth.

Another prediction of the model is that the impact of the composition margin is stronger in economies with better financial selection. In fact, economies characterized by lower screening accuracy exhibit a higher elasticity of growth to entry, as growth and entry rates respond to changes in the tax levels more in lockstep with deteriorating screening accuracy. This result emerges because the inadequacy of the financial system in selecting better-prospect projects leads to more muted adjustments in the quality of the marginal entrant with respect to the size of the entrant cohort, thus strengthening the pass-through of the changes in the entry margin to the growth rate. Section 4 uses cross-country-industry data to show that industries that are more exposed to financial screening indeed give milder responses of entry and growth to taxation.[13]

Appendix E introduces an extended framework that captures the dynamics of innovation by the incumbent firms as well and replicates the numerical exercise in that version. While closed-form analytical expressions are not possible to derive in the extended framework, the numerical example illustrates that the intuitions discussed in this section also hold in that version. The exercise also demonstrates that the role played by the composition of incumbent firms in the pass-through of variation in taxes to growth depends on the degree of financial screening quality. We refer the reader interested in further details of the extended model to Appendix E and proceed with the empirical section, which presents new evidence supporting the theoretical predictions of the baseline model.

[13]The model can also be used to understand the effect of a corporate tax reduction. Appendix D shows how the effects of a tax reform depend crucially on the screening accuracy of the financial system.

4 Empirical Analysis

In this section, we empirically study the differential effect of taxation on firm entry and growth. We also document that higher exposure to financial selection can have a dampening role in the pass-through from taxation to entry and growth. In particular, we first present the regression results regarding the significant and negative relationship between taxation and firm entry, and a weaker one between taxation and productivity growth of countries.[14] In the second part, we show the dampening effect of higher intensity of financial selection on these relationships using cross-country cross-industry analysis.

4.1 Data

To conduct the cross-country analysis we employ two main data sources. First, we use cross-country data on effective corporate tax rates from Djankov et al. (2010). The data are based on a survey conducted jointly by the authors and the PricewaterhouseCoopers to calculate the effective tax rate of a standardized fictitious company in several countries. The data are available only for 2004, and we assume that the rates remained constant over the period between 2004 and 2007, which provides the basis for our analysis. Second, we obtain one of the main dependent variables, TFP growth across countries from Penn World Tables (version 9.1). Third, we obtain other country-level data from the World Bank databases. These data include new business density (new businesses per 1000 people) from the Doing Business Survey—the other dependent variable—along with control variables such as GDP per capita and the cost of starting a business (as a percent of GNI per capita). Another control variable, the degree of bank concentration, is obtained from the Global Financial Development database, also available from the Word Bank.

The country-industry analysis takes advantage of Eurostat databases. We measure entry as the number of new firms over the number of active firms, taken from the Business Demography Database. For the growth rate at the industry level, our main variable is growth in labor productivity, which is measured as the value added per person employed. A final key variable in our industry-level analysis is the degree of exposure to financial selection. To control for this variable, we use the financial dependence index of Rajan and Zingales (1998).[15]

[14] In the model, labor productivity growth determines the growth of aggregate output. As there is no physical capital in the model, it also happens to be the TFP growth. In the main text we present results based on cross-country TFP growth rates. Appendix C replicates the analysis using real GDP growth rates, which obtains similar findings.

[15] The index is available at the sector level only according to ISIC Revision 2 classification. To map the index to Eurostat data, we map it to NACE 1.1 classification using correspondence tables available from United Nations Statistical Division.

4.2 Country Regressions

First we study the effect of corporate taxes on firm entry and economic growth. We use the following linear regression specification at the country level:

$$Y_c = \beta_1 Tax_c + \beta_2 FinDev_c + \beta_3 StartUp_c + \beta_4 \text{log} GDPpc_c + \varepsilon_c \tag{19}$$

where the dependent variable is either the log new business density or TFP growth.[16] For Tax_c we use three variables: effective tax rates in first year of business, average effective tax rates over the first five years of business, and the statutory corporate tax rate. $FinDev_c$ refers to financial development and controls for ρ at the country level. We measure $FinDev_c$ by the average level of bank concentration over 2000 to 2004, a variable closely associated with financial screening. A lower level means higher competition among banks and thus a potentially better allocation of available funds. $StartUp_c$ controls for the average cost of starting a business (κ). We also control for countries' initial level of development by including the logarithm of real GDP per capita (log$GDPpc_c$) averaged over the period between 2000 and 2004. Table 2 presents the results of three specifications with different tax variables for each of our two dependent variables.

For both firm entry and TFP growth, we have consistent results across different tax variables used in the regressions. The results point to a negative effect of higher taxes on both dependent variables. Also consistent with economic intuition, higher costs of forming a business is detrimental for both entry and growth. Indeed, additional propositions derived in Appendix A.7 proves theoretically that the model reproduces these relationships. Although the coefficient associated with bank concentration has a negative sign, it is not significant. This result is consistent with the non-monotonic effect of ρ on growth for different tax levels at lower tax rates. In fact, as seen in Appendix E in Figure E.3c, countries with low ρ grow faster and have higher entry rates. Finally, countries with higher initial per capita income grow at a slower pace, replicating the standard observation in the economic development literature.

The main takeaway from Table 2 is that the negative effect of taxation is stronger on entry than on growth. Consider the first and fourth specifications and a hypothetical country where the dependent variables are at the mean values of the sample. The regression coefficients suggest that this country would have 2.2 new businesses per 1000 people of working age with an annual TFP growth of 1.5%. A one standard deviation rise in the tax rate (7%) would imply that these values fall to 1.03 and 1.2%, respectively. These values represent a 53% fall in entry whereas the fall in

[16] Appendix C presents the same analysis based on GDP growth rates, which we take from World Bank's World Development Indicators.

growth is 20%.[17]

Table 2: Firm Entry and TFP Growth

	Log new business density (avg. 2004-07)			TFP growth (avg. 2004-07)		
	(1)	(2)	(3)	(1)	(2)	(3)
1st year tax rate	-4.573**			-0.045		
	(1.834)			(0.036)		
5-year tax rate		-4.400**			-0.067*	
		(2.019)			(0.039)	
statutory corporate tax rate			-6.122***			-0.071**
			(1.602)			(0.033)
bank concentration (avg. 2000-2004)	-0.198	-0.150	-0.418	0.006	0.003	0.001
	(0.605)	(0.611)	(0.574)	(0.012)	(0.012)	(0.012)
start-up cost (percent of GNIpc)	-0.778*	-0.848**	-1.035***	-0.030***	-0.029***	-0.029***
	(0.406)	(0.407)	(0.355)	(0.005)	(0.005)	(0.005)
log GDPpc (avg. 2000-04)	0.444***	0.431***	0.425***	-0.008***	-0.008***	-0.008***
	(0.0981)	(0.0986)	(0.0910)	(0.002)	(0.002)	(0.002)
Constant	-2.280**	-2.124**	-0.919	0.101***	0.105***	0.112***
	(0.949)	(0.986)	(1.002)	(0.018)	(0.018)	(0.018)
Observations	66	66	66	65	65	65
Adjusted R^2	0.558	0.549	0.607	0.354	0.369	0.384

