Financial Markets, Industry Dynamics, and Growth

Maurizio Iacopetta, OFCE (Sciences-Po) and SKEMA
Raoul Minetti,* Michigan State University Pietro F. Peretto, Duke University

April 6, 2014

Abstract

We study the impact of corporate governance frictions on growth in an economy where growth is driven both by the foundation of firms that offer new products and by the in-house investment of incumbent firms. Managers can engage in tunnelling and empire building activities at the expense of firms' shareholders. Firm founders can monitor managers on behalf of all shareholders, but can shirk on their monitoring, damaging minority shareholders. We investigate the effects of these conflicts among firms' stakeholders and financiers on both the entry of new firms and the investment of existing firms. The analysis also characterizes conditions under which the effects of corporate governance frictions on growth boost or reduce welfare.

Keywords: Endogenous Growth, Market Structure, Financial Frictions, Corporate Governance.

JEL Classification Numbers: E44, O40, G30

1 Introduction

Financial markets and corporate governance are increasingly viewed as major determinants of the long-run performance of industrialized and emerging economies. Several scholars argue that cross-country differences in growth and productivity can be attributed to a significant extent to differences in corporate governance, including the rules governing conflicts among shareholders and between shareholders and managers (Bloom et al., 2012). Recent empirical studies confirm the importance of corporate governance in the growth process (see, e.g., De Nicolo', Laeven, Ueda, 2008). The OECD (2012) summarizes this body of evidence by arguing that "corporate governance exerts a strong influence on resource allocation. It impacts upon innovative activity and entrepreneurship. Better corporate governance, therefore, both within OECD and non-OECD countries should manifest itself in enhanced corporate performance and can lead to higher economic growth."

In contrast with this broad consensus about its relevance, there is little consensus about the channels through which corporate governance affects growth. On the one hand, the advocates of

*E-mail address: minetti@msu.edu

the "rule of law" maintain that economies characterized by stronger protection of minority shareholders and managerial discipline enjoy more intense competition and better growth performance. According to this view, the inability of some emerging economies to ameliorate governance problems hinders their efforts to catch up with advanced economies. On the other hand, especially in middle-income countries, governments have often pursued financial and corporate policies that have instead accommodated the informational opacity of businesses in financial markets as well as managers' empire building attitudes. The experience of business groups – ubiquitous in middle-income countries – is paradigmatic in this respect. Many emerging countries have enacted policies that have protected business groups, allowing them to disclose limited information to financial markets. A side consequence has been that managers of large group affiliates have been able to engage in tunneling activities, diverting resources especially at the expense of minority shareholders. In addition, in the belief that large businesses would better compete in global markets, governments have often favored the appointment of managers with empire building attitudes. The advocates of these policies stress that large business group affiliates have turned out to be the engines of the rapid growth of several countries, such as Japan, Korea, Indonesia, and Thailand.[1] By contrast, their opponents maintain that these policies have forestalled competition and inhibited entrepreneurship. The impact on economic growth and the overall welfare consequences thus remain ambiguous a priori (see, e.g., Khanna, 2000, and Morck, Wolfenzon and Yeung, 2005, for a discussion).

Regardless of which view one endorses, the above discussion implies that, to understand the effects of financial and corporate governance frictions on the long-run performance of an economy, one needs to investigate how such frictions influence both entrepreneurship, that is, the ease with which new firms can enter product markets, and the speed at which incumbent firms grow. Indeed, scholars document the profound effects that corporate reforms have had on the market structure of various countries in recent decades, influencing the ease with which firms break into new markets (see, e.g., Fulghieri and Suominen, 2013, and Hyytinen, Kuosa and Takalo, 2002). And there is also established evidence that governance frictions can distort the investment decisions of incumbent firms (e.g., Aghion, Van Reenen and Zingales, 2013; Manso, 2012; Shleifer and Vishny, 1997; Morck, Wolfenzon and Yeung, 2005).[2] Clearly, analyzing how corporate governance shapes the entry of new firms and the growth of incumbent ones can also yield far-reaching insights for the current policy debate. The Great Recession has led to calls for financial and corporate reforms. Reforms that reduce uncertainty and boost the investments of incumbent firms may entail a cost in terms of more rigidity in the entry of new firms and, hence, in the market structure (Economist, 2012).

[1] Several empirical studies find that business groups exhibit higher growth rates than normal (see, e.g., Campbell and Keys, 2002, and Choi and Cowing, 1999). The empirical results about their relative profitability are instead generally ambiguous (see, e.g., Khanna and Palepu, 2000, and Bertrand, Metha and Mullainathan, 2002).

[2] There is also a vast literature, started by Schumpeter, that maintains that when investigating technological change, one should differentiate between the introduction of radically new products and technologies (radical innovations) and the process of continuous improvement of existing products and technologies (incremental innovation). Schumpeter also argued that financial markets can have a key role in shaping both margins of innovation and their interaction.

This paper takes a step towards addressing these issues. We embed imperfect corporate governance in a model economy where endogenous growth is driven both by the foundation of new firms that offer new products (the "extensive margin" of innovation) and by the improvement in the quality of the products offered by existing firms (the "intensive margin" of innovation). The economy is populated by households, firm founders, and managers. Firm founders gather funds from households to start up new firms and introduce new varieties of intermediate goods. Managers are in charge of production decisions and of investment decisions concerning the quality improvement of existing products. The critical feature of our economy consists of the presence of financial frictions, in the form of conflicts between managers and shareholders and between majority shareholders (firms founders) and minority shareholders (households). We model frictions taking a leaf from the finance literature, especially Nikolov and Whited (2013). We let managers and firm founders (majority shareholders) engage in moral hazard. In particular, as in Nikolov and Whited (2013), managers can engage in tunneling activities (divert resources) and empire building (pursue private benefits tied to firm size). Firm founders can monitor managers on behalf of all shareholders to mitigate managers' moral hazard. However, they can shirk on their monitoring role, putting little effort in monitoring managers. The incentive of majority shareholders to monitor managers depends on the equity stake they retain in firms: to induce monitoring, dispersed financiers (households) need to surrender part of the surplus to founders. Thus, firm founders extract rents from minority shareholders. This way of modelling frictions not only replicates prior studies but also matches extant evidence on the problems surrounding large businesses in middle-income countries.

We examine how corporate governance frictions affect the intensive and the extensive margin of endogenous growth as well as their interaction. The analysis reveals that both empire building and tunnelling activities exert an upward pressure on the size of firms and, on the transition path, slow down the rate of entry of new firms. This, in turn, implies that governance frictions depress the product variety. On the other hand, governance frictions boost the intensive margin of growth, increasing the rate at which incumbent firms invest in the improvement of the quality of existing products. While this comparison should not be stretched, notably these results closely match the historical experience of large business group affiliates in middle-income countries. For instance, prior static partial equilibrium studies suggest that the agency costs structure of Korean chaebol firms prompted them to pursue faster growth (see, e.g., Bebchuk, Kraakman and Triantis, 1999; Lee, 2000).

Based on these results, the net welfare impact of an increase in governance frictions is ambiguous a priori: the impact trades off the welfare-worsening effect due to the increase in market concentration with the welfare-enhancing effect due to faster growth of incumbent firms. To better grasp this trade-off, consider an increase in the severity of the tunnelling problem, such that managers can divert more resources from firms. This shrinks the returns that can be pledged to dispersed financiers (households), deterring firm entry. In equilibrium, this implies that firms' size grows larger, which in turn stimulates the investment in quality of incumbent firms. Interestingly, when we calibrate corporate governance parameters in line with the empirical findings of Nikolov and

Whited (2013), we obtain that the welfare benefit associated with the faster growth of incumbent firms tends to outweigh the welfare cost associated with the lower dynamism on the entry margin. However, for higher values of

The analysis further reveals rich interactions between the two types of governance frictions, identifying conditions under which the frictions on the two margins of growth reinforce or mitigate each other. There is a growing literature on the role of financial markets in the growth process. Yet, little is known about the role of corporate governance frictions, especially when we take the market structure of the economy into account. Despite early attempts and calls for more research, more notably in Aghion and Howitt (1998), theoretical work on how corporate governance affects growth has lagged behind the policy-oriented debate. With this paper, we hope to make a first step toward filling the gap.

We model growth borrowing from ideas that researchers have used over the last twenty years to extend the domain of applicability of the original models of endogenous growth to include endogenous market structure and to solve some empirical difficulties exhibited by the early models. On the first point, see the discussions in Peretto (1996, 1999) and the recent survey by Etro (2009). On the second point, as is well known, first-generation endogenous growth models feature a positive relation between aggregate market size and growth that results in a positive relation between the scale of aggregate economic activity and the growth rate of income per capita. Several contributions proposed solutions based on product proliferation: Peretto (1998, 1999), Dinopoulos and Thompson (1998), Young (1998), and Howitt (1999). This version of Schumpeterian theory has recently received empirical support in Ha and Howitt (2007), Laincz and Peretto (2006), Sedgley (2006), Madsen (2008) and Ulku (2007).[3]

The main strength of the latest vintage of Schumpeterian models is that they sterilize the scale effect through a process of product proliferation that fragments the aggregate market into submarkets whose size does not increase with the size of the workforce. This approach allows one to introduce population growth and elastic labor supply without generating counterfactual behavior of the growth rate. It also implies that fundamentals and policy variables that work through the size of the aggregate market have no growth effects, whereas fundamentals and policy variables that reallocate resources between vertical (quality/productivity) and horizontal (variety) innovation do have long-run growth effects.

The remainder of the paper is organized as follows. Section 2 presents the model. Section 3 characterizes the dynamics of the economy while Section 4 solves for the steady state. In Section 5, we investigate the response of the economy to shocks in the intensity of corporate governance frictions. Section 6 concludes. The proofs of the model and details about the numerical experiments are relegated to the Appendix.

[3] See Aghion and Howitt (1998, 2006), Dinopoulos and Thompson (1999), Jones (1999), Peretto and Smulders (2002) for reviews of the various approaches and of the early empirical evidence.

2 The model

The economy is closed. There is a final good and a continuum of non-durable intermediate goods. To keep things simple, there is no physical capital. All variables are functions of (continuous) time but to simplify the notation we omit the time argument unless necessary to avoid confusion.

2.1 Households

The economy is populated by a continuum of households of mass $L = L_0 e^{\lambda t}$, $L_0 \equiv 1$. A household supplies labor and trades assets in competitive markets. A household can also provide managerial services or act as a firm founder. The representative household has preferences

$$U(t) = \int_t^\infty e^{-(\rho-\lambda)s} \log\left(\frac{C(s)}{L(s)}\right) ds, \quad \rho > \lambda \geq 0 \tag{1}$$

where t is the point in time when the household makes decisions, ρ is the individual discount rate, and C is consumption. Since each household is endowed with one unit of time, L is the total endowment of labor. Each household supplies labor inelastically and thus faces the flow budget constraint

$$\dot{A} = rA + wL + R - C, \tag{2}$$

where A is assets holding, r is the rate of return on assets and w is the wage. The term R denotes the income that the household receives from the provision of managerial services or from the activity of firm inception. The intertemporal consumption plan that maximizes (1) subject to (2) consists of the Euler equation

$$r = \rho - \lambda + \dot{C}/C, \tag{3}$$

the budget constraint (2) and the usual boundary conditions.

2.2 Final producers

A competitive representative firm produces a final good Y that can be consumed, used to produce intermediate goods, invested in the improvement of the quality of existing intermediate goods, or invested in the creation of new intermediate goods. The final good is the numeraire so its price is $P_Y \equiv 1$. The technology for the production of the final good is

$$Y = \int_0^N X_i^\theta \left[Z_i^\alpha Z^{1-\alpha} \frac{L}{N^{1-\sigma}} \right]^{1-\theta} di, \quad 0 < \theta, \alpha < 1 \tag{4}$$

where N is the mass of intermediate goods, X_i is the quantity of intermediate good i, and L is labor. Given the inelastic labor supply of the household and the one-sector structure of the model, labor market clearing yields that employment in the final sector is equal to population size. Quality is the ability of a good to raise the productivity of the other factors: the contribution of good i depends on its own quality, Z_i, and on the average quality, $Z = \int_0^N (Z_j/N)\, dj$, of intermediate goods. Social returns to quality are equal to 1. The parameter σ measures instead social returns to variety. The first-order conditions for the profit maximization problem of the final producer yield that each intermediate producer faces the demand curve

$$X_i = \left(\frac{\theta}{P_i}\right)^{\frac{1}{1-\theta}} Z_i^{\alpha} Z^{1-\alpha} \frac{L}{N^{1-\sigma}}, \tag{5}$$

where P_i is the price of intermediate good i. The first-order conditions then yield that the final producer pays total compensation

$$\int_0^N P_i X_i di = \theta Y \quad \text{and} \quad wL = (1-\theta) Y \tag{6}$$

to intermediate goods and labor suppliers, respectively.

2.3 Intermediate producers

The typical firm producing an intermediate good i operates a technology that requires one unit of final good per unit of intermediate good and a fixed operating cost $\phi Z_i^{\alpha} Z^{1-\alpha}$, also in units of final good. The firm can increase the quality of its intermediate good according to the technology

$$\dot{Z}_i = I_i, \tag{7}$$

where I_i is investment in quality, in units of final good. Using (5), the firm's gross profit (i.e., the profit before investment expenditure) is

$$\Pi_i = \left[(P_i - 1)\left(\frac{\theta}{P_i}\right)^{\frac{1}{1-\theta}} \frac{L}{N^{1-\sigma}} - \phi\right] Z_i^{\alpha} Z^{1-\alpha}. \tag{8}$$

It is useful to consider the problem of an intermediate firm in a benchmark economy without financial and governance frictions. At time t, absent such frictions, the intermediate firm would choose for $s \in [t, \infty)$ paths of the product's price, $P_i(s)$ and investment, $I_i(s)$, so to maximize

$$\widetilde{V}_i(t) = \int_t^{\infty} e^{-\int_t^s r(v)dv} \left[\Pi_i(s) - I_i(s)\right] ds \tag{9}$$

subject to (7) and (8), and taking the paths of the interest rate, $r(s)$, and of average quality, $Z(s)$, as given.

Next, we need to specify the process of formation of intermediate firms. At time t, a household member who wants to found a new firm has to sink $\beta X(t)$ units of final good. Because of this sunk cost, the new firm cannot supply an existing good in Bertrand competition with the incumbent monopolist but must introduce a new good that expands product variety. New firms enter at the average quality level, and therefore at average size (this simplifying assumption preserves symmetry of equilibrium at all times). We let a founder (henceforth, also majority shareholder) finance a share $1-\gamma$ of the entry cost $\beta X(t)$ and borrow the funds to cover the remaining portion of the entry cost from other household members (henceforth, also minority shareholders).

2.4 Financial and governance frictions

We depart from a frictionless environment by allowing for financial and governance frictions. The goal of our analysis is to study how such frictions affect economic growth by influencing firms' production and investment decisions as well as market structure. Specifically, we are interested in capturing conflicts of interest between managers and shareholders on one side and between large (majority) and dispersed (minority) shareholders on the other side. To this end, we posit that the investment and production decisions of each intermediate firm are made by a manager who maximizes his own objective function, which needs not be aligned with the objective function of the shareholders of the firm. The decisions of a manager can be monitored by the founder ("majority shareholder") of the intermediate firm. However, we posit that, in turn, the firm founder cannot commit vis-à-vis the households providing the funds for setting up the firm (dispersed financiers or "minority shareholders"). As detailed below, we are interested in capturing two types of frictions: a "tunnelling" problem, such that managers and majority shareholders can siphon off resources from intermediate good firms; and an "empire building" problem such that managers derive private benefits from expanding the size of firms. These are the two frictions considered by Nikolov and Whited (2013) when modelling corporate governance issues. Most importantly, they are the frictions that have allegedly characterized the experience of several middle income countries in recent decades (see, e.g., Khanna, 2000; Morck, Wolfenzon and Yeung, 2005; Campbell and Keys, 2002; Choi and Cowing, 1999).

2.4.1 Managers' problem

Let the net profit generated by an intermediate firm be

$$\Pi_i^N \equiv (P_i - 1)\, X_i - \phi Z_i^{\alpha} Z^{1-\alpha} - I_i. \tag{10}$$

Following the corporate governance literature (see, e.g., Nikolov and Whited, 2013), we let the compensation package of a manager consist of two components: a share of the firm's profits and a portion of profits he diverts from the firm (tunneling). Formally, the manager owns a share, $m_i \geq 0$, of the company and steals a fraction $\Sigma_i (M_i, S_i)$ of the net profit Π_i^N, where S_i is the manager's effort in tunneling activities and M_i is the effort of the firm's founder in monitoring the manager. We assume $\partial \Sigma_i (M_i, S_i) / \partial M_i < 0$ and $\partial \Sigma_i (M_i, S_i) / \partial S_i > 0$. The cost of engaging in tunneling is $c^S(S_i) \cdot \Pi_i^N$ in units of final good, where the function $c^S(S_i)$ satisfies $\partial c^S(S_i)/\partial S_i > 0$, $\partial^2 c^S(S_i)/\partial S_i^2 \geq 0$.

As in Nikolov and Whited (2013), on top of the conflicts with shareholders stemming from his tunneling activity, the manager's objectives can also depart from the shareholders' objectives due to an innate taste of the manager for building empires. We model such an empire building motive by letting the manager have a preference for the firm's gross volume of earnings. In particular, we write the manager's utility flow as

$$\left[m_i\left(1-\Sigma_i\left(M_i,S_i\right)\right)+\Sigma_i\left(M_i,S_i\right)-c^S(S_i)\right]\cdot\Pi_i^N+\ \left[m_i\left(1-\Sigma_i\left(M_i,S_i\right)\right)+\Sigma_i\left(M_i,S_i\right)-c^S(S_i)\right]\cdot\Omega P_iX_i \tag{11}$$

Thus, a manager derives an extra utility from the flow of gross earnings P_iX_i (here, proxying for the firm's size), irrespective of the costs sustained.[4] When the parameter Ω is positive it captures the intensity of the empire building motive. When $\Omega<0$ it means that there are private costs the managers faces as the firm becomes larger and larger. In section () we will show that if Ω is sufficiently small (and negative) the moral-hazard issues may wash out altogether. In what follows we assume that $\Omega>0$.

At time t, given the path of monitoring of the founder, $M_i\left(s\right)$, and the path of his shareholding, $m_i\left(s\right)$, for $s\in[t,\infty)$, the manager chooses the paths $S_i\left(s\right)$, $P_i(s)$, $I_i(s)$, to maximize

$$\int_t^{+\infty}e^{-\int_t^s r(v)dv}\left[m_i\left(1-\Sigma_i\left(M_i,S_i\right)\right)+\Sigma_i\left(M_i,S_i\right)-c^S(S_i)\right]\left[\Pi_i^N+\Omega P_iX_i\right]ds.$$

This expression makes explicit that the objective of the manager is not the maximization of the value $\widetilde{V}_i\left(t\right)$ defined in equation (9) above. By contrast, he forms the following Hamiltonian

$$H_i=\left[m_i\left(1-\Sigma_i\left(M_i,S_i\right)\right)+\Sigma_i\left(M_i,S_i\right)-c^S(S_i)\right]\cdot\left[\Pi_i^N+\Omega P_iX_i\right]+q_iI_i,$$

where q_i is the shadow value of the marginal increase in quality. The first-order conditions with respect to P_i, I_i, Z_i and S_i are (dropping the s index of calendar time for simplicity):

$$\left[m_i\left(1-\Sigma_i\left(M_i,S_i\right)\right)+\Sigma_i\left(M_i,S_i\right)-c^S(S_i)\right]\cdot\left[\frac{\partial\Pi_i^N}{\partial P_i}+\Omega\frac{\partial\left(P_iX_i\right)}{\partial P_i}\right]=0; \tag{12}$$

$$\left[m_i\left(1-\Sigma_i\left(M_i,S_i\right)\right)+\Sigma_i\left(M_i,S_i\right)-c^S(S_i)\right]\cdot\frac{\partial\Pi_i^N}{\partial I_i}+q_i=0; \tag{13}$$

$$\left[m_i\left(1-\Sigma_i\left(M_i,S_i\right)\right)+\Sigma_i\left(M_i,S_i\right)-c^S(S_i)\right]\cdot\frac{\partial\Pi_i^N}{\partial Z_i}=-\dot{q}_i+rq_i; \tag{14}$$

$$\frac{\partial\left[m_i+\left(1-m_i\right)\Sigma_i\left(M_i,S_i\right)-c^S(S_i)\right]}{\partial S_i}\cdot\Pi_i^N=0. \tag{15}$$

A useful property of this system of conditions is that the first three can be solved for given S_i (the manager's tunneling effort), while the fourth yields the optimal decision about S_i given the value of the net profit Π_i^N generated by the triple P_i, I_i, Z_i. In other words, in our setup the decisions about P_i, I_i, Z_i and S_i are separable. The triple P_i, I_i, Z_i drives the evolution of the net profit, the decision about S_i drives the evolution of the share of net profit that the manager diverts.

In what follows, to compress notation, it is useful to define

$$\Phi_i\equiv m_i\left(1-\Sigma_i\left(M_i,S_i\right)\right)+\Sigma_i\left(M_i,S_i\right)-c^S(S_i). \tag{16}$$

[4] For computational tractability, we let the size preference of the manager be proportional to the portion of gross earning effectively accruing to him.

The first-order condition with respect to P_i yields

$$P_i = \frac{1}{1+\Omega}\frac{1}{\theta}. \tag{17}$$

This condition highlights the incentive that the manager has to underprice the intermediate good relative to the frictionless monopoly value $1/\theta$ in order to increase the size of the firm. Combining this result with the conditions for I_i and Z_i (and anticipating that Φ_i is constant), we obtain an expression that describes the rate of return to investment in quality:

$$r_Z = \alpha\left[\left(\frac{1}{1+\Omega}\frac{1}{\theta}-1\right)\frac{X_i}{Z_i} - \phi\left(\frac{Z}{Z_i}\right)^{1-\alpha}\right]. \tag{18}$$

This expression makes clear the distortion in the quality investment due to the manager's preference for current gross earnings. This distortion results in a gross profit margin $(P_i - MC)/MC = (P_i - 1)$ that is smaller than the frictionless one, $\left(\frac{1}{\theta}-1\right)$.[5] To ensure that the pricing decision is economically meaningful, we impose the restriction $\theta(1+\Omega) < 1$.

The first-order condition for S_i says that the manager sets the marginal benefit of his tunneling effort equal to its marginal cost,

$$(1-m_i)\frac{\partial \Sigma_i(M_i,S_i)}{\partial S_i} = \frac{\partial c^S(S_i)}{\partial S_i}. \tag{19}$$

The marginal benefit is given by the marginal increase in the net profit that the manager diverts from the share $1-m_i$ that the ownership structure allocates to the shareholders. This says that a higher share m_i in the firm discourages managerial moral hazard because the manager would merely make costly effort to steal from himself. Thus, m_i is a first tool through which the manager's objectives can be better aligned with shareholders' objectives.

2.4.2 Founders' problem

The founder of an intermediate firm can monitor and mitigate the misbehavior (tunneling) of the firm's manager.[6] To capture conflicts between majority and minority shareholders, we posit that the founder maximizes his own expected utility, rather than the total value of the firm. Put differently, majority shareholders cannot commit to a given level of monitoring but must be provided with incentives to monitor through the participation to the profits of the firms.

We assume that the cost of monitoring is $c^M(M_i)\cdot\Pi_i^N$ in units of final good and the monitoring cost function $c^M(M_i)$ has the same properties as $c^S(S_i)$. At time t, given the paths $S_i(s)$, $P_i(s)$, $I_i(s)$ and $f_i(s)$ for $s \in [t,\infty)$, the founder chooses the path of monitoring $M_i(s)$ to maximize

$$\int_t^{+\infty} e^{-\int_t^s r(v)dv}\left[f_i(s)\left[1-\Sigma_i(M_i,S_i)\right] - c^M(M_i(s))\right]\Pi_i^N(s)ds.$$

[5] Interestingly, this is in line with the finding of some empirical papers that, controlling for market structure and other factors, empire building motives tend to depress firm profitability.

[6] For simplicity, the founder cannot interfere with the distortions directly arising from the manager's empire building motive.

The first-order condition with respect to M_i is

$$\frac{\partial\left[f_i\left[1-\Sigma_i\left(M_i,S_i\right)\right]-c^M(M_i)\right]}{\partial M_i}\cdot\Pi_i^N=0,$$

which becomes

$$-f_i\frac{\partial\Sigma_i\left(M_i,S_i\right)}{\partial M_i}=\frac{\partial c^M(M_i)}{\partial M_i}. \tag{20}$$

This conveys a similar intuition as the condition for the manager. The share f_i of equity in the hands of the founder determines the extent to which the founder makes an effort to monitor and prevent the manager's tunneling.

2.4.3 Minority shareholders' problem

We think of (19) and (20) as reaction functions that at time $s\geq t$ yield a Nash equilibrium $\left(M_i^*\left(m_i\left(s\right),f_i\left(s\right)\right),S_i^*\left(m_i\left(s\right),f_i\left(s\right)\right)\right)$ as the solution of the pair of equations (dropping the s index of calendar time for simplicity)

$$\begin{aligned}(1-m_i)\frac{\partial\Sigma_i\left(M_i\left(m_i,f_i\right),S_i\left(m_i,f_i\right)\right)}{\partial S_i} &= \frac{\partial c^S(S_i)}{\partial S_i},\\ -f_i\frac{\partial\Sigma_i\left(M_i\left(m_i,f_i\right),S_i\left(m_i,f_i\right)\right)}{\partial M_i} &= \frac{\partial c^M(M_i)}{\partial M_i}.\end{aligned}$$

Given the assumptions on the function $\Sigma_i\left(M_i,S_i\right)$, these two equations yield a pair $\left(M_i^*,S_i^*\right)$ that depends on the equity shares of manager and founder m_i, f_i.