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.3 Country-Industry Regressions

Finally, we use cross-country industry-level data to document that financial selection dampens the negative effect of corporate taxation on firm entry and economic growth. In particular, we estimate the following regression to study how the effects of taxation vary with the level of exposure to the financial at the industry level:

$$Y_{ic} = \beta \left(RZ_i \times Tax_c \right) + \phi_i + \gamma_c + \varepsilon_{ic}, \tag{20}$$

where the subscripts c and i denote country and industry, respectively. As in the cross-country regressions, the two dependent variables are firm entry rate and labor productivity growth at the industry level. We use the same tax measures as previously. RZ_i denotes the degree of financial

[17] The magnitude of the decline in the entry rate is 69% of the standard deviation of the sample. The respective value for the decline in the TFP growth rate is 22%.

dependence at the industry level proposed by Rajan and Zingales (1998). In our context, this variable captures the extent of the exposure of firms to financial screening and selection.[18] We include both country (γ_c) and industry (ϕ_i) fixed effects. The former captures the effect of country-specific factors such as the corporate tax rate, level of development, entry costs, and financial development, while the latter controls for financial dependence among other industry-specific factors. Thus, the isolated effects of the individual variables that form the interaction term are taken into account by the fixed effect terms.

Table 3: Enterprise Entry and Labor Productivity Growth

	Enterprise Birth Rate			L-productivity growth		
	(1)	(2)	(3)	(1)	(2)	(3)
RZ*1st year effective tax	0.270**			0.711*		
	(0.100)			(0.355)		
RZ*5-year effective tax		0.254*			0.900**	
		(0.125)			(0.335)	
RZ*statutory tax			0.213**			0.762***
			(0.0996)			(0.262)
Constant	0.0329***	0.0342***	0.0317***	0.00558	0.00152	-0.00799
	(0.00738)	(0.00774)	(0.00783)	(0.0143)	(0.0134)	(0.0154)
country FE	Yes	Yes	Yes	Yes	Yes	Yes
industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	320	320	320	321	321	321
Adjusted R^2	0.620	0.618	0.619	0.392	0.394	0.396

Standard errors in parentheses

SE clustered at the country level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

As shown in Table 3, we obtain a positive and significant coefficient on the interaction term between taxes and financial dependence measure in all specifications. This positive term indicates that higher financial dependence provides a shield against the negative effect of corporate taxation documented in the cross-country regressions. We interpret this result as follows. As the country fixed effects control for differences in the quality of financial sectors across countries, higher dependence of firms on external finance in a given sector captures the average effect on those firms of facing more scrutiny and being subject to a more intense selection. Consistent with our model's mechanism, this relationship means that the marginal entrant is of higher quality and is more suitable to bear the tax burden. Therefore, marginal changes in taxes have a relatively weaker effect on performance measures in sectors with higher financial dependence.

[18]The details of mapping the original measure in Rajan and Zingales (1998) to Eurostat industry classification are explained in Appendix B.

5 Conclusion

This paper proposes a mechanism that rationalizes how corporate taxation can exert only mild negative effects on economic growth and, at the same time, have strong detrimental effects on firm entry. The main intuition is simple; ideas are heterogeneous and good ones are scarce. Therefore, if the financial sector allocates funds efficiently, with higher tax rates, fewer projects might get funds, but those are exactly the projects that drive economic growth.

The mechanism is formalized augmenting a quality ladder framework to firm and project heterogeneity along with imperfect selection. A mass-composition trade off arises where larger cohorts have smaller fractions of high-quality firms. Increases in taxes reduce the expected value of every project. When the financial system is better able to select the best ideas, the reduction in entry is coupled with a strong increase in the fraction of high-type firms in the economy. The composition effect dampens the effect of corporate taxation on economic growth. Empirically, cross-country cross-industry analysis confirms that taxes are less detrimental in industries that are more exposed to financial selection.

The simple framework proposed in this paper to model financial selection can be used in richer models. For instance, it provides a suitable ground for the analysis of the recurring fiscal debate on how a tax reform would affect firm dynamics and economic growth in economies, further recognizing the important role financial development may play for policy implications. Similarly, the analysis complements studies that investigate the effectiveness of fiscal policy under financial frictions (see, e.g., Fernández-Villaverde, 2010) by emphasizing the interplay between decisions of heterogeneous firms and the efficiency of the financial sector.

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APPENDIX

A Proofs

A.1 Lemma 1

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

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

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

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

Further algebraic transformations deliver

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

□

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

A.2 Proposition 1

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

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

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

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

□

A.3 Proposition 3

Proof. We start solving for the profits of the intermediate good sector. Given (6), (8), and (16), the profits of a type d firm are given by

$$\pi_{j,t}^d = l_{j,t}^d q_{j,t}\left(\frac{w_t}{\tilde{q}_{j,t}} - \frac{w_t}{q_{j,t}}\right) = l_{j,t}^d w_t \sigma^d = \frac{\sigma^d}{(1+\sigma^d)} Y_t. \tag{21}$$

Thus, $\forall j \in [0,1]\,,\ \pi_{j,t}^d = \pi_t^d$. Then, by (9), we have $\forall j \in [0,1]\,,\ V_{j,t}^d = V_t^d$. Also, as $\sigma^H > \sigma^L$, we have $\pi_t^H > \pi_t^L$, and then $V_t^H > V_t^L$. This rationalizes the equilibrium cut-off strategy of the financial intermediary. Moreover, σ^d determines the constant markup of type d leader in any product line.

The last part of equation (21) reveals that $l_{j,t}^d = l_t^d$ for all industries. Using (14) and (21), we can find the expression for the labor demand that only depends on the type of the leader, d:

$$l_t^L = \frac{(1+\sigma^H)\left[L - (1-\bar{e}_t)\kappa\right]}{1+\sigma^H - \mu_t^H(\sigma^H - \sigma^L)}; \qquad l_t^H = \frac{(1+\sigma^L)\left[L - (1-\bar{e}_t)\kappa\right]}{1+\sigma^H - \mu_t^H(\sigma^H - \sigma^L)}. \tag{22}$$

Note that $l_t^L > l_t^H$. □

A.4 The Dynamic System

From (21) and (22) we get the following expression for wages:

$$w_t = \frac{\left[1+\sigma^H - \mu_t^H(\sigma^H - \sigma^L)\right]}{(1+\sigma^L)(1+\sigma^H)\left[L - (1-\bar{e}_t)\kappa\right]} Y_t. \tag{23}$$

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

$$g_t = \frac{dY_t/dt}{Y_t} = \frac{d\ln Y_t}{dt} = \frac{d}{dt}\left[\int_0^1 \ln l_{j,t}dj + \int_0^1 \ln q_{j,t}dj\right]. \tag{24}$$