We now turn to the decisions of the financiers (dispersed shareholders) at the foundation stage of a firm. The financiers' only decision is about the paths $m_i(s)$ and $f_i(s)$ of the ownership shares to be allocated to the manager and to the founder in order to induce the behavior that maximizes the value of their stake in the firm.[7] We consider an arrangement whereby the shares are chosen at the foundation time, t, and are not altered afterwards. This implies that $M_i^*(s)$ and $S_i^*(s)$ are constant for all $s\geq t$. The financiers' objective is to maximize

$$[1-m_i(t)-f_i(t)]\cdot V_i(t),$$

subject to the participation constraint

$$\gamma\beta X\left(t\right)\leq\left[1-f_i\left(t\right)-m_i\left(t\right)\right]V_i(t), \tag{21}$$

where on the right-hand side $V_i(t)$ is the value of the new firm (specified below) and $1-f_i\left(t\right)-m_i\left(t\right)$ is the ownership share that the contract allocates to the dispersed financiers. On the left-hand side $\beta X\left(t\right)$ is the technological cost of entry that the financiers fund, and γ is the fraction paid by the shareholders. The remaining fraction of the cost $(1-\gamma)$ is paid by the monitor agent, who, in

[7] Although perhaps extreme, this feature can reflect the slow adjustment that characterizes firms' ownership structure.

virtue of his role, is able to appropriate a share f of the value of the firm. The monitor agents's participation constraint is

$$(1-\gamma)\beta X(t) \leq f V_i(t) - \Lambda(t),$$

where $\Lambda(t)$ are the present and future monitoring costs incurred privately by the financier. The value of the firm is

$$V_i(t) = \left[1 - \Sigma_i\left(M_i^*\left(m_i(t), f_i(t)\right), S_i^*\left(m_i(t), f_i(t)\right)\right)\right] \cdot \int_t^{+\infty} e^{-\int_t^s r(v)dv} \Pi_i^N(s) ds.$$

We again see the discrepancy between the objective of the financiers and that of the manager. Since the financiers take the path $M_i(s)$, $S_i(s)$, $P_i(s)$, $I_i(s)$, $Z_i(s)$, $Z(s)$, $X_i(s)$ as given, and thus take the whole integral on the right-hand side as given, the problem reduces to optimizing the function with respect to the quotas m_i and f_i. The managers tunnel the present and future resources stripped from the intermediate producer in an entity to which we will refer as "shell" company. For simplicity, we assume that all tunneling costs are privately incurred by the manager. Because the manager expects to extract a constant fraction $0 \leq \Sigma_i < 1$ of the net profit of the firm, the value of the shell is

$$V_i^S(t) = \frac{\Sigma_i}{1-\Sigma_i} V_i.$$

Equity shares in intermediate firms are the only assets of this economy. Therefore, the overall wealth of the households at time t equals

$$A(t) = \int_0^N \left(1 + \frac{\Sigma_i}{1-\Sigma_i}\right) V_i(t) di.$$

The following example provides analytical results on the mechanism just discussed.

Example 1 *Let*

$$\Sigma_i\left(M_i, S_i\right) = \mu_S \log\left(1+S_i\right) - \mu_M \log\left(1+M_i\right);$$

$$c^M\left(M_i\right) = \eta_M M_i \text{ and } c^S\left(S_i\right) = \eta_S S_i.$$

Assume

$$\mu_S > \mu_M \quad \text{and} \quad 1 - \left(\mu_S - \mu_M\right) - \mu_S \log\left(\frac{\mu_S}{\eta_S}\right) + \mu_M \log\left(\frac{\mu_M}{\mu_S}\right) + \mu_M \log\left(\frac{\mu_M}{\eta_M}\right) < 0.$$

Then,

$$m_i^* = 1 - \exp\left\{\frac{1 - \left(\mu_S - \mu_M\right) - \mu_S \log\left(\frac{\mu_S}{\eta_S}\right) + \mu_M \log\left(\frac{\mu_M}{\mu_S}\right) + \mu_M \log\left(\frac{\mu_M}{\eta_M}\right)}{\mu_S - \mu_M}\right\} \in (0,1);$$

$$f_i^* = \left(1 - m_i^*\right) \frac{\mu_M}{\mu_S} \in (0,1).$$

Proof. See the Appendix. ■

These expressions yield sensible comparative statics with respect to the fundamentals. For example, an increase in the cost of stealing η_S reduces f_i^* and raises m_i^*.

2.4.4 The entry decision

Because anybody can start up a new firm, the participation constraint (21) holds as an equality. The free-entry condition thus reads

$$V_i(t) = \frac{\gamma\beta}{1 - f_i(t) - m_i(t)} X(t).$$

From the previous analysis, $f_i(t)$ and $m_i(t)$ satisfy the Nash equilibrium (f^*, m^*). We thus can write

$$\frac{\beta\gamma}{1 - f_i(t) - m_i(t)} = \frac{\gamma\beta}{1 - f^* - m^*} \equiv \text{ financier's effective entry cost,}$$

which is equal across all new firms and is time-invariant. According to this expression, the governance frictions that induce the dispersed financiers to surrender the shares f^* and m^* to the founder and the manager to preserve incentives raise the entry cost that the financiers face for given value of the firm to be created.

Taking logs and time derivatives of the free-entry condition and of equation (9), and imposing symmetry, yields

$$r_N = \Theta \frac{\Pi^N}{\gamma\beta X} + \frac{\dot{X}}{X}, \tag{22}$$

where

$$\Theta \equiv (1 - f^* - m^*) [1 - \Sigma(f^*, m^*)]. \tag{23}$$

This expression shows that the return to entry — i.e., the return to setting up new corporate entities subject to the governance frictions discussed above — is given by the dividend price ratio plus capital gains/losses, with the addition of a "leakage" term. This term captures the two channels through which the tunneling distortion manifests itself. The first channel is direct: the household owns only a fraction $1 - f^* - m^*$ of the firm. The second channel is indirect: given ownership structure $1 - f^* - m^*$, f^* and m^*, the manager and the founder make stealing and monitoring decisions that result in a share $\Sigma(f^*, m^*)$ of the net profits being diverted from dividend distribution to the manager's pockets. Recall that, in turn, the net profit Π^N is influenced by the empire building distortion.

3 The economy's dynamics

This section studies the economy's allocation of final output Y to consumption and production of intermediate goods and derives the reduced-form representation of the resulting equilibrium dynamics.

3.1 Structure of the equilibrium

Intermediate producers receive $N \cdot PX = \theta Y$ from the final producer. Imposing symmetry in the production function (4) and using this result to eliminate X yields

$$Y = \left(\frac{\theta}{P}\right)^{\frac{\theta}{1-\theta}} N^{\sigma} Z L. \tag{24}$$

The definition of gross profit (8) and equations (18) and (22) show that the returns to innovation and to entry depend on the quality-adjusted gross cash flow of the firm $(P-1)\,X/Z$ — i.e., revenues minus variable production costs, all scaled by quality — since this is the appropriate measure of profitability for firms that spread fixed costs, including the cost of developing quality-improving innovations, over their volume of sales. Scaling by quality is required to make variables stationary in steady state. Using equation (24), we thus write both returns as functions of

$$\frac{(P-1)\,X}{Z} = (P-1)\,\frac{\theta}{P}\frac{Y}{NZ} = (P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} \frac{L}{N^{1-\sigma}}. \tag{25}$$

To isolate the role of the price decision from the other determinants of the quality-adjusted cash flow, we define $x \equiv L/N^{1-\sigma}$ and use it as our state variable. We also keep P to denote the price in order to emphasize the channel through which corporate governance frictions due to empire building work their way through the economy. Recall that the manager's price decision is $P = 1/\theta\,(1+\Omega)$; see equation (17).

Substitution of expression (25) in (18) and (22) yields the following expressions for the returns to innovation and to entry:

$$r_Z = \alpha\left[(P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x - \phi\right]; \tag{26}$$

$$r_N = \frac{\Theta}{\gamma\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}}\left[(P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} - \frac{\phi+z}{x}\right] + \frac{\dot{x}}{x} + z. \tag{27}$$

These two equations show that firm-level decisions depend on the quality-adjusted gross cash flow, which is increasing in labor use in the downstream final sector (since production of final goods drives the demand for intermediate goods) and decreasing in the mass of firms. It should be clear, however, that from the viewpoint of the managers of incumbent firms and of the founders of new firms the critical market size variable is total expenditure on intermediate goods, θY; the terms L and N^{σ} enter the calculation of the returns once we want to trace the general equilibrium determinants of θY.

The two equations reveal that the returns to investment and to entry are critically influenced by the corporate governance frictions captured by Θ and $P = 1/\theta\,(1+\Omega)$. Specifically, the empire building problem (Ω) reduces the quality-adjusted gross profit margin $(P-1)\,X/Z$ and thereby reduces both the return to in-house quality innovation (26) and the return to entry (27). We have already discussed the first result; the second follows from the fact that in addition to reducing the quality-adjusted gross profit margin, the decision to price low enlarges the volume of production X and thus raises the cost of entry. On the other hand, the return to entry is decreasing in the severity of the tunneling problem (Θ): with no tunnelling we have $\Theta = 1$, with tunnelling $\Theta < 1$.

3.2 Dynamics

The model has the desirable feature that it reduces to a single differential equation in the state variable x. The following propositions characterize the dynamics it produces. We begin with a useful result on the consumption flow as a function of x.

Proposition 2 *Let $c \equiv C/Y$ be the economy's consumption ratio. Let $z \equiv \dot{Z}/Z$ and $n \equiv \dot{N}/N$ be the rates of quality and variety innovation, respectively. In equilibrium,*

$$c = \begin{cases} 1-\theta+\frac{\theta}{P}\left[(P-1)-\frac{\phi+z}{\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x}\right] & n=0 \quad z \geq 0 \\ 1-\theta+\frac{(\rho-\lambda)\gamma\beta}{1-f^{*}-m^{*}}\frac{1}{1-\Sigma}\frac{\theta}{P}; & n>0 \quad z\geq 0 \end{cases}. \tag{28}$$

Proof. See the Appendix. ■

This result identifies two regimes. In one, x is too small and there is no entry, in which case the consumption ratio is increasing in x because firms earn escalating rents (uncontested by entrants) from the growing size of the market (recall that we postulate population growth). Such rents are distributed to the shareholders who consume them. In the other regime, x is sufficiently high and there is entry, in which case the rents are capped and the consumption ratio is constant. This structure yields a closed-form solution for the dynamics of the model.

Proposition 3 *Assume:*

$$(P-1) > \frac{\beta(\rho-\lambda)}{\Theta}; \tag{29}$$

$$\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x_N-\phi\right)\left(\alpha-\frac{\sigma\Theta}{\gamma\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x_N}\right) < (1-\sigma)\rho+\sigma\lambda \tag{30}$$

$$1 > \frac{\sigma\Theta}{\gamma\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x_N}. \tag{31}$$

There exists a finite threshold firm size

$$x_N \equiv \frac{\phi\left(\frac{\theta}{P}\right)^{-\frac{1}{1-\theta}}}{(P-1)-\frac{\gamma\beta(\rho-\lambda)}{\Theta}}$$

that triggers investment in variety innovation (entry) and a finite threshold

$$x_Z \equiv \arg\text{solve}\left\{\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x-\phi\right)\left(\alpha-\frac{\sigma\Theta}{\gamma\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x}\right)=(1-\sigma)\rho+\sigma\lambda\right\}$$

that triggers investment in quality innovation. The ordering of the thresholds is $x_N < x_Z$*. In equilibrium, the rates of quality and variety innovation are:*

$$
z\left(x\right)=\begin{cases} 0 & \phi\leq x\leq x_N \\ 0 & x_N<x\leq x_Z \\ \frac{\left(\left(P-1\right)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x-\phi\right)\left(\alpha-\frac{\sigma\Theta}{\gamma\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x}\right)-\left(1-\sigma\right)\rho-\sigma\lambda}{1-\frac{\sigma\Theta}{\gamma\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x}} & x_z<x<\infty \end{cases}; \tag{32}
$$

$$
n\left(x\right)=\begin{cases} 0 & \phi\leq x\leq x_N \\ \frac{\Theta}{\gamma\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}}\left(\left(P-1\right)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}-\frac{\phi}{x}\right)-\rho+\lambda & x_N<x\leq x_Z \\ \frac{\Theta}{\gamma\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}}\left(\left(P-1\right)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}-\frac{\phi+z(x)}{x}\right)-\rho+\lambda & x_z<x<\infty \end{cases}. \tag{33}
$$

Firm size obeys the differential equation

$$
\frac{\dot{x}}{x}=\Psi\left(x\right)\equiv\lambda-\left(1-\sigma\right)n\left(x\right). \tag{34}
$$

Proof. See the Appendix. ■

Assumptions (29)-(31) are technical conditions that we impose to focus on the model's equilibrium configuration that yields the most interesting results. Assumption (29) says that the threshold for entry x_N is finite. Assumption (30) says that when the economy crosses the threshold x_N, and activates variety innovation, quality innovation is not yet profitable and that therefore it takes additional growth of our proxy for firm size x to activate it. In other words, the assumption says that $x_N < x_Z$. Assumption (31) says that when the economy crosses the threshold x_Z the no-arbitrage condition that returns be equalized if both quality and variety R&D are to take place identifies a stable Nash equilibrium (see the proof of the Proposition for details). Figure 1 illustrates the rates of innovation as functions of x. Figure 2 illustrates the dynamics of x while Proposition 4 states the formal result, including the condition that ensures that the economy does cross the threshold x_Z.

Proposition 4 *Assume*

$$
\frac{\sigma\lambda}{1-\sigma}+\rho>\frac{\Theta}{\gamma\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}}\left(\left(P-1\right)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}-\frac{\phi}{x_Z}\right); \tag{35}
$$

$$
\lim_{x\to\infty}\Psi\left(x\right)=\lim_{x\to\infty}\left[\rho+\frac{\sigma\lambda}{1-\sigma}-\frac{\Theta}{\gamma\beta}\left(1-\alpha\right)\left(P-1\right)\right]<0. \tag{36}
$$

There exists a unique equilibrium trajectory: given initial condition x_0 *the economy converges to the steady state* x^*.

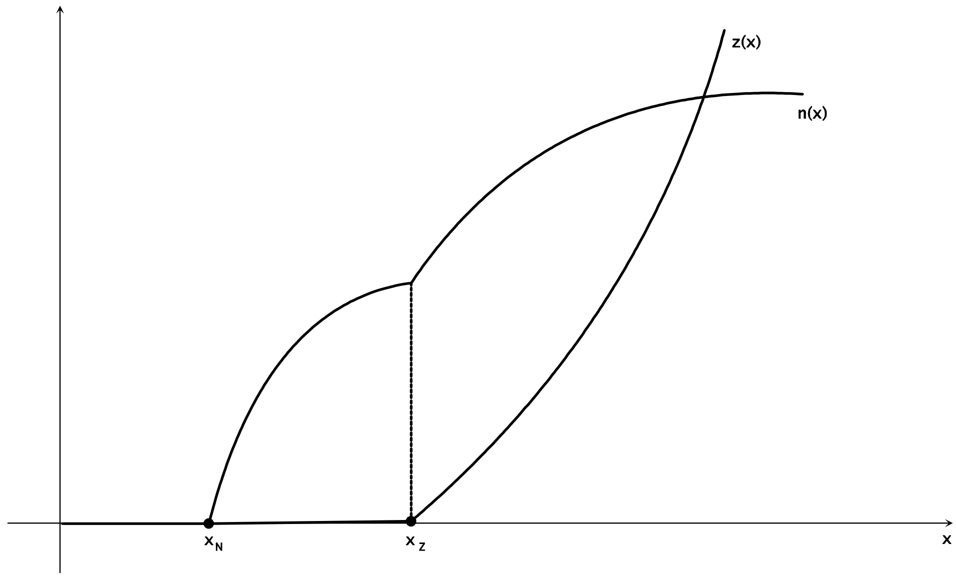

Figure 1: Innovation rates

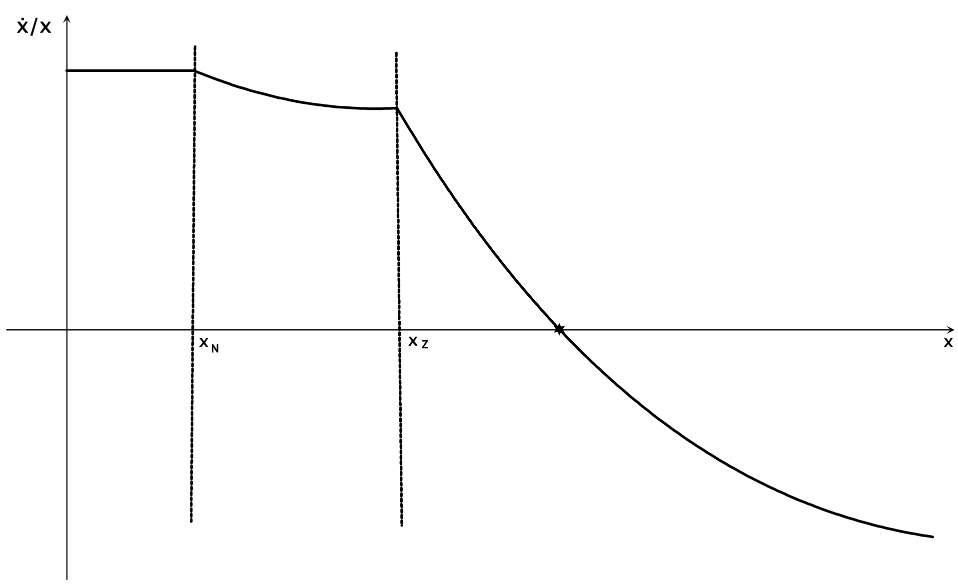

Figure 2: Equilibrium dynamics

Proof. See the Appendix. ■

For $x \leq x_N < x_Z$, we have $\dot{x}/x = \lambda$ and therefore the economy crosses the threshold for entry in finite time in light of assumption (29) that guarantees that x_N is finite. For $x_N < x < x_Z$ we have, after rearranging terms,

$$\frac{\dot{x}}{x} = \sigma\lambda + (1-\sigma)\,\rho - (1-\sigma)\,\frac{\Theta}{\gamma\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}}\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} - \frac{\phi}{x}\right).$$

Therefore, the economy crosses the threshold for quality innovation in finite time since x is still growing at $x = x_Z$ in light of assumption (35). Note that the threshold x_Z is always finite so that, given population growth, the economy can fail to cross it only if there is premature market saturation due to entry.[8]

3.3 The steady state

We now turn to the characterization of the steady state. We use the saving behavior of the household

$$r^* = \rho + \frac{\sigma\lambda}{1-\sigma} + z^*,$$

and manipulate the returns to quality investment and to entry to obtain:

$$z^* = \alpha\,(P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x^* - \alpha\phi - \left(\rho + \frac{\sigma\lambda}{1-\sigma}\right); \tag{CI}$$

$$z^* = \left[(P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} - \frac{\gamma\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}}{\Theta}\left(\rho + \frac{\sigma\lambda}{1-\sigma}\right)\right] x^* - \phi. \tag{EI}$$

The first curve, which we call the corporate innovation (CI) locus, describes the steady-state rate of vertical innovation that incumbents generate given the value of x that they expect to hold in equilibrium. The second curve, that we call the entrepreneurial locus (EI), describes the steady-state value of x that entrants generate — recall that $x \equiv L/N^{1-\sigma}$ — given the value of the growth rate of quality that they expect in the post-entry equilibrium. The steady state is the intersection of these two curves in the (x, z) space. After some algebra, we obtain:[9]

$$x^* = \frac{(1-\alpha)\,\phi - \left(\rho + \frac{\sigma\lambda}{1-\sigma}\right)}{(1-\alpha)\,(P-1) - \frac{\gamma\beta}{\Theta}\left(\rho + \frac{\sigma\lambda}{1-\sigma}\right)}\left(\frac{\theta}{P}\right)^{-\frac{1}{1-\theta}}; \tag{37}$$

[8] The intuition behind these dynamics is that we have chosen a parameters' configuration such that the quality-adjusted gross profitability of firms, $(P-1)\,X/Z$, rises throughout the range $[\phi, x_Z]$. Consequently, the dissipation of profitability due to entry gains sufficient force to induce convergence to a constant value of x only in the region where firms have already activated their in-house quality-improving operations.

[9] Existence and stability of this steady state requires the intercept condition that EI curve starts out below the CI curve and the the slope condition that EI curve is steeper than CI curve. Together they say that intersection exists with EI line cutting CI line from below. The restrictions on the parameters that guarantee this configuration are those, stated in Propositions 3-4, that yield the global stability of the economy's GE dynamics.

$$z^{*}=\frac{\left[\alpha\phi+\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)\right]\frac{\gamma\beta}{\Theta}-\alpha\left(P-1\right)}{\left(1-\alpha\right)\left(P-1\right)-\frac{\gamma\beta}{\Theta}\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)}\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right). \tag{38}$$

Associated to these, we have variety growth,

$$n^{*}\equiv\left(\frac{\dot{N}}{N}\right)^{*}=\frac{\lambda}{1-\sigma}. \tag{39}$$

Recall also that $P=1/\theta\left(1+\Omega\right)$.

Figure 3 shows the comparative statics effects of tunnelling. Recall that Θ reflects the share of the net profit that the minority shareholders retain in equilibrium once we account for the portion surrendered to the manager and to the founder. The frictionless economy features $\Theta=1$; the economy with tunnelling has $\Theta<1$. The EI locus is increasing in Θ, that is, for given x a lower Θ reduces the innovation rate consistent with entrepreneurs' entry decisions. Intuitively, expenditures on in-house innovation must drop to compensate for the drop in the share of profits that can be appropriated by the financiers. On the other hand, the tunneling friction does not affect the CI locus, because it equally erodes returns and costs of investment in in-house innovation. Consider then a shock to the severity of the tunneling problem in the form of a reduction in the cost faced by managers when diverting resources. The drop in Θ makes the EI locus shift down. Figure 3 illustrates the effect of the shock: both steady-state firm size and steady-state innovation growth rise. Thus, an increase in the severity of the tunneling problem promotes growth and makes the industry structure more concentrated in the sense that product variety falls.[10]

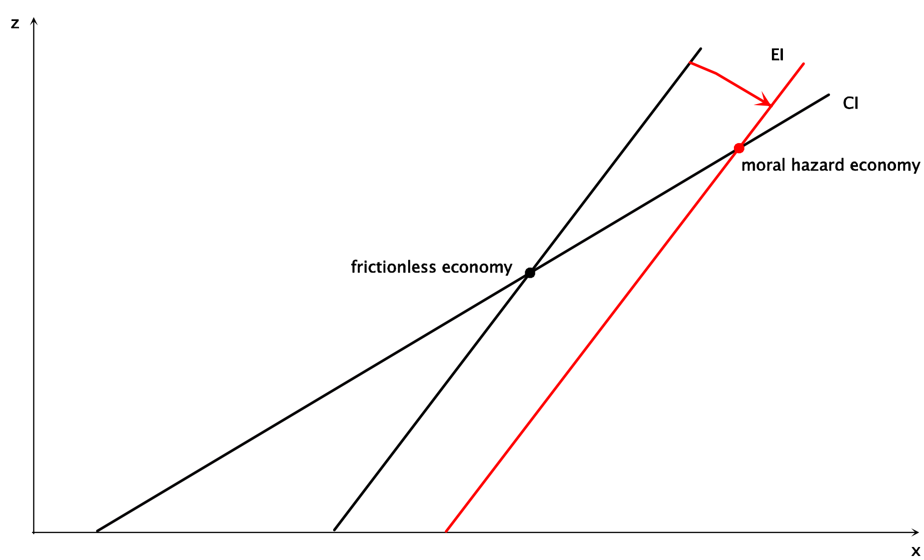

Figure 3: The steady-state effect of a worsening of governance frictions that results in a lower Θ

[10]The intuition is that since entry more costly the financial market reallocates resources to existing firms.

Next, we study the comparative statics effects of empire building. A shock to Ω pushes both the EI and CI loci down because by construction the empire building distortion lowers the quality-adjusted gross profit margin $(P-1)\,X/Z$ and raises the cost of entry βX. Intuitively, both the rate of return to entry and to in-house innovation fall because managers' price decisions are more distorted. Thus, for given x the expenditure on in-house innovation consistent with equalization of each type of investment to the reservation rate of return of savers must fall. Since both loci shift down, we have a potentially ambiguous effect. However, our algebra reveals that the increase in Ω unambiguously lowers the in-house innovation rate z and thus must reduce our measure of firm size x; see Figure 4 for an illustration. As a result of the shock, therefore, the industry structure becomes more concentrated because that is what is required to have firms that grow faster through in-house innovation.

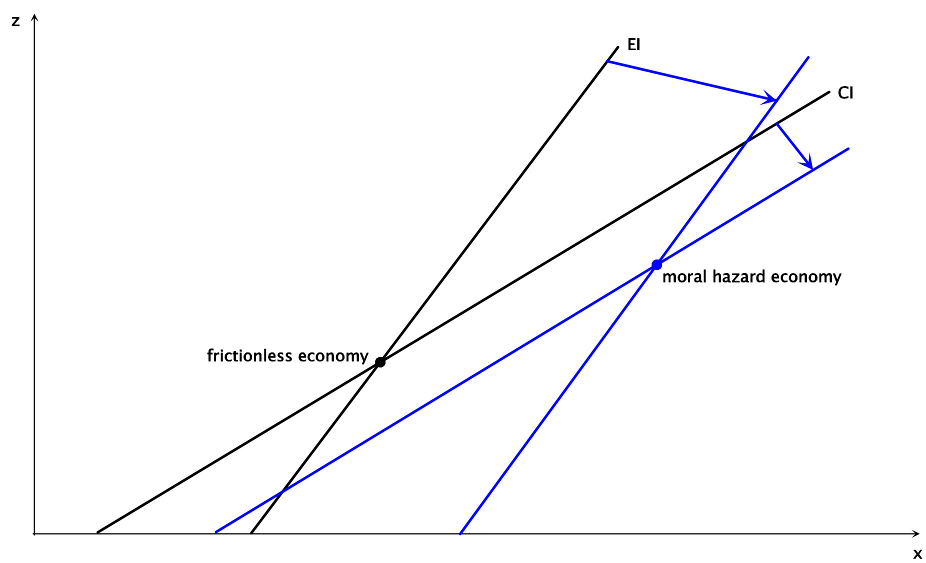

Figure 4: The steady-state effect of a worsening of governance frictions that results in a lower Ω

3.4 GDP and welfare

To complete the characterization of the model, we examine the effects of corporate governance frictions on GDP and welfare. Let G denote the GDP of this economy. Subtracting the cost of intermediate production from the value of final production and using (25) yields

$$GDP \equiv G = Y - N\,(X + \phi Z) = \left[1 - \frac{\theta}{P}\left(1 + \frac{\phi Z}{X}\right)\right] Y = \left[1 - \frac{\theta}{P}\left(1 + \frac{\phi}{\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x}\right)\right] Y,$$

where $P = 1/\,(1+\Omega)\,\theta$. The term in brackets is increasing in X, and therefore in x, because the unit cost of production of the typical intermediate firm falls as its scale of operation rises. GDP per capita equals

$$\frac{G}{L} = \underbrace{\left(\frac{\theta}{P}\right)^{\frac{\theta}{1-\theta}}}_{\text{final demand (static)}} \cdot \underbrace{\left[1 - \frac{\theta}{P}\left(1 + \frac{\phi}{\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x}\right)\right]}_{\text{intermediate efficiency (static IRS)}} \cdot \underbrace{N^{\sigma} Z}_{\text{intermediate technology (dynamic IRS)}} . \tag{40}$$

This expression says that GDP per capita rises with efficiency (firms' average scale) and with technology (product variety and average quality). It also identifies the channels through which pricing decisions operate. The contrasting effects of the deviation from the profit maximizing price on total demand for intermediates and firm size result in GDP per capita being hump-shaped in Ω. In steady state the growth rate of final output and GDP per capita is

$$\left(\frac{\dot{Y}}{Y}\right)^{*} - \lambda = \left(\frac{\dot{G}}{G}\right)^{*} - \lambda = \frac{\sigma\lambda}{1-\sigma} + z^{*}. \tag{41}$$

To carry out the analysis of welfare, we start with the following result.