First, consider the time-derivative of the second part in the bracket. Recall that $\ln Q_t \equiv \int_0^1 \ln q_{j,t}dj$. Then $\frac{d}{dt}\left[\int_0^1 \ln q_{j,t}dj\right] = \frac{d\ln Q_t}{dt} = \lim_{\Delta t\to 0}\frac{\ln Q_{t+\Delta t}-\ln Q_t}{\Delta t}$. Solving for $\ln Q_{t+\Delta t}$ obtains

$$\begin{aligned}
\ln(Q_{t+\Delta t}) = \lambda\Delta t M_{t+\Delta t}&\left\{\tilde{\mu}^H_{t+\Delta t}\int \ln[q_{jt}(1+\sigma^H)]\,dj + \left(1-\tilde{\mu}^H_{t+\Delta t}\right)\int \ln[q_{jt}(1+\sigma^L)]\,dj\right\}\\
&+ (1-\lambda\Delta t M_{t+\Delta t})\int \ln q_{jt}\,dj\\
&\Rightarrow \frac{\ln Q_{t+\Delta t}-\ln Q_t}{\Delta t} = \lambda M_{t+\Delta t}\left\{\tilde{\mu}^H_{t+\Delta t}\ln(1+\sigma^H) + \left(1-\tilde{\mu}^H_{t+\Delta t}\right)\ln(1+\sigma^L)\right\}\\
&\Rightarrow \frac{d}{dt}\left[\int_0^1 \ln q_{j,t}dj\right] = \lambda M_t\left\{\tilde{\mu}^H_t\ln(1+\sigma^H) + \left(1-\tilde{\mu}^H_t\right)\ln(1+\sigma^L)\right\}.
\end{aligned} \tag{25}$$

We also have $\int_0^1 \ln(l_{j,t})\,dj = \mu^H_t\ln\left(l^H_t\right) + (1-\mu^H_t)\ln\left(l^L_t\right)$, therefore

$$\frac{d}{dt}\left[\int_0^1 \ln l_{j,t}dj\right] = \dot{\mu}^H_t\left[\ln\left(l^H_t\right) - \ln\left(l^L_t\right)\right] + \mu^H_t\frac{\dot{l}^H_t}{l^H_t} + (1-\mu^H_t)\frac{\dot{l}^L_t}{l^L_t} \tag{26}$$

where $\dot{x} \equiv dx/dt$ denotes the time derivative. Using (25) and (26) on (24) we get

$$g_t = \ln\left(\left[(1+\sigma^H)^{\tilde{\mu}^H_t}(1+\sigma^L)^{1-\tilde{\mu}^H_t}\right]^{\lambda(1-\bar{e}_t)}\right) + \left[\dot{\mu}^H_t\left[\ln\left(l^H_t\right)-\ln\left(l^L_t\right)\right] + \mu^H_t\frac{\dot{l}^H_t}{l^H_t} + (1-\mu^H_t)\frac{\dot{l}^L_t}{l^L_t}\right]. \tag{27}$$

Notice that the second part drops out of the equation on the balanced growth path. Finally, combining equations (3) and 17, we get the following equilibrium relationship between output growth and interest rate:

$$g_t = r_t - \upsilon. \tag{28}$$

Moreover, notice that the firm values are growing as profits do so, being proportional to the aggregate output. Normalizing them by the output and defining $v_t^d \equiv V_t^d / Y_t$ we obtain

$$
\begin{aligned}
r_t v_t^d Y_t - \frac{d}{dt}\left[v_t^d Y_t\right] &= \frac{(1-\tau)\sigma^H}{1+\sigma^H} Y_t + \lambda M_t V_t^d \Rightarrow \\
r_t v_t^d Y_t - v_t^d \dot{Y}_t - \dot{v}_t^d Y_t &= \frac{(1-\tau)\sigma^H}{1+\sigma^H} Y_t + \lambda M_t V_t^d \Rightarrow \\
r_t v_t^d - g_t v_t^d - \dot{v}_t^d &= \frac{(1-\tau)\sigma^H}{1+\sigma^H} + \lambda M_t v_t^d \Rightarrow \\
\upsilon v_t^d - \dot{v}_t^d &= \frac{(1-\tau)\sigma^H}{1+\sigma^H} + \lambda M_t v_t^d
\end{aligned}
$$

The following nine-equation dynamic system fully characterizes the equilibrium of this economy. The system is written in its stationary form, normalized by the level of final output.

$$r_t = g_t + \upsilon \tag{29}$$

$$\dot{\mu}_t^H = \lambda(1-\bar{e}_t)\left[\frac{1}{\nu+1}\left(1-\rho+\frac{\rho}{1-\bar{e}_t}\left(1-\bar{e}_t^{\nu+1}\right)\right)-\mu_t^H\right] \tag{30}$$

$$l_t^H = \frac{(1+\sigma^L)(L-(1-\bar{e}_t)\kappa)}{1+\sigma^H-\mu_t^H(\sigma^H-\sigma^L)} \tag{31}$$

$$l_t^L = \frac{(1+\sigma^H)(L-(1-\bar{e}_t)\kappa)}{1+\sigma^H-\mu_t^H(\sigma^H-\sigma^L)} \tag{32}$$

$$
\begin{aligned}
g_t = \ln&\left(\left[(1+\sigma^H)^{\tilde{\mu}_t^H}(1+\sigma^L)^{1-\tilde{\mu}_t^H}\right]^{\lambda(1-\bar{e}_t)}\right) \\
&+\left[\dot{\mu}_t^H\left[\ln\left(l_t^H\right)-\ln\left(l_t^L\right)\right]+\mu_t^H\frac{\dot{l}_t^H}{l_t^H}+(1-\mu_t^H)\frac{\dot{l}_t^L}{l_t^L}\right]
\end{aligned}
\tag{33}
$$

$$\frac{w_t}{Y_t} = \frac{(1+\sigma^H-\mu_t^H(\sigma^H-\sigma^L))}{(1+\sigma^L)(1+\sigma^H)(L-(1-\bar{e}_t)\kappa)} \tag{34}$$

$$\upsilon v_t^H = \frac{(1-\tau)\sigma^H}{1+\sigma^H} + \lambda M_t v_t^H + \dot{v}_t^H \tag{35}$$

$$\upsilon v_t^L = \frac{(1-\tau)\sigma^L}{1+\sigma^L} + \lambda M_t v_t^L + \dot{v}_t^L \tag{36}$$

$$\bar{e}_t = \left[\frac{\frac{\kappa}{\lambda}\frac{w_t}{Y_t}(1+r_t)-v_t^L}{\rho\left(v_t^H-v_t^L\right)}-\frac{1-\rho}{\rho(\nu+1)}\right]^{\frac{1}{\nu}} \tag{37}$$

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

A.5 Theorem 1

First, we characterize the system of the two fundamental equations, which defines an interior BGP.