Proposition 5 *Consider the transition path of an economy that starts at time* 0 *with initial condition* $x_0 > x_Z$ *and converges to* x^*. *Under the approximation* $\sigma\Theta/\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x \cong 0$, x *evolves according to the linear differential equation:*

$$\dot{x} = \nu \cdot (x^{*} - x),$$

where

$$\nu \equiv (1-\sigma)\left[(1-\alpha)(P-1)\frac{\Theta}{\gamma\beta} - \left(\rho + \frac{\sigma\lambda}{1-\sigma}\right)\right].$$

Therefore the explicit solution for the economy's path is

$$x(t) = x_0 e^{-\nu t} + x^{*}\left(1 - e^{-\nu t}\right).$$

At time $t \geq 0$, *the utility flow associated to this path*

$$\begin{aligned}
\log\left(\frac{C(t)}{L(t)}\right) \quad = \quad & \underbrace{\log\left[1 - \theta + \frac{(\rho-\lambda)\gamma\beta}{1 - f^{*} - m^{*}}\frac{\theta}{P}\frac{1}{1-\Sigma}\right]\left(\frac{\theta}{P}\right)^{\frac{\theta}{1-\theta}}}_{\textit{initial consumption}} \\
& + \underbrace{\left(\frac{\sigma\lambda}{1-\sigma} + z^{*}\right)t}_{\textit{steady-state growth}} \\
& + \underbrace{\left[\frac{\alpha x_0}{\nu}(P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} + \frac{\sigma}{1-\sigma}\right]\left(1 - \frac{x^{*}}{x_0}\right)\left(1 - e^{-\nu t}\right)}_{\textit{transitional dynamics}}.
\end{aligned}$$

Substituting in the welfare functional and integrating yields

$$\begin{aligned} U &= \frac{1}{\rho-\lambda}\log\left[1-\theta+\frac{(\rho-\lambda)\gamma\beta}{1-f^*-m^*}\frac{\theta}{P}\frac{1}{1-\Sigma}\right]\left(\frac{\theta}{P}\right)^{\frac{\theta}{1-\theta}} \\ & +\frac{1}{(\rho-\lambda)^2}\left(\frac{\sigma\lambda}{1-\sigma}+z^*\right) \\ & -\frac{\alpha x_0(P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}+\frac{\sigma\nu}{1-\sigma}}{(\rho-\lambda)(\rho-\lambda+\nu)}\left(\frac{x^*}{x_0}-1\right). \end{aligned}$$

Proof. See the Appendix. ■

According to this proposition, the welfare associated to the transition to the steady state x^* from initial condition x_0 has three components: the intercept (or initial consumption or level effect) component, the steady-state growth component, and the transitional component. The expression for U assigns weight $1/(\rho-\lambda)$ to the intercept component, weight $1/(\rho-\lambda)^2$ to the steady-state component, and weight

$$\frac{1}{\rho-\lambda}\frac{\alpha x_0(P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}+\frac{\sigma\nu}{1-\sigma}}{\rho-\lambda+\nu}, \quad \nu\equiv(1-\sigma)\left[(1-\alpha)(P-1)\frac{\Theta}{\gamma\beta}-\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)\right]$$

to the transitional component. The transitional component captures a key channel at work in this model. Consider an increase of the tunnelling or of the empire building problem that triggers a consolidation of the industry, so that over time it converges to larger firms that grow faster, i.e., consider a transition with $x^*>x_0$. While such consolidation entails an acceleration of quality growth, it also entails a slowdown of entry and thus a loss of product variety relative to the baseline path. To see it, recall that

$$\log N(t)=\frac{1}{1-\sigma}\log\left(\frac{L(t)}{x(t)}\right)$$

so that throughout the transition to the higher x^* the rate of entry falls below the rate of population growth. In other words, the model exhibits a dynamic quality/variety trade-off that manifests itself as a growth/variety trade-off. The key implication of this trade-off is that when x rises, the benefit of faster quality growth has to be weighed against the cost of the foregone product variety required to achieve the larger firm size that supports the faster quality growth.

Some intuitive properties of this calculation are straightforward. First, holding constant the magnitude of the changes $\partial z^*/\partial\Omega>0$ and $\partial x^*/\partial\Omega>0$, the faster the transition, the more weight we put on the steady state and the more we tend to find a positive welfare effect of Ω. In contrast, if the transition is very slow and the economy spends a lot of time out of steady state, we put more weight on the welfare cost of higher Ω and we tend to find a welfare loss. Given these considerations, it should be clear that it is relatively easy to obtain a hump-shaped relation between Ω and U: starting from $\Omega=0$, the introduction of a small deviation from the profit-maximizing price of intermediate goods yields a consolidation of the industry that produces faster growth sufficient to compensate for the foregone variety. But at some point, as Ω grows, the deviation from the profit-maximizing price yields a welfare loss because the gain in faster growth does not compensate for the foregone variety breadth.

3.5 Welfare: a more refined exercise

In this section, we compute analytically how a variation in Ω affects households' welfare. The starting point is the value of the households' welfare described in Proposition (5). Let U_0 be welfare when the economy is in a steady state with $x = x_0$ and $z = z_0$. Let also the initial values of Ω and P be $\Omega = \Omega_0$ and $P_0 = \frac{1}{\theta(1+\Omega_0)}$. Let the new values of Ω and P be Ω_1 and P_1, and the new steady state values of x and z be x_1 and z_1. Imagine that $\Omega_1 < \Omega_0$ so that the empire building distortion becomes less severe. The difference between the new and the old level of utility is

$$U_1 - U_0 = \frac{1}{\rho - \lambda} \log(\frac{\omega_1}{\omega_0}) + \frac{z_1 - z_0}{(\rho - \lambda)^2} + \frac{\alpha\,(P_1 - 1)\left(\frac{\theta}{P_1}\right)^{\frac{1}{1-\theta}} x_0 + \frac{\sigma\nu}{1-\sigma}}{(\rho - \lambda)\,(\rho - \lambda + \nu)} \left(1 - \frac{x_1}{x_0}\right),$$

where

$$\omega_j = \left[1 - \theta + \frac{(\rho - \lambda)\,\gamma\beta}{1 - f - m} \frac{1}{1 - \Sigma} \frac{\theta}{P_j}\right] \left(\frac{\theta}{P_j}\right)^{\frac{\theta}{1-\theta}}$$

for $j = 0, 1$ and

$$\nu = (1 - \sigma)\left[(1 - \alpha)\,(P_1 - 1)\,\frac{\Theta}{\gamma\beta} - \left(\rho + \frac{\sigma\lambda}{1 - \sigma}\right)\right].$$

The first term, $\log(\frac{\omega_1}{\omega_0})$, is negative because consumption drops as intermediate prices rise. The second term captures the long-run effect of the friction on innovation and thereby on the growth rates of output and consumption. As discussed with the graphical steady-state analysis, the innovation rate declines because in the long run firms are smaller in an economy with a more modest friction, and therefore invest less in innovation. Finally, the third term is always positive because firms are smaller, $\frac{x_1}{x_0} < 1$. This captures the social benefits of having a greater variety of intermediate goods. In brief, the reduction of the distortion leads to a welfare improvement only if the transition effect is greater than the sum of the long-run effect of z and the short-run distortion caused by the price increase. In what follows, we compare these three components from a quantitative point of view.

4 Family Control and Corporation

In this section we consider a type of friction that goes in the opposite direction relative to the classic Jensen's empire building preference. We explore the case in which the increase in the size of the firm generates a disutility to the manager. [Raoul: Literature on this interpretation].

To minimize the formal elaboration needed to capture this new type of friction, we allow the parameter Ω to become negative: For a given amount of profits, the larger the size of the firm the

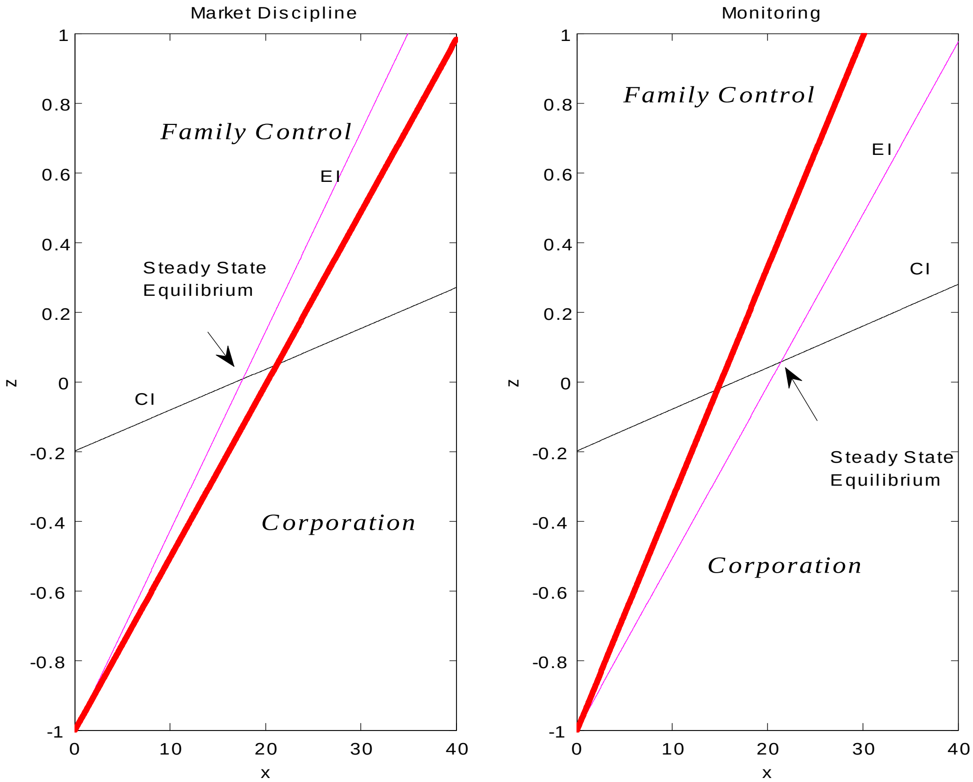

Figure 5: Family Control and Corporation

more limited the possibility for the managers to extract private benefits from running the firm. Formally, the manager's utility flow as

$$\begin{array}{ll} \Phi_i \cdot [\Pi_i^N + \Omega P_i X_i] & \text{if } \Pi_i^N + \Omega P_i X_i > 0 \\ 0 & \text{otherwise.} \end{array} \tag{42}$$

where $-1 < \Omega < \frac{1}{\theta} - 1$ (a restriction needed to have a price larger than one). Clearly if $\Omega < 0$ the size of the firm represents a private cost for the manager. In principle this can be so large that he will give up any plan to tunnel funds out of the firm. In this case, there is no need for the households to award any share of the profit neither to the manager nor to the monitor's agent. One consequence of this state of affairs is that the economy could potentially be in a situation with no moral-hazard issues. Indeed after some algebra one obtains that when the size of the firm is relatively small, namely when

$$x \leq \frac{\phi + z}{\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} [(P-1) + \Omega P]}, \tag{43}$$

then $\Pi_i^N + \Omega P_i X_i \leq 0$. In such a case a profit-share agreement between the three parties is not feasible.

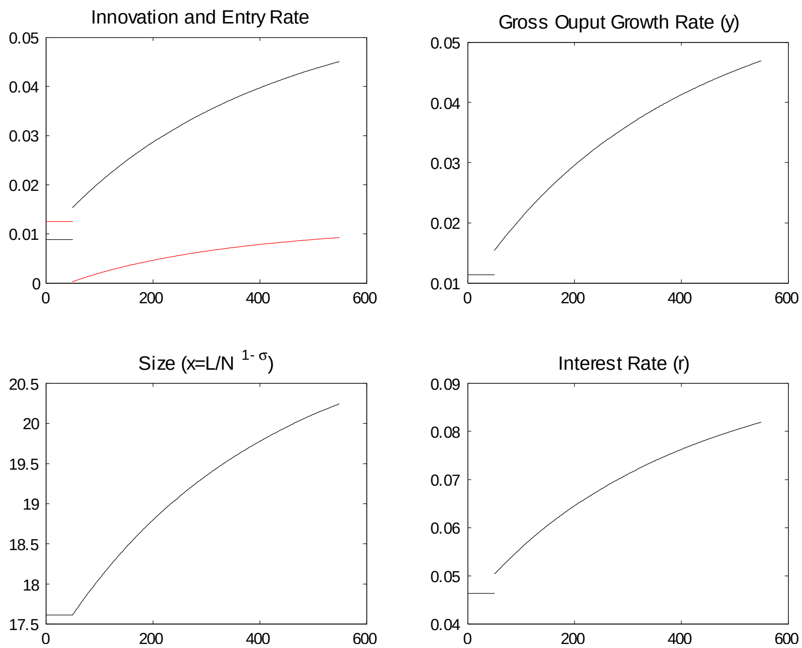

Figure 6: From Family Control to Corporation

Fig. (5) depicts two economies that differ in the value of Ω (in the left plot $\Omega = -0.25$; in the right-plot $\Omega = -0.08$). The plane is split into two regions by a thick red line derived from condition (43). In left plot equilibrium firms are run directly by the households; they are relatively small. In the right-plot equilibrium households choose to delegate managerial decisions and to hire a monitoring agents. The intuition for the different governance arrangement is the following. When Ω is substantially below zero households have expectations of that in case of power delegation managers should be respnsible for distributiting an important flow of profits. The expectation expressed as a proportion to the volume of sales. The greater is such a requirement, the less intersting becomes for an individual to accept an offer to become the firm's manager. In consequence, households themselves run the firms – which is typical assumption in standard growth models. The right plot instead represents a situation where the trilateral agreement for the creation of a corporation is mutually beneficial.

The graphical analysis suggest that corporate firms are larger than family controlled firms. This seems to in line with casual observation that the frequency of small and medum firms is greater in countries where firms are more likely to be family managed.

The value of Ω can change within the same economy. Cultural or technological developments can induce households to change their views about power delegation. A scenario of this type is represented in Fig. (6). The economy is on its long run family controlled equilibrium. A sudden increase in Ω triggers the transition towards a long run equilibrium with frictions. In the illustration, the economy switches to the corporate Nash equilibrium immediately after the shock arrives. In consequence, returns on in-house investments becomes more profitable and the entrance

Table 1: Baseline Case: Parameters Values

Production and Entry					Households		Moral Hazard				
α	σ	θ	ϕ	β	ρ	λ	η_S	η_M	μ_S	μ_M	Ω
0.16	0.2	0.3	1	12.75	0.035	0.01	0.88	0.001	1.068	0.07	0.001

Table 2: Steady State Equilibrium: Baseline Case

(percentage)												
x	z	n	y	r	C/GDP	f	m	a	Θ	$c_S(S)$	$c_M(M)$	$\sum$
17.96	1.75	1.25	2	5.5	97.38	5.94	9.37	84.69	84.5	9.4	0.32	0.20

of new firms slows down.

5 Experiments

We conduct experiments to investigate the dynamic adjustment of the economy when it is hit by shocks to corporate governance frictions. All the shocks are permanent and are perceived as such. For simplicity, we also assume they are not anticipated. Table 1 displays the chosen parameterization of the baseline economy. We rely on prior literature to calibrate most of the parameters. We set the discount rate $\rho = 3.5\%$ and the population growth rate $\lambda = 1\%$. The entry cost and the operating cost parameters, β and ϕ, govern the long run output growth. We set $\phi = 1$ and choose β to target a 2% growth rate, as suggested by the U.S. experience. The externality parameter $1 - \alpha$ is 0.84 and the parameter regulating the degree of market power, θ, is fixed at 0.3 (see Peretto (?) for a discussion).

We choose the parameters reflecting the corporate governance frictions following Nikolov and Whited (2013). Their estimates suggest tunneling (Σ) and empire-building (Ω) parameters in the order of 0.1 and 0.2 percent, respectively. Because in our model Σ is endogenous, it is compatible with different combination of moral hazard parameters (i.e., the parameters capturing monitoring and tunneling costs). To reduce the degrees of freedom in choosing these parameters, we target an equity share of the managers, m, below 10 percent, in line with what found by Nikolov and Whited (2013).

5.1 Shocks

The shocks we consider have a similar flavor as those discussed in the analysis of the steady state. Here, however, we follow the adjustment process of an economy that is hit by a shock when it is in steady state and moves to the new one. The values of the baseline parameter values are in Table (1). We posit that when it is hit by a shock the economy is in the steady state characterized in Table (2): the interest rate is 5.5%, the innovation rate is 1.75%, and the output growth rate is

Table 3: Shocks to Frictions: Long Run Effects

		Variations in percentage points							
	Δx	y	f	m	a	Θ	$c_S(S)$	$c_M(M)$	$\sum$
$\Omega = 0$	-0.01	-0.1	0	0	0	0	0	0	0
$\Delta\mu_M = 0.84\%$	-0.01	-0.1	0.07	-0.24	0.17	0	0.25	0	0.06
$\Delta\eta_M = -2\%$	-0.01	-0.1	0.01	-0.13	0.12	0	0.14	0	0
$\Delta\mu_S = -0.12\%$	-0.01	-0.1	0.02	-0.26	0.24	0	0.15	0	0.13
$\Delta\eta_S = 0.13\%$	-0.01	-0.1	0.01	-0.14	0.13	0	0.02	0	0

Table 4: Welfare Decomposition

Starting E.B. Friction	U: Variations in percentage points					W: Variations in percentage points ($\eta = 0.9$)		
	y	U_{SS}	U_T	$U_{SS} + U_T$		W_{SS}	W_T	$W_{SS} + W_T$
$\Omega = 0.001$	-0.01	-0.097	0.074	-0.023		-0.11	-0.916	-1.03
$\Omega = 0.8$	-0.01	-0.08	0.13	+0.05		-1.43	1.66	0.22

Note: In both experiments Ω declines by 0.01%; β is adjusted to keep the original y equal to 2%. U_{SS} and U_T (W_{SS} and W_T) indicate welfare changes due to steady state and transition dynamics effects excluding (including) the managers' empire building utility.

2%. In each experiment, we change only one parameter. Table (3) shows the long-run variations caused by the shock to a selected number of macroeconomic variables.

First, consider the effect of an elimination of the empire building friction, Ω. It is easier to interpret the dynamic responses to the shock by keeping in mind two aspects of the frictionless economy. First, the presence of monopolistic power generates a classic static inefficiency that translates into a sub-optimal level of production. Second, an incumbent intermediate firm can appropriate only a fraction of its own investment in quality innovation, while benefiting from knowledge developed by other firms. Therefore, the decentralized solution implies levels of investment in quality innovation below those that would be chosen by a social planner. In other words, the frictionless economy is hardly a first best environment.

Fig. (7) plots the impulse responses (dashed-lines) to a permanent drop of Ω from 0.1% to zero. The immediate response to the shock is a reduction of the quantity produced, obtained via an increase of the monopolistic price. Because the price is brought to the optimal monopolistic level, profits expand. This is a positive development not only from the perspective of the incumbent firms but also from the point of view of potential entrants. Indeed, lured by the higher profits, more entrepreneurs set up firms leading to an expansion of the array of intermediate goods, which boosts the productivity of the final good sector. The entry effect can indeed be strong enough to displace resources that incumbent firms would have allocated to in-house investment in an economy affected by empire building. The relatively modest initial contraction of in-house investment is followed by a slow century-long decline. The greater intensity with which new firms flock in not only causes a reduction of firms' average size, but indirectly prompts firms to slow down their investment in quality innovation. To put it differently, the long-run drop of in-house investment is the consequence of the acceleration in firm entry.

The figure shows an undershooting phenomenon in the consumption-GDP ratio. Because the frictionless economy has to sustain a relatively greater number of firms, each of which comes with an operating cost, there is a larger gap between gross output and the GDP. The long-run consumption-output ratio also declines but not to the point of compensating the increased gap between net output and GDP. Nonetheless, because forward-looking households immediately adjust on the new long-run lower consumption-output ratio, whereas the mass of firms adjusts gradually, the consumption-GDP ratio drops in the long run.

Following the discussion of section (4.3) we decompose the steady state and the transition welfare effects of the shock. The elimination of the friction has the expected negative long-run effect due to the decline of the innovation rate, but also brings benefits along the transition thanks to the more intense entry of new firms. In Figure (7) the change in the long-run welfare component induced by the shock is calculated by taking the difference between the instantaneous discounted utilities of the original and the shocked economy when both are on their long run path. Because the shock causes a long-run decline in the per capita output growth rate, this part of the welfare change is necessarily negative. Conversely, the transitional component is positive for the most part, because it reflects the benefits of a greater variety of intermediate goods. However, notice that when the shock hits the economy, the transitional welfare component drops temporarily: the elimination of the friction means that every intermediate good is sold at a higher price. In the current simulation, the long-term component prevails. The positive transitional effect prevails, however, when the original economy features an important empire building distortion. This scenario is illustrated in Figure (9).

We also conducted experiments in which the empire building utility is included in the households' welfare. The per capita welfare function we considered is:

$$W = \eta U + (1-\eta) U^M, \ 0 \leq \eta \leq 1$$

where U is defined in (1) and $U^M = \Omega \int_t^\infty e^{-(\rho-\lambda)s} \frac{NPX}{L} ds$. Using the property $NPX = \theta Y$ and the consumption-output ratio, c defined in (28), we obtain

$$W = \int_t^\infty e^{-(\rho-\lambda)s} [\eta \log(\frac{C(s)}{L(s)}) + (1-\eta)\Omega \frac{\theta}{c} \frac{C(s)}{L(s)}] ds.$$

In the second experiment, we alter the tunneling distortion by enhancing the efficiency of the monitoring technology, μ_M. To better compare the quantitative effects of the shock with those of the previous shock, we reduce the monitoring cost so as to obtain the same long-run decline of the interest rate and of the output growth rate (0.01%). The second row of Table (3) displays the long-run variations of other indicators. By construction, some of the long-run outcomes of this experiment are qualitatively similar to those associated with the removal of the empire-building friction. An improvement of the tunneling effect, brought about by an improvement of the monitoring technique or by greater barriers in stealing, leads to faster entry and to a gradual of the relative demand share faced by each firm. This effect inevitably reduces firms' incentives to innovate. In the long run the economy will converge to an equilibrium with more firms of smaller size that devote a relatively smaller share of their sales to innovation. These dynamics are illustrated in Fig. (9) when the shock affects the monitoring technology.

The long-run and the transitional components of the welfare change roughly balance each other. The decline of the long-run component of welfare is still caused by the drop of the innovation rate. The source of the short-run benefits is the greater variety of intermediate goods. In contrast with the previous experiment, the tunneling distortion does not alter directly the static inefficiency due to monopolistic power; therefore, the transitional component of the welfare change is always positive. Changes in the cost of stealing and of monitoring (η_S and η_M) or in the ease of stealing, have similar qualitative and quantitative effects (seeTable (3)). Shocks of similar magnitude applied to economies with more severe moral hazard issues generate similar quantitative results.

If the adjustment process echoes the one described on the empire-building experiments, some of its underlying mechanisms are specific to the tunneling friction. To be concrete, consider a positive shock to the monitoring technology due to a rise in μ_M. The financiers will find it optimal to reward more generously monitoring agents by giving them a greater share of the company (f) and at the same time to reduce the managers' equity stake (m). Overall, this reshuffling implies that the financiers retain a larger fraction of the company (a). Monitoring agents, lured by induced by the large stake in the company, exert greater monitoring effort which would make more difficult for managers to abscond profits. Nevertheless because managers are now entitled at a smaller portion of the firms profits, they are less relucted in trying to abscond profits. The variation of the quota concealed by the managers Σ is ambiguous because two competing forces tend to offset one another. It is not difficult to produce situations where the reduction of the managers' quota is large or small enough so that Σ goes up rather then down. We find that the variation of Σ is dwarfed by that of the tunneling parameter $(1 - \Theta)$.

5.2 Long run

In this section, we first compare the patterns of development of an economy that suffers from an empire-building friction with those of a frictionless economy. In Figure (**??**) the trajectories of the economy with (without) friction are represented by continuous (dashed) lines. The two economies are in the same initial position x_0. This starting point is chosen to be small enough relative to the steady state so that both economies go through three stages of development. At first, both economies simply produce the final good using an exogenously given variety of intermediate goods. The state of technology does not improve and there is no entry. Specifically, equations (26) and (27) hold as inequalities because both the return to entry and the return to in-house investment are too small relative to the discount rate. Hence, the whole net output is consumed. In this