A.5.1 The System on BGP

Note that (28) implies that the interest rate is constant along the BGP. Then, as $\gamma \geq 1$, we can collapse (9) using (21) and (28):

$$V_t^d = \frac{(1-\tau)\sigma^d}{[\upsilon + \lambda M](1+\sigma^d)} Y_t. \tag{38}$$

In an interior BGP (13) must hold, so, using (23) and (38), we obtain the following relationship:

$$\rho \bar{e}_t^{\nu} = \frac{1}{\Gamma_0}\left[\frac{(1+g+\upsilon)\left[1+\sigma^H - \mu_t^H \Delta_\sigma\right]\left(\frac{\upsilon}{\lambda} + (1-\bar{e}_t)\right)}{\frac{L}{\kappa} - (1-\bar{e}_t)} - \sigma^L(1+\sigma^H)(1-\tau)\right] - \frac{1-\rho}{(\nu+1)} \tag{39}$$

where $\Gamma_0 = (1-\tau)\Delta$ and $\Delta_\sigma = \sigma^H - \sigma^L$. The previous formula proves that indeed $\bar{e}_t$ is constant on BGP, and so is $\tilde{\mu}_t^H$, hence, $\tilde{\mu}^H = \mu^H$. Then, from (22), it follows that l_t^d is also constant. Hence, (27) becomes

$$g = \ln\left[\left(1+\sigma^H\right)^{\mu^H}\left(1+\sigma^L\right)^{1-\mu^H}\right]^{\lambda(1-\bar{e})}. \tag{40}$$

Then, the system is characterized by

$$\Gamma_0\left(\rho\bar{e}^{\nu} + \frac{1-\rho}{(\nu+1)}\right) = \frac{(1+g+\upsilon)\left[1+\sigma^H - \mu_t^H\Delta_\sigma\right]\left(\frac{\upsilon}{\lambda} + (1-\bar{e}_t)\right)}{\left[\frac{L}{\kappa} - (1-\bar{e}_t)\right]} - \sigma^L(1+\sigma^H)(1-\tau)$$
$$g = \lambda(1-\bar{e})\ln\left[\left(1+\sigma^H\right)^{\mu^H}\left(1+\sigma^L\right)^{1-\mu^H}\right]$$
$$\mu^H(\bar{e}) = \frac{1}{\nu+1}\left[1-\rho+\frac{\rho}{1-\bar{e}}\left(1-\bar{e}^{\nu+1}\right)\right].$$

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

A.5.2 Existence and Uniqueness

Preliminary Derivations

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

This implies:

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

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

$$\Lambda(\bar{e}) = \frac{(1+g+\upsilon)\left[1+\sigma^H-\mu_t^H\Delta_\sigma\right]\left(\frac{\upsilon}{\lambda}+(1-\bar{e}_t)\right)}{\left[\frac{L}{\kappa}-(1-\bar{e}_t)\right]}$$

Then we can rewrite (39) as

$$\rho\bar{e}^{\nu} = \frac{1}{\Gamma_0}\left[\Lambda(\bar{e})-(1+\sigma^H)(1-\tau)\sigma^L\right]-\frac{1-\rho}{(\nu+1)} \tag{41}$$

Note that the left-hand side of (41) is increasing in $\bar{e}$. Then, if the right-hand side of (41) is decreasing in $\bar{e}$ any interior solution must be unique. The right-hand side of (41) is decreasing if and only if $\Lambda(\bar{e})$ is decreasing. Thus, we focus on a the monotonic transformation $\ln(\Lambda(\bar{e}))$, which reads as

$$\ln(\Lambda(\bar{e})) = \ln[1+g+\upsilon]+\ln[1+\sigma^H-\Delta_\sigma\mu^H(\bar{e})]+\ln\left[\frac{\upsilon}{\lambda}+(1-\bar{e}_t)\right]-\ln\left[L-(1-\bar{e})\kappa\right].$$

Differentiating, we get

$$\begin{aligned}\frac{\partial\ln(A(\bar{e}))}{\partial\bar{e}} &= \frac{1}{1+g+\upsilon}\frac{\partial g(\bar{e})}{\partial\bar{e}} - \frac{\frac{\partial\mu^H(\bar{e})}{\partial\bar{e}}\Delta_\sigma}{1+\sigma^H-\mu^H(\bar{e})(\sigma^H-\sigma^L)} \\ &\quad - \frac{\lambda}{\upsilon+\lambda(1-\bar{e}_t)} - \frac{\kappa}{L-(1-\bar{e})\kappa}\end{aligned}$$

We have $\frac{\partial\ln(A(\bar{e}))}{\partial\bar{e}} < 0$ for all $\bar{e}\in[0,1]$. Hence, if the system composed by (39) and (40) has an interior solution, it is unique.

Existence Now we need to find sufficient conditions for the existence of $\bar{e} \in [0,1]$ that solves (41). Note that (41) is continuous in $\bar{e}$, then if the right-hand side of (39) is smaller than ρ when $\bar{e} \to 1$ and positive at $\bar{e}=0$, the existence of an interior solution is guaranteed.
The first condition will hold if

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

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

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

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

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

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

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

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

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

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

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

Then, with $\forall \frac{\kappa}{L} \in [a,b]$, we have existence and uniqueness of an interior solution. Finally, after solving for $\{e,g\}$ in equations (39) and (40), all the other variables can be recovered.

A.5.3 Recovering all Variables

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

A.6 Proposition 4

Proof. We start with the result regarding the entry rate. Derivations regarding the growth rate and the composition follow easily.

A.6.1 Entry

Preliminary Derivations Define the parameter set of the model as $\Omega \equiv \left\{\rho,\tau,\sigma^H,\sigma^L,\gamma,\nu,\upsilon,\lambda,\kappa,L\right\}$. We can rewrite equation (41) as

$$\Lambda(\bar{e},\Omega) = \Upsilon(\bar{e},\Omega) \tag{42}$$

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

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

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

$$\begin{aligned} \Lambda(\bar{e},\Omega) > 0 \quad &; \quad \Lambda_{\bar{e}}(\bar{e},\Omega) < 0 \\ \Upsilon(\bar{e},\Omega) > 0 \quad &; \quad \Upsilon_{\bar{e}}(\bar{e},\Omega) > 0 \end{aligned}$$

Then, using implicit derivative on equation (42) for $\bar{e}$ and any parameter $p \in \Omega$, we get

$$\frac{\partial \bar{e}}{\partial p} = \frac{\Lambda_p(\bar{e},\Omega) - \Upsilon_p(\bar{e},\Omega)}{\Upsilon_{\bar{e}}(\bar{e},\Omega) - \Lambda_{\bar{e}}(\bar{e},\Omega)} \Rightarrow sign\left(\frac{\partial \bar{e}}{\partial p}\right) = sign\left(\Lambda_p(\bar{e},\Omega) - \Upsilon_p(\bar{e},\Omega)\right).$$

Corporate tax rate τ

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

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

A.6.2 Growth

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

$$\frac{\partial g}{\partial \tau} = \frac{\partial g}{\partial \bar{e}}\frac{\partial \bar{e}}{\partial \tau} < 0$$

A.6.3 Composition

From previous results, it follows

$$\frac{\partial \mu^H}{\partial \tau} = \frac{\partial \mu^H}{\partial \bar{e}}\frac{\partial \bar{e}}{\partial \tau} > 0$$

□

A.7 Effect of changes in enacting cost κ

Proposition 5. *An economy with higher enacting cost κ has higher lending standards and less entry but better composition in equilibrium. Long-run growth decreases with κ:*

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

Proof. Based on derivations presented in Appendix A.6, we get

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

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

B Data

Table B.1 lists the data sources used in the empirical analysis, Table B.2 presents the summary statistics, and Table B.3 gives the list of countries and the number of industries from each of those that are included in our cross-country-industry investigation.

Table B.1: Variable Sources

Variable Name	Source	Years
Country-Level		
Log new business density, per 1000 people	World Bank, Doing Business Survey	Avg. 2004-2007
Bank concentration (%)	World Bank, Global Financial Development Database	Avg. 2000-2007
GDP growth (annual, %)	World Bank,	Avg. 2000-2004
	World Development Indicators	Avg. 2000-2004
Log GDP per capita (constant 2005, US$)	World Bank, World Development Indicators	Avg. 2000-2004
Cost of business start-up procedures (% of GNI per capita)	World Bank, World Development Indicator	Avg. 2003-2004
TFP growth rates	Penn World Tables 9.1	Avg. 2004-2007
Statutory corporate tax rate	Djankov et al. (2010)	2004
1st year tax rate	Djankov et al. (2010)	2004
5-year tax rate	Djankov et al. (2010)	2004
Industry-Level		
Financial dependence (RZ)	Rajan and Zingales (1998)	1998
Number of enterprise births/ number of active enterprises	Eurostat, Business Demography	Avg. 2004-2007
Growth of value added at factor cost	Eurostat, Structural Business Statistics	Avg. 2004-2007
Growth of gross value added per person employed	Eurostat, Structural Business Statistics	Avg. 2004-2007

Table B.2: Summary Statistics

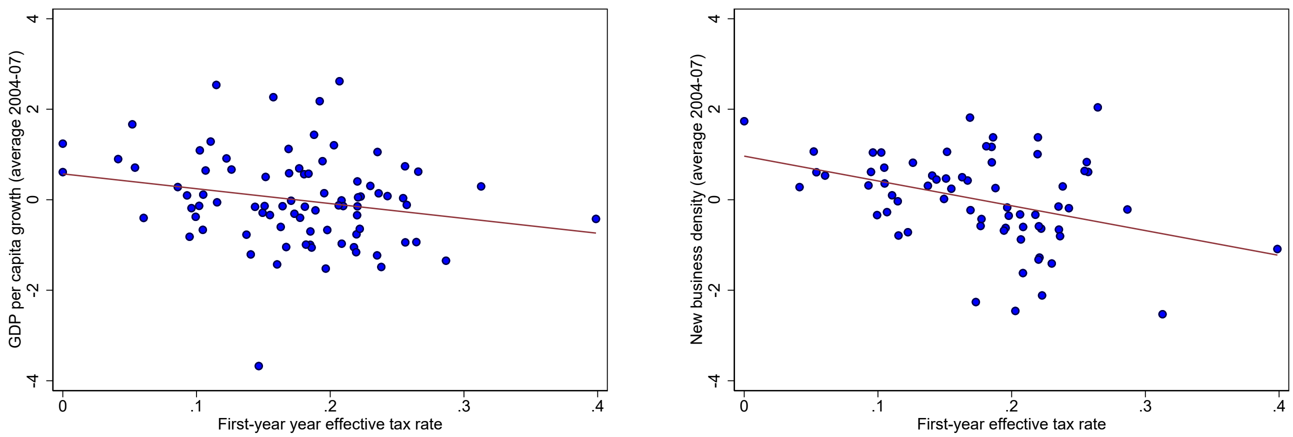
	Count	Mean	St. Dev.	25th	75th
Country-Level					
Log new business density	67	0.38	1.37	-0.48	1.25
Bank concentration	84	0.69	0.20	0.55	0.86
Annual GDP growth	84	0.05	0.02	0.03	0.06
Log GDP per capita	83	8.38	1.64	7.00	10.04
Cost of business start-up	84	0.42	0.62	0.09	0.45
Statutory tax rate	84	0.29	0.07	0.25	0.34
1st year tax rate	84	0.17	0.07	0.13	0.22
5-year tax rate	84	0.20	0.06	0.15	0.24
Industry-Level					
Financial dependence (RZ)	462	0.33	0.15	0.24	0.41
RZ * 1st year tax	378	0.05	0.03	0.02	0.07
RZ * 5-year tax	378	0.05	0.03	0.03	0.07
RZ * Statutory tax	378	0.09	0.05	0.05	0.12
Firm birth rate	360	0.07	0.04	0.04	0.09
Growth of value added	372	0.09	0.12	0.02	0.13
Growth of labor productivity	371	0.09	0.10	0.04	0.12

Constructing the variable RZ_i The level of disaggregation in our cross-country cross-industry analysis is limited by the Business Demography database of Eurostat, which is in turn based on two-digit level Statistical Classification of Economic Activities in the European Community, NACE 1.1. The original financial dependence measure of Rajan and Zingales (1998), however, is based on the three-digit level International Standard Industrial Classification, ISIC Rev.2. We map the original variable into Eurostat classification as follows. First, we use the equality between two-digit NACE 1.1 and ISIC Rev.3 classifications, which in turn can easily be mapped to four-digit level ISIC Rev.2 and be aggregated to three-digit industry level. Once this link is established, we obtain a mapping of three-digit ISIC Rev.2 industries to NACE 1.1. However, the classification used in the Business Demography data of Eurostat is not exactly NACE 1.1; in fact, some groupings in the former incorporate multiple industries from NACE 1.1. To accommodate this, we create a weighted financial dependence measure for Eurostat groupings, with the weights being determined according to the number of four-digit sectors that belong to each three-digit industry that maps to a certain Eurostat grouping.

Table B.3: Countries & Number of Industries Included

	Birth Rate	**Growth VA**	**Growth L. prod**
Austria	14	12	12
Belgium	13	14	14
Bulgaria	14	13	12
Cyprus	14	13	13
Czech Republic	14	14	14
Denmark	14	12	12
Estonia	14	14	14
Finland	14	14	14
France	14	14	14
Germany	14	14	14
Greece	14	14	14
Hungary	14	14	14
Ireland	0	12	12
Italy	14	14	14
Latvia	14	11	11
Lithuania	14	14	14
Luxembourg	12	12	12
Malta	0	11	11
Netherlands	14	14	14
Norway	14	14	14
Poland	14	14	14
Portugal	14	12	12
Romania	14	14	14
Slovakia	14	12	12
Slovenia	14	14	14
Spain	13	14	14
Sweden	14	14	14
United Kingdom	14	14	14

C Corporate Tax Reform and Financial Development



(a) Growth (b) Entry

Figure C.1: Effect of Corporate Taxes on GDP Growth and Firm Entry

Notes: For the sake of comparison, both GDP growth rates and the new business density values are normalized and standardized by the respective sample averages and standard deviations.