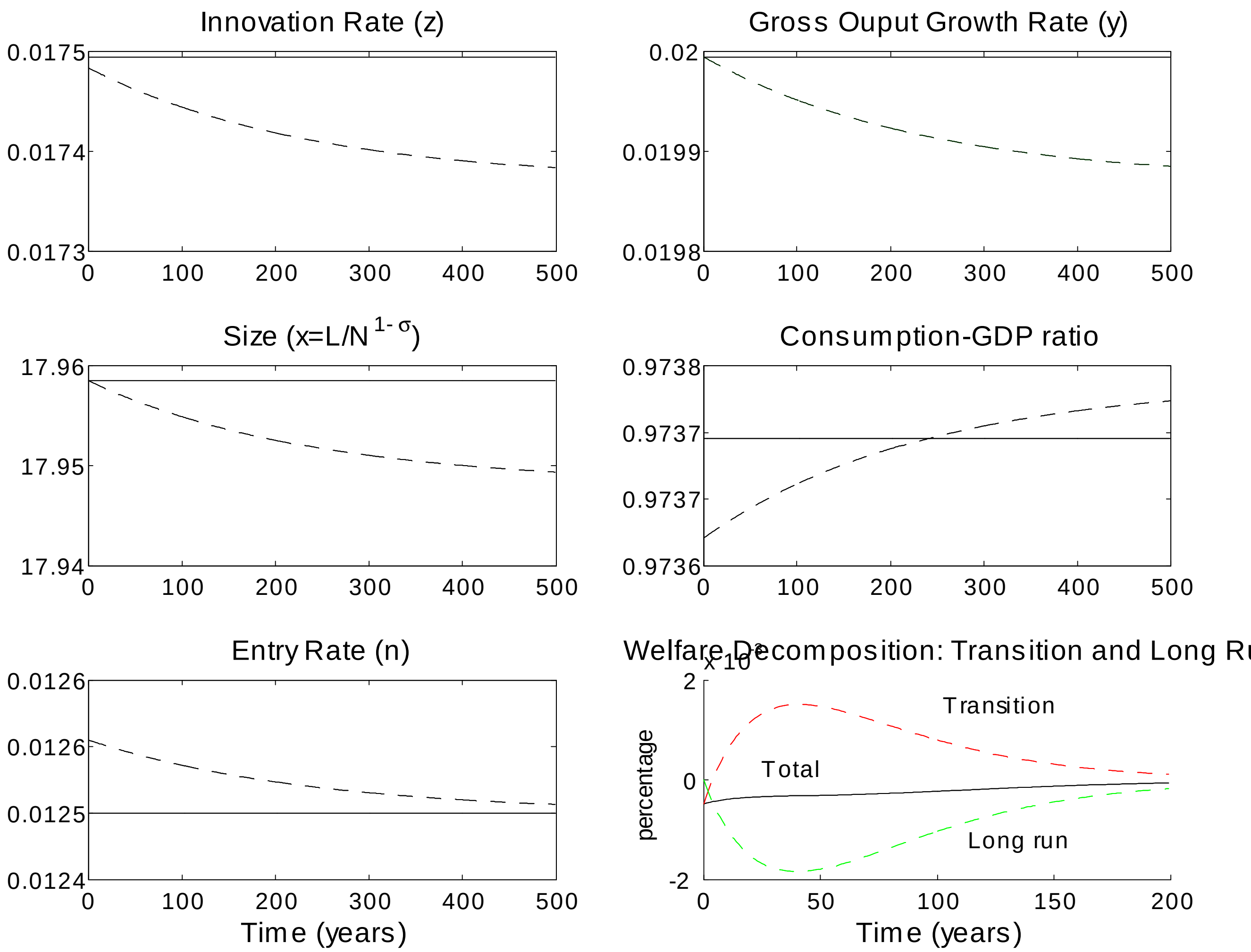

Figure 7: Empire Building: Baseline Case

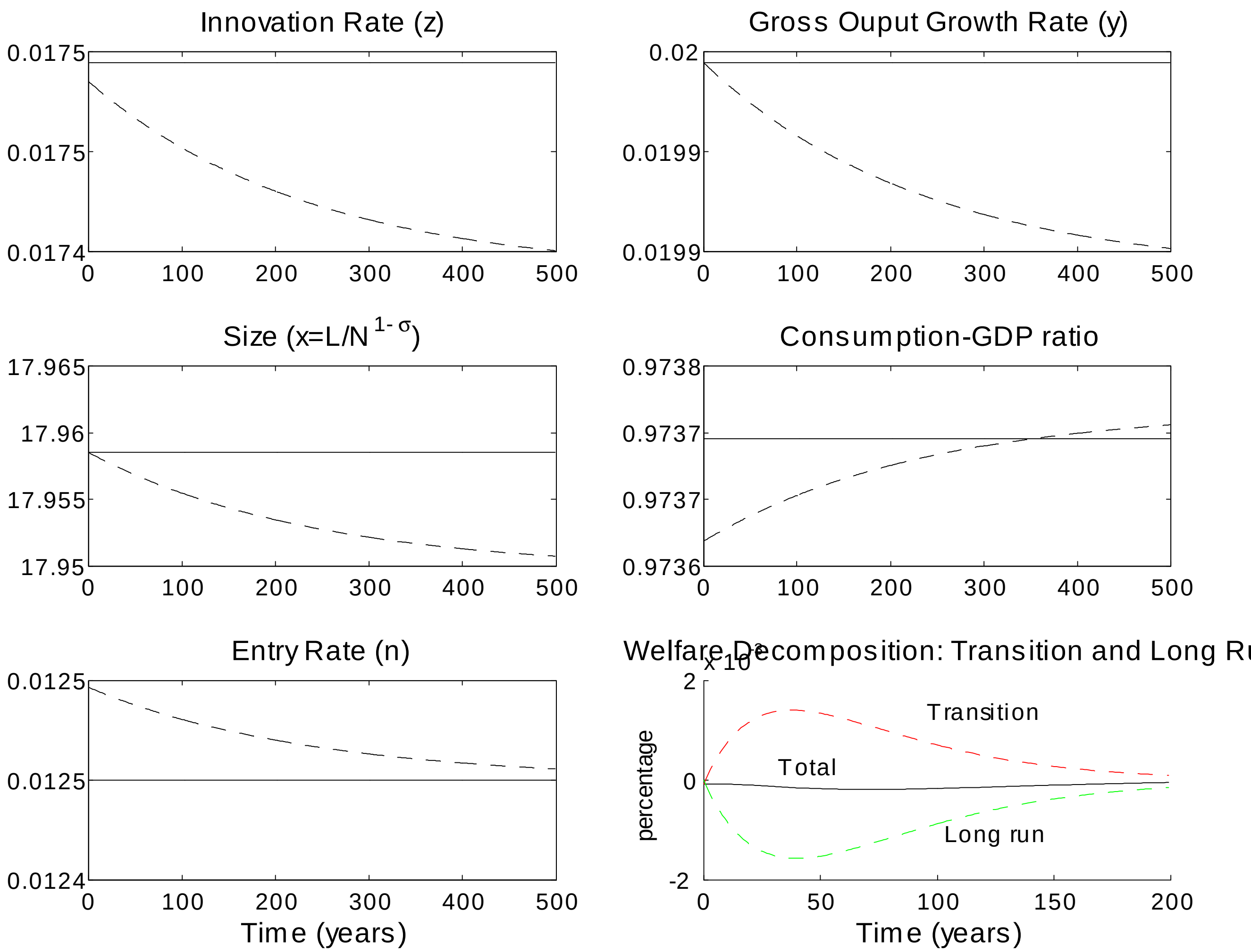

Figure 8: Monitoring

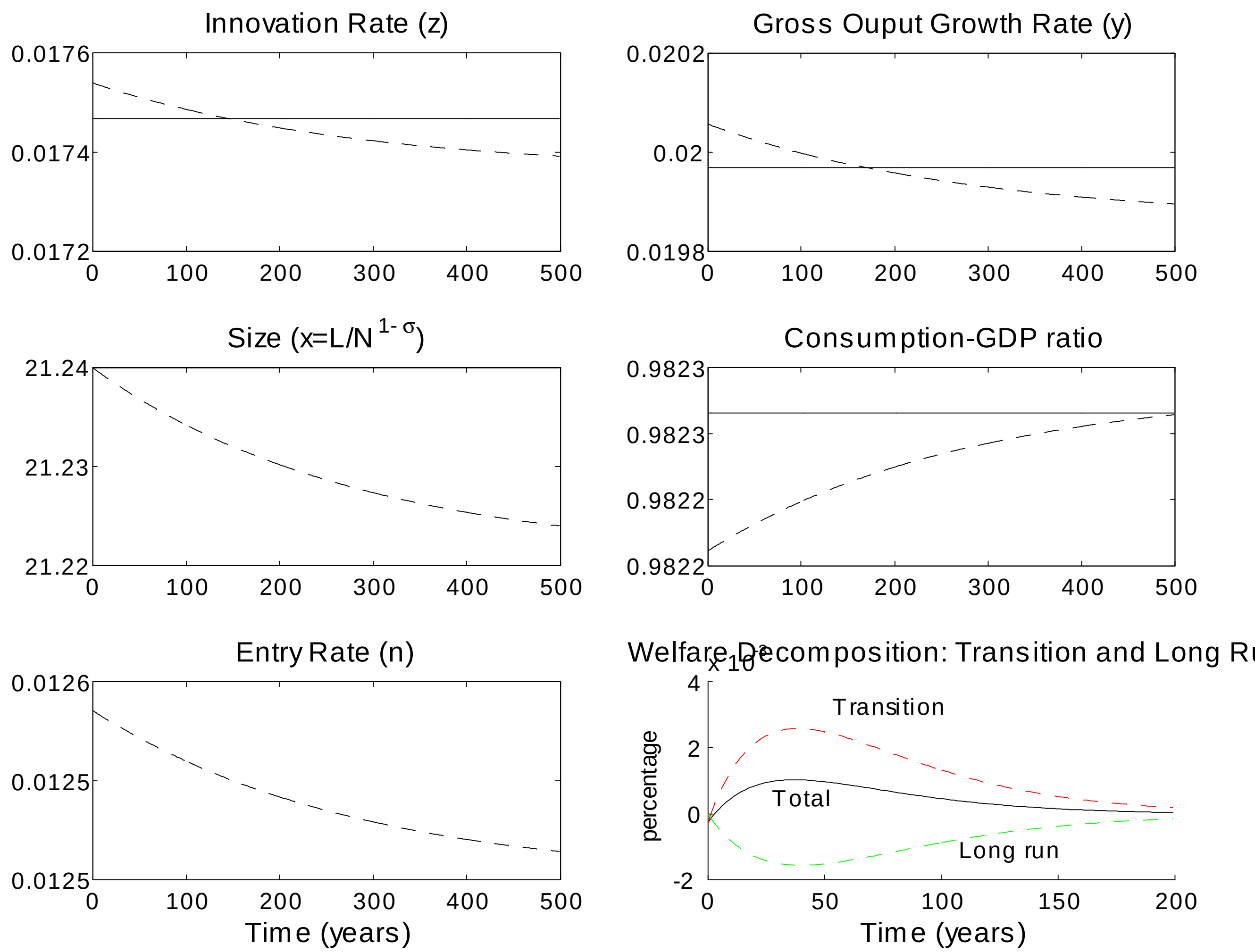

Figure 9: Empire Building: High Initial Level of Friction

phase, therefore, the only source of dynamics is the enlargement of the population that causes a gradual increase of firm size x and thereby of the profitability of firms. As the (quality-adjusted) gross profit rate rises, at a certain point entry becomes profitable. The trigger point is reached first in the frictionless economy. Indeed, for a given size of the firm — which is identical in the two economies during the first phase of development — in the economy without frictions profits tend to be higher; hence, the earlier entry.[11] Afterwards, the paths of development of the two economies are no longer the same. The delay in turning on entry in the economy with frictions implies that firms are relatively larger. Indeed, from the time it turns on entry the economy with frictions will always have a lower rate of entry and consequently a systematic difference in industry structure: it will have smaller firms, and more of them, and will use a greater variety of intermediate goods to produce the final consumption good.

In the second phase of development, incumbent firms do not yet invest in innovation because it is not profitable to do so — formally, the right-hand-side of equation (26) is smaller that the right-hand-side of equation (27). Because the firms that populate the frictionless economy are of smaller size, their rate of return on innovation is systematically lower than in the economy with frictions. Consequently, the frictionless economy entering the innovation phase of development (third phase) later that the economy with frictions, and has a relatively poorer innovation performance even when innovation is profitable in both economies. In brief, the frictionless economy grows at a faster pace in the second phase (endogenous entry), but in the long run it is outpaced in terms of growth by the economy with frictions, which has a positive bias towards in-house investment because of the managers' empire-building motive that causes them to price more aggressively. In the current experiment, the long-run effect slightly dominates so that the welfare of the economy with frictions, evaluated at the starting position, is about 0.9% greater than that of the frictionless economy.

In a second experiment, we compare the transition paths of two economies characterized by a different monitoring efficiency μ_M and with no empire-building frictions. Table (6) summarizes the long-run values of the key macroeconomic indicators of the two economies. Their patterns are shown in Figure (**??**) with the dashed (continuous) lines representing the economy with a relatively better (worse) monitoring efficiency. As it was detailed in the previous section the economy with a more efficient monitoring technology is the one in whish the tunneling issue is less important, monitoring agents have more shares of the company, and managers fewer of them.

The key variable that explains the different transitional experiences of the two economies is Θ, namely the size of the firms' profits that remains in the hands of dispersed shareholders, net of the share Σ subtracted by the managers. Because Θ is bigger in the more efficient economy, entry occurs earlier, and thereafter is systematically more intense. As a result, firms' size is always smaller, which explains the relatively more modest innovation performance of incumbent firms. Despite these differences in industry structure, our calculations suggest that the two economies

[11] In light of historical evidence, we focus on a sequence of development in which endogenous entry precedes investment in quality innovation. In principle, under an alternative parametrization, the model allows for an inverted sequencing in which quality innovation kicks in first (see Peretto 2013).

Table 5: Steady State Values: Frictionless Economy, and Economy with Empire Building Friction

		(percentage)			
Economy with	x	z	n	y	r
$\Omega = 0.1$	18.37	2.17	1.25	2.42	5.92
$\Omega = 0$	17.34	1	1.25	1.25	4.75

Note: Based on Table (1) parameters, except that there are no tunneling frictions, and that $\beta = 13.77$

Table 6: Steady State Values of Economies with Different Monitoring Efficiencies

		(percentage)										
	x	z	n	y	r	f	m	a	Θ	$c_S(S)$	$c_M(M)$	$\sum$
Baseline	17.96	2.75	1.25	3	6.5	5.35	18.43	76.23	75.07	7.37	0.27	0.20
Higher μ_M (50%)	17.96	1.75	1.25	2	5.5	9.63	2.67	87.69	84.39	24.2	0.92	3.77

Note: Based Table (1) parameters, except that $\Omega = 0$ (no empire-building frictions) and that $\eta_s = 0.795$.

enjoy about the same level of welfare, evaluated from the initial viewpoint: the more efficient economy, with its greater size of minority shareholders, benefits relatively more on the variety dimension, whereas the alternative economy reaps relatively more benefits from the faster pace at which intermediate inputs are improved. As with the previous experiment, during the transition neither economy systematically outperforms the other with respect to the per capita output growth rate.