Table C.4: Firm Entry and GDP Growth

	Log new business density (avg. 2004-07)			GDP growth (avg. 2004-07)		
	(1)	(2)	(3)	(1)	(2)	(3)
1st year tax rate	-4.573**			-0.0910***		
	(1.834)			(0.0348)		
5-year tax rate		-4.400**			-0.118***	
		(2.019)			(0.0373)	
statutory corporate tax rate			-6.122***			-0.114***
			(1.602)			(0.0328)
bank concentration (avg. 2000-2004)	-0.198	-0.150	-0.418	-0.0185	-0.0210*	-0.0206*
	(0.605)	(0.611)	(0.574)	(0.0116)	(0.0115)	(0.0112)
start-up cost (percent of GNIpc)	-0.778*	-0.848**	-1.035***	-0.0254***	-0.0245***	-0.0265***
	(0.406)	(0.407)	(0.355)	(0.00478)	(0.00472)	(0.00456)
log GDPpc (avg. 2000-04)	0.444***	0.431***	0.425***	-0.0135***	-0.0133***	-0.0135***
	(0.0981)	(0.0986)	(0.0910)	(0.00175)	(0.00172)	(0.00170)
Constant	-2.280**	-2.124**	-0.919	0.210***	0.217***	0.229***
	(0.949)	(0.986)	(1.002)	(0.0182)	(0.0183)	(0.0195)
Observations	66	66	66	83	83	83
Adjusted R^2	0.558	0.549	0.607	0.466	0.486	0.498

Standard errors in parentheses

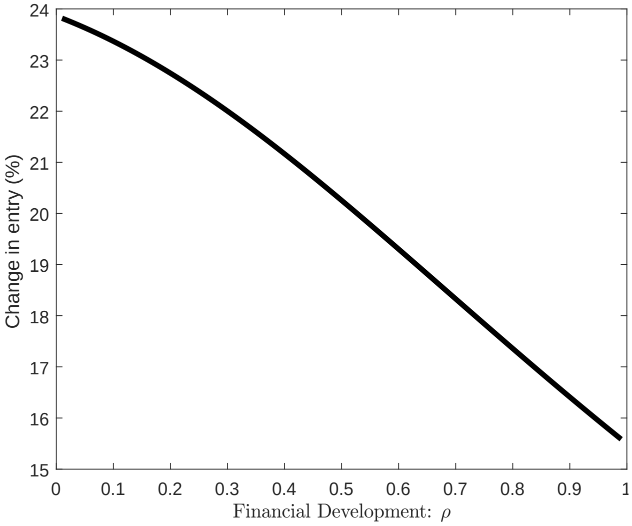
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

D Corporate Tax Reform and Financial Development

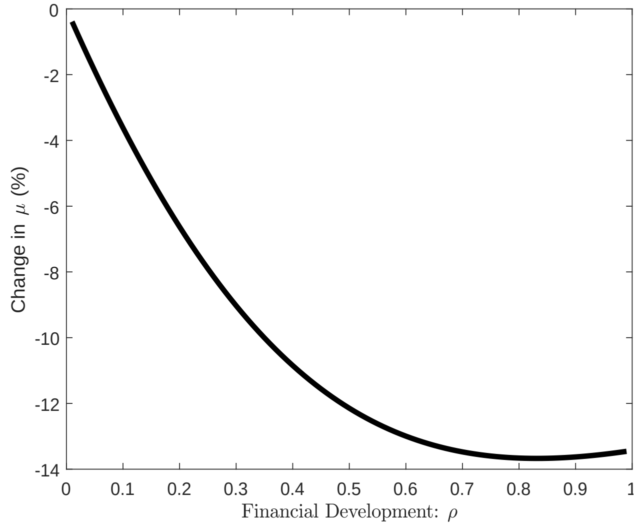
Advocates for corporate tax reductions emphasize how lower taxes can increase firm entry and accelerate growth. Moreover, even the possibility of future corporate tax reform generates increases in stock prices. Nevertheless, little attention is paid to the interaction of such a reform with the financial system of the economy. This section sheds light on this interaction through the lens of our model. Figure D.2 compares the percentage changes in composition, entry, growth, and average firm value to GDP when an economy with a given level of accuracy (ρ) reduces taxes from 35% to 20%.[19]

Panels D.2a and D.2b show that entry increases and composition decreases for every economy.

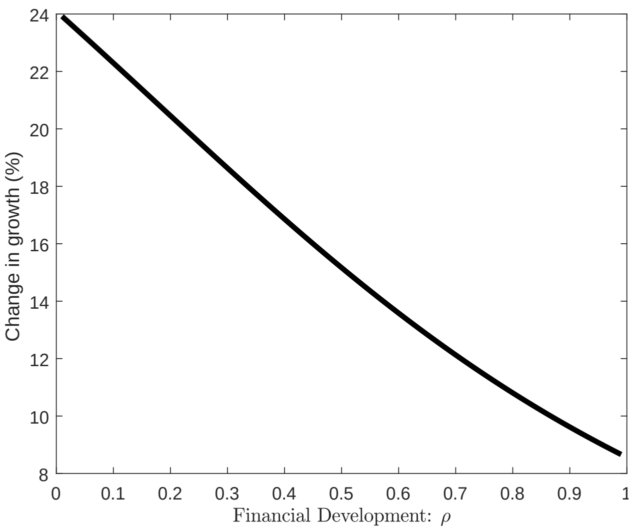
[19] All other parameters are kept at the values in Table 1.



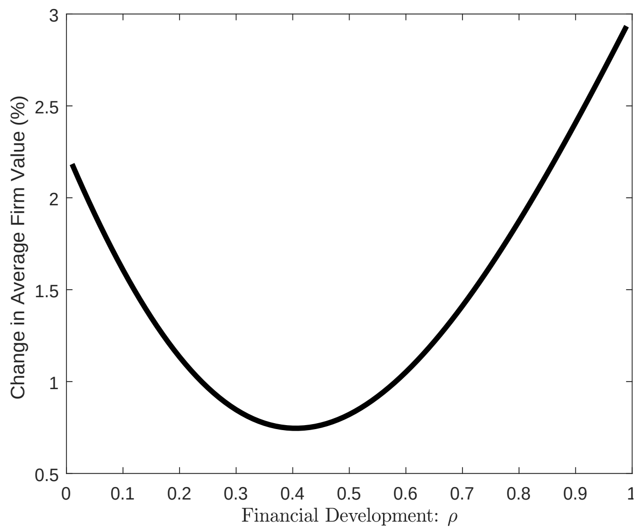
(a) Entry



(b) Composition



(c) Growth



(d) Average Firm Value

Figure D.2: Corporate Tax Reform and Financial Development

Interestingly, economies with lower screening accuracy see a milder decrease in composition and a higher increase in entry. The intuition of this result is very simple. For a given level of entry, the pool of projects that are not enacted is better for economies with lower financial screening technology. In fact, better financial systems are more likely to have already enacted the most promising projects; therefore, when they expand their lending, they draw from a lower-quality pool and decide to proportionally extend fewer new loans. The combination of both effects is shown in Panel D.2c, where we see that less-selective economies benefit more from a tax reform in terms of growth.

Panel D.2d shows the change in average firm value to GDP defined as $\frac{\mu^H V^H + (1-\mu^H) V^L}{Y}$. The tax reform is characterized by a nonlinear boom in the stock market. This U-shape is explained by two opposing forces. First, because firm values are decreasing in entry as a result of creative destruction, and because entry increases less in high ρ economies, firm values are increasing in the screening accuracy. Second, as seen in Panel D.2b, higher ρ economies have a larger drop in composition. Therefore, at low levels of screening accuracy, the increase in entry is large, causing smaller gains in firm values, but the composition decreases mildly. On the other extreme, at high levels of accuracy the decrease in composition is large while the increase in entry, and thus the negative influence in firm values, is smaller. Thus, the model predicts that the boom in stock prices should be smallest in an economy with intermediate screening accuracy.

E Extended Model

Our baseline model, which captures the entrant firm dynamics, enables us to derive analytical expressions that explain the empirical relationships between taxation, firm entry, and economic growth demonstrated in Section 4. In this section, we extend this baseline model to incorporate dynamics of incumbent firms. In particular, we follow Klette and Kortum (2004) to allow incumbent firms to invest in R&D and expand their portfolio of product lines while still retaining type heterogeneity across firms and financial selection. Although this framework restricts our ability to derive analytic results, we will show numerically that the basic promise of the baseline mechanism is at work also in this extended version.

We start with the problem of incumbent firms. In this version, an incumbent firm can own multiple product lines, reaping profits in each line of its portfolio. An incumbent invests in R&D in order to expand its portfolio by generating efficiency improvements. An efficiency improvement allows the firm to obtain a marginal cost advantage over the current incumbent of a random product line and replace it taking over the ownership of the line, in the same fashion as entry operates in the baseline model. Hiring l_r researchers, an incumbent firm obtains a Poisson arrival rate of $\mathbb{N}(n)$ of efficiency improvements, which is determined by the following Cobb-Douglas form:

$$\mathbb{N}(n) = \left(\frac{l_r}{\varphi}\right)^{\frac{1}{\xi}} n^{1-\frac{1}{\xi}}$$

with $\xi > 1$ and $\varphi > 0$. The total arrival rate depends positively on both the number of researchers hired and the number of product lines currently owned by the firm, n. The latter is a proxy for the existing knowledge capital of the firm, as labeled in Klette and Kortum (2004). The implied cost of generating $\mathbb{N}(n)$ is given by

$$R(n) = l_r w = \varphi n \left(\frac{\mathbb{N}}{n}\right)^{\xi} w.$$

Incumbents are free of any financial constraints and fund their investment out of the profit stream. Therefore, they do not need financing from the financial intermediary.

Like entrants, incumbent firms have also a type $d \in \{L, H\}$. This type is determined by the realized type of the initial project that gave birth to the incumbent firm and remains the same over the life of the incumbent. Therefore, the step size of the efficiency improvements and the resulting profits obtained in each product line are heterogeneous across incumbent firms with permanent types. Then, the value of an incumbent firm of type d that currently owns n product lines is given as[20]

$$rV^d(n) - \dot{V}^d(n) = n\pi^d - \varphi n \left(\frac{\mathbb{N}}{n}\right)^{\xi} w + \mathbb{N}\left[V^d(n+1) - V^d(n)\right] + \Phi n \left[V^d(n-1) - V^d(n)\right]$$

where Φ denotes the total creative destruction generated by the incumbent and entrant investment in R&D.[21] With the aggregate arrival rate Φ, an efficiency may hit any one of the n product lines of the incumbent and result in loss of its ownership, decreasing the size of the portfolio to $n-1$. On the other hand, the incumbent may add a new line to its portfolio with the arrival rate $\mathbb{N}$, paying the cost $R(n)$.[22] Notice that the incumbent generates π^d in all n lines it owns because any efficiency improvement it obtains has a step size σ^d. Guessing that the solution takes the form $V^d(n) = nv^d$ - which will be verified below - the optimal arrival rate the firm chooses is

$$\mathbb{N}^d = n\left(\frac{v^d}{\xi\varphi}\right)^{\frac{1}{\xi-1}} \equiv n\iota^d.$$

Here ι^d refers to the arrival intensity per product line. Notice that it is independent of the number of lines the firm currently owns, which implies that the firm generates an expansion or spin-off of any of its current lines with the same intensity. Also notice that the intensity per product line, and thus the aggregate arrival rate, are determined by firm's type d.[23]

[20]We drop the time derivative of the value function as it becomes zero in BGP.

[21]In contrast to Klette and Kortum (2004), the option value of the firm on the left-hand side includes a time derivative. This term arises because profits, and thus the firm value, vary with the level of the growing final output. The reason is that while Klette and Kortum (2004) normalize the value of total consumption, our numeraire is the aggregate price level. The time derivative is equal to gV^d in BGP.

[22]As the economy is modeled in continuous time, the arrival of multiple improvements at a given instance is a measure zero event. This feature of continuous-time modeling rules out gains or losses of multiple product lines, or any combination of those.

[23]Given a mass M of entrants starting the business, aggregate creative destruction becomes $\Phi = \lambda M + \mu^H \iota^H +$

With a mass $1-\bar{e}$ of entrant firms, the total R&D effort in the economy is given by $\lambda\left(1-\bar{e}\right)+\mu^{H}\iota^{d}+\left(1-\mu^{H}\right)\iota^{L}$, where the evolution of μ^{H} now reads as

$$\dot{\mu}^{H}=\mu^{H}+\lambda\left(1-\bar{e}\right)\left(\tilde{\mu}^{H}-\mu^{H}\right)+\mu^{H}\left(1-\mu^{H}\right)\left(\iota^{H}-\iota^{L}\right).$$

This expression shows that the share of product lines owned by H-type firms is now driven by an additional force stemming from incumbent efforts, in contrast to the baseline model.[24] The implied growth rate of the economy is now given by

$$g(\bar{e})=\lambda(1-\bar{e})\times\ln\left[(1+\sigma^{H})^{\tilde{\mu}^{H}}(1+\sigma^{L})^{1-\tilde{\mu}^{H}}\right]+\ln\left[(1+\sigma^{H})^{\mu^{H}\iota^{H}}(1+\sigma^{L})^{\left(1-\mu^{H}\right)\iota^{L}}\right].$$

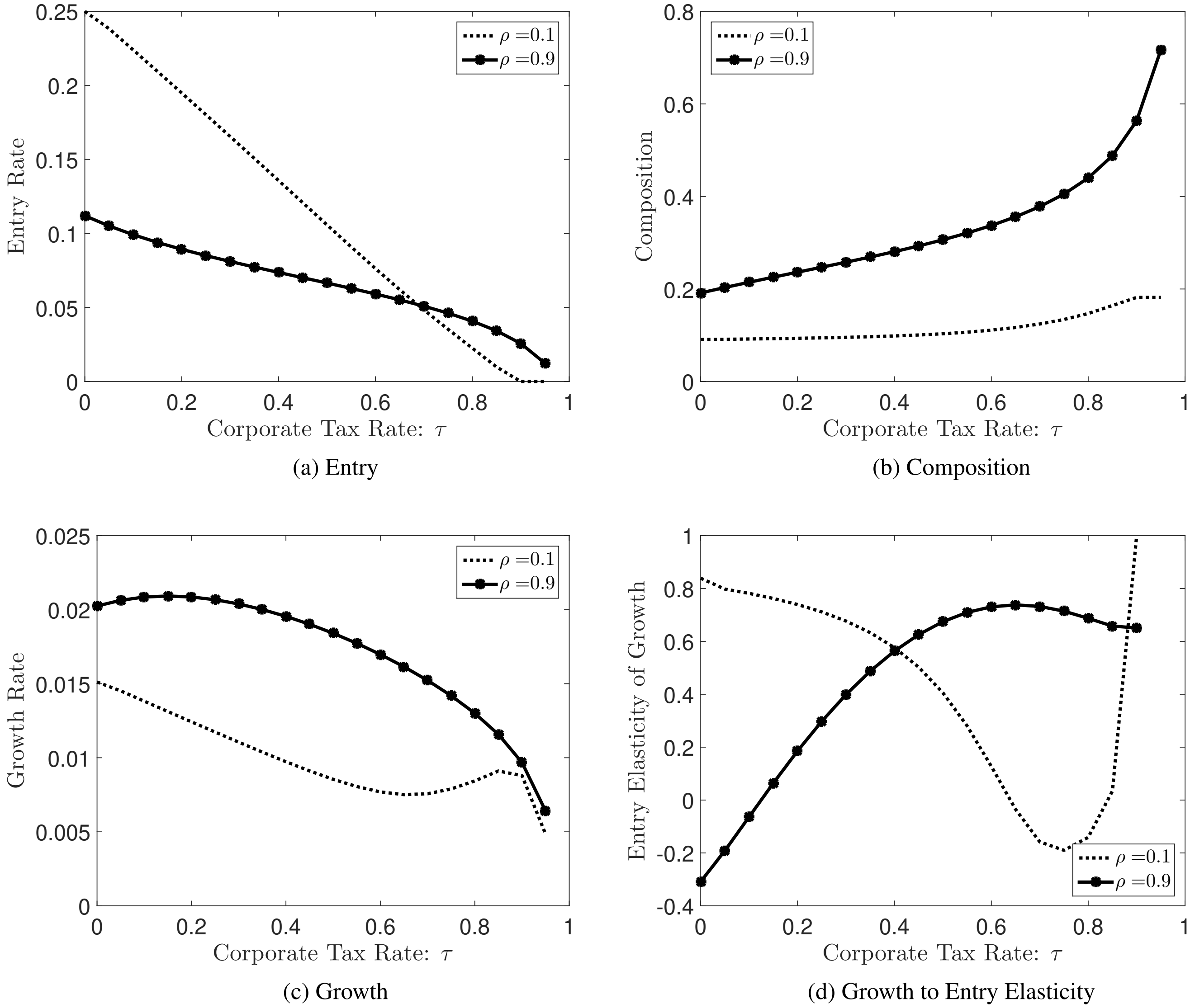
Again, incumbent effort for expansion introduces another source of growth in addition to entrants, which already existed in the baseline model. Similar to the entrant component, the expression is the logarithm of a weighted geometric average of step sizes, with the weights being the total effort by different type of firms.

Although our analytical results on the effect of taxation on firm entry still go through in this setting, deriving further analytical relationships is much more complicated. Therefore, we illustrate the properties of the model with a numerical simulation. In this numerical example we set the parameters of the model $\{\sigma_H,\sigma_L,\nu,\kappa,\varphi\}$ to $\{40.2\%,2.6\%,10,0.036,11.1\}$, keeping other parameter values as in the benchmark configuration. These parameters help the model generate reasonable aggregate values such as a growth rate of 2.2% and an entry rate of 9.5%. Moreover, the average number of establishments per firm is around 1.3, close to what is suggested by the Business Dynamics Statistics of the U.S. Census Bureau for the past four decades (1.26). Last but not least, the contribution of the entrant cohort to aggregate growth is about 40%, in line with the estimates provided by Bartelsman et al. (2009).

Focusing on the solid circled line in Figure E.3, we observe the same relationship between taxation, the entry rate, and the growth rate: The entry rate responds proportionally more to tax changes than the growth rate does (Figure E.3d) as the entry composition improves with higher taxes (Figure E.3a), mitigating the elasticity of growth to entry. Moreover, this relationship is stronger for higher levels of financial selection quality for the realistic values of corporate tax rates (less than 40%). However, we observe a clear U-shape profile of entry elasticity of growth when $\rho=0.1$, reversing the result that the composition effect is stronger for better financial selection quality at high taxation levels. This difference from the benchmark model is driven by general

$\left(1-\mu^{H}\right)\iota^{L}$, which is taken as given by incumbents. Inserting this expression together with optimal R&D efforts into the value function verifies the linearity of the value function in the number of product lines.

[24] Notice that in this framework, μ^{H} and $\tilde{\mu}^{H}$ do not necessarily become equal anymore in the balance growth path.



(a) Entry (b) Composition (c) Growth (d) Growth to Entry Elasticity

Figure E.3: The Effect of Corporate Taxation on Aggregate Variables

equilibrium effects that operate through firm dynamics, in particular the composition of incumbent firms, as shown in Figure E.4. At higher taxes, the equilibrium composition of incumbents shifts toward high types, increasing their relative contribution to aggregate growth. This change raises aggregate growth while entry is declining, decreasing the elasticity of growth to entry. However, this weaker elasticity is not a result of better entrant composition but a result of incumbent firms' own quality improvement efforts. Therefore, it would be a mistake to think that in this extended version of the model there are regions where the mass-composition trade-off in entry is stronger for lower levels of financial selection quality.

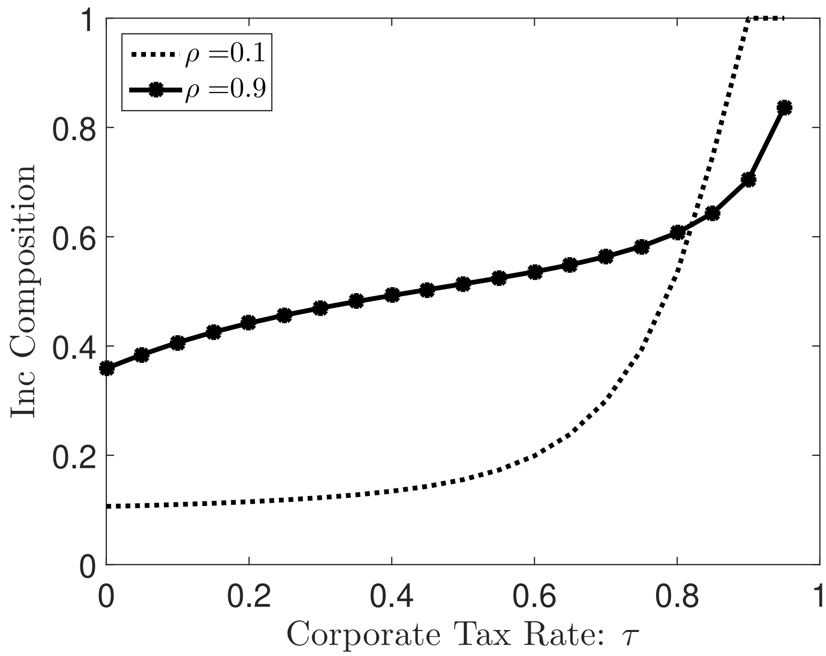


Figure E.4: The Effect of Corporate Taxation on Incumbent Composition