6 Conclusion

This paper has investigated the impact of financial market imperfections, in the form of corporate governance frictions, on growth and industrial structure. Following prior literature, we have posited two forms of frictions: an empire building problem, such that managers enjoy private benefits from their firms' size, and a tunneling issue, such that managers can divert resources from firms. We have also posited that, though majority shareholders (firm founders) can monitor and discourage managers' tunneling activities, they cannot commit to monitoring. The design of monitoring incentives for majority shareholders allows them to extract rents, compounding managers' tunneling activities. The analysis reveals that both corporate governance frictions examined tend to increase the concentration of the market structure and depress the entry rate of new firms. However, we have also uncovered mechanisms through which the governance issues stimulate both production and innovation of incumbent firms. The empire building friction "corrects" the standard monopoly price distortion that results in a lower than Pareto optimal level of production. Delegating the production power to managers who have a bias for a larger production, this classic static distortion is partly muted. The correction of the static distortion has also long run repercussions through the rate of returns on innovation. Because the cost of development a technology is independent of the amount of production, the greater this is, the higher is the return on innovation. Moral hazard issues about the governance of the firm by making relatively more costly from the point of view of the financier the start-up of a firm, also tend to depress the entry rate and to generate larger firms relatively more engaged in innovation. In this case it is the lower return entry that pushes resources into vertical innovation. We quantified the relative importance of the forces that lead to an acceleration or a deceleration of the rate of the entry and of the innovation rate through a number of experiments. These also allowed us to make an educated guess of the likely welfare consequences of correcting corporate frictions. We concluded that the positive transitional welfare effects associated with the acceleration in firms' entry rate can be dumped down by the slower innovation rate. When the friction to be corrected is the empire building one, the monopolistic price distortion makes it more unlikely for the positive transitional welfare effects to prevail.

The analysis leaves interesting questions open for future research. The paper does not make explicit the conditions on the supply side of the financial market that could exacerbate or alleviate corporate governance issues. However, it is often argued that lax credit policies of financial institutions have allowed large businesses to pursue empire building objectives. Furthermore, such policies, and the resulting firm leverage build up, have allegedly influenced managers' ability to divert resources from firms. Thus, explicitly accounting for the role of financial institutions could yield important insights into the relation between corporate governance and growth. We leave this and other issues for future research.

Finally, one could extend the analysis by comparing the short and long run consequences corporate frictions in different industrial environments – for instance by allowing outsiders to challenge incumbent firms.

References

[1] Aghion, Philippe, and Peter Howitt. (1998) *Endogenous Growth Theory.* Cambridge, MA: MIT University Press.

[2] Aghion, Philippe, and Peter Howitt. (2006) "Growth with Quality-Improving Innovations: An Integrated Framework." In *Handbook of Economic Growth*, Edited by Philippe Aghion and Stephen Durlauf. North Holland.

[3] Bebchuk, L. A., R. Kraakman and G. G. Triantis (2000) Stock Pyramids, Cross-Ownership, and Dual Class Equity: The Creation and Agency Costs of Separating Control from Cash Flow Rights, in: Concentrated Corporate Ownership, R. Morck, ed., pp. 295-315.

[4] Bertrand, M., P. Mehta and S. Mullainathan (2002) "Ferreting Out Tunneling: An Application to Indian Business Groups," Quarterly Journal of Economics 117, 1, 121-148.

[5] Bloom, N. and J. Van Reenen (2010) "Why Do Management Practices Differ across Firms and Countries?," Journal of Economic Perspectives 24, 1, 203-24.

[6] Campbell, T. L. and P. Y. Keys (2002) "Corporate Governance in South Korea: the chaebol experience," Journal of Corporate Finance 8, 373-391.

[7] Choi, J.-P. and T. G. Cowing (1999) "Firm Behavior and Group Affiliation: The Strategic Role of Corporate Grouping for Korean Firms," Journal of Asian Economics 10, 195-209.

[8] Cooley, T. F. and V. Quadrini (2001) "Financial Markets and Firm Dynamics" The American Economic Review, Vol. 91, No. 5, pp. 1286-1310

[9] De Nicolò, G., L. Laeven and K. Ueda (2008) "Corporate Governance Quality: Trends and Real Effects," Journal of Financial Intermediation 17, 2, 198-228.

[10] Dinopoulos, Elias, and Peter Thompson. (1998) "Schumpeterian Growth without Scale Effects." *Journal of Economic Growth*, 3, 313-335.

[11] Dinopoulos, Elias, and Peter Thompson. (1999) "Scale Effects in Schumpeterian Models of Economic Growth." *Journal of Evolutionary Economics*, 9, 157-187.

[12] Djankov, Simeon, Rafael La Porta, Florencio Lopez-de-Silanes, Andrei Shleifer. (2002) "The Regulation of Entry." *Quarterly Journal of Economics*, 117, 1-37.

[13] Etro, F. (2009), Endogenous Market Structures and the Macroeconomy, Berlin and New York: Springer.

[14] Fulghieri, P. and M. Suominen (2012) "Corporate Governance, Finance, and the Real Sector," Journal of Financial and Quantitative Analysis, 47, 6, 1187-1214.

[15] Lee, P.-S. (2000) Economic Crisis and Chaebol Reform in Korea, Discussion Paper, APEC Study Center, Columbia Business School.

[16] Holmen, M. and P. Högfeldt (2009) "Pyramidal Discounts: Tunneling or Overinvestment?," International Review of Finance 9, 1-2, 133–175.

[17] Howitt, Peter. (1999) "Steady Endogenous Growth with Population and R&D Inputs Growing." *Journal of Political Economy*, 107, 715-730.

[18] Hyytinen, A., I. Kuosa and T. Takalo (2003) "Law or Finance: Evidence from Finland," European Journal of Law and Economics 16, 1, 59-89.

[19] Khanna, T. (2000) "Business Groups and Social Welfare in Emerging Markets: Existing Evidence and Unanswered Questions," European Economic Review 44, 748-761.

[20] Khanna, T. and K. Palepu (2000) "Is Group Affiliation Profitable in Emerging Markets? An Analysis of Diversified Indian Business Groups," Journal of Finance 55, 2, 867-891.

[21] Jones, Charles I. (1999) "Growth: With or without Scale Effects?" *American Economic Review Papers and Proceedings*, 89, 139-144.

[22] Laincz, Christopher, and Pietro F. Peretto. (2006) "Scale Effects in Endogenous Growth Theory: An Error of Aggregation, not Specification." *Journal of Economic Growth*, 11, 263-288.

[23] Madsen, Jakob. (2008) "Semi-endogenous versus Schumpeterian Growth Models: Testing the Knowledge Production Function Using International Data." *Journal of Economic Growth*, 13, 1-26.

[24] Manso, G. (2011) "Motivating Innovation," Journal of Finance 66, 1823-1869.

[25] Morck, R., D. Wolfenzon and B. Yeung (2005) "Corporate Governance, Economic Entrenchment, and Growth," Journal of Economic Literature 43, 3, 655-720.

[26] Nikolov, B. and T. Whited (2013) Agency Conflicts and Cash: Estimates from a Dynamic Model, Journal of Finance, forthcoming.

[27] OECD (2012) Corporate Governance, Value Creation and Growth. The Bridge between Finance and Enterprise, OECD, Paris.

[28] Peretto, Pietro F. (1998) "Technological Change and Population Growth." *Journal of Economic Growth*, 3, 283-311.

[29] Peretto, Pietro F. (1999) "Cost Reduction, Entry, and the Interdependence of Market Structure and Economic Growth." *Journal of Monetary Economics*, 43, 173-195.

[30] Peretto, Pietro F. (2003) "Fiscal Policy and Long-Run Growth in R&D-Based Models with Endogenous Market Structure." *Journal of Economic Growth*, 8, 325-347.

[31] Peretto, Pietro F., and Sjak Smulders. (2002) "Technological Distance, Growth, and Scale Effects." *The Economic Journal*, 112, 603-624.

[32] Sedgley N., 2006, A Time Series Test of Innovation-Driven Endogenous Growth, *Economic Inquiry*, 44, 318-332.

[33] Turnovsky, Stephen. (1995) *Methods of Macroeconomics Dynamics*. Cambridge, MA: MIT University Press.

[34] Ulku, Hula. (2007) "R&D, Innovation, adn Growth: Evidence from Four Manufacturing Sectors in OECD Countries." *Oxford Economic Papers*, 59, 513-535.

[35] Young, Alwyn. (1998) "Growth Without Scale Effects." *Journal of Political Economy*, 106, 41-63.

[36] Zeng, Jinli, and Jie Zhang . (2002) "Long-Run Effects of Taxation in a Non-Scale Growth Model with Innovation." *Economics Letters*, 75, 391-403.

[37] Shleifer, A. and R. W. Vishny (1997) "A Survey of Corporate Governance," Journal of Finance 52, 2, 737-83.

7 Appendix

7.1 Derivation of Example 1

Let

$$\Sigma_i(M_i, S_i) = \mu_S \log(1+S_i) - \mu_M \log(1+M_i);$$
$$c^M(M_i) = \eta_M M_i \text{ and } c^S(S_i) = \eta_S S_i.$$

The first-order conditions are

$$(1-m_i)\frac{\partial \Sigma_i(M_i(m_i,f_i), S_i(m_i,f_i))}{\partial S_i} = \frac{\partial c^S(S_i)}{\partial S_i} \Rightarrow \mu_S \frac{1-m_i}{1+S_i} = \eta_S;$$
$$-f_i \frac{\partial \Sigma_i(M_i(m_i,f_i), S_i(m_i,f_i))}{\partial M_i} = \frac{\partial c^M(M_i)}{\partial M_i} \Rightarrow \mu_M \frac{f_i}{1+M_i} = \eta_M.$$

We thus have

$$\begin{aligned}\Sigma_i(M_i(m_i,f_i), S_i(m_i,f_i)) &= \mu_S \log(1+S_i) - \mu_M \log(1+M_i) \\ &= \mu_S \log(1-m_i) + \mu_S \log\left(\frac{\mu_S}{\eta_S}\right) - \mu_M \log(f_i) - \mu_M \log\left(\frac{\mu_M}{\eta_M}\right).\end{aligned}$$

Then, we have the problem

$$\max_{f_i, m_i} \left\{ (1-m_i-f_i)\left[1 - \mu_S \log(1-m_i) - \mu_S \log\left(\frac{\mu_S}{\eta_S}\right) + \mu_M \log(f_i) + \mu_M \log\left(\frac{\mu_M}{\eta_M}\right)\right]\right\},$$

which gives us

$$1 - \mu_S \log(1-m_i) - \mu_S \log\left(\frac{\mu_S}{\eta_S}\right) + \mu_M \log(f_i) + \mu_M \log\left(\frac{\mu_M}{\eta_M}\right) = \mu_S \frac{1-m_i-f_i}{1-m_i};$$
$$1 - \mu_S \log(1-m_i) - \mu_S \log\left(\frac{\mu_S}{\eta_S}\right) + \mu_M \log(f_i) + \mu_M \log\left(\frac{\mu_M}{\eta_M}\right) = \mu_M \frac{1-m_i-f_i}{f_i}.$$

Taking the ratio

$$(1-m_i)\frac{\mu_M}{\mu_S} = f_i.$$

Substituting back in the first of the two first-order conditions above and rearranging terms

$$1 - (\mu_S - \mu_M) - \mu_S \log\left(\frac{\mu_S}{\eta_S}\right) + \mu_M \log\left(\frac{\mu_M}{\mu_S}\right) + \mu_M \log\left(\frac{\mu_M}{\eta_M}\right) = (\mu_S - \mu_M)\log(1-m_i).$$

Assuming

$$\mu_S > \mu_M \quad \text{and} \quad 1-(\mu_S-\mu_M)-\mu_S\log\left(\frac{\mu_S}{\eta_S}\right)+\mu_M\log\left(\frac{\mu_M}{\mu_S}\right)+\mu_M\log\left(\frac{\mu_M}{\eta_M}\right)<0$$

we can solve for

$$m_i^* = 1-\exp\left\{\frac{1-(\mu_S-\mu_M)-\mu_S\log\left(\frac{\mu_S}{\eta_S}\right)+\mu_M\log\left(\frac{\mu_M}{\mu_S}\right)+\mu_M\log\left(\frac{\mu_M}{\eta_M}\right)}{\mu_S-\mu_M}\right\}\in(0,1)\,;$$

$$f_i^* = (1-m_i^*)\,\frac{\mu_M}{\mu_S}\in(0,1)\,.$$

7.2 Proof of Proposition 2

When $n>0$ assets market equilibrium requires

$$A = NV\frac{1}{1-\Sigma} = \frac{\gamma\beta}{1-f^*-m^*}\frac{1}{1-\Sigma}\cdot NX = \frac{\gamma\beta}{1-f^*-m^*}\frac{1}{1-\Sigma}\frac{\theta}{P}\cdot Y, \tag{44}$$

which says that the wealth ratio A/Y is constant. This result and the saving schedule (3) allow us to rewrite the household budget (2) as the following unstable differential equation in $c\equiv C/Y$

$$\frac{\dot{C}}{C}-\frac{\dot{Y}}{Y} = (-\rho+\lambda)-(1-\theta)\frac{1}{\varsigma}+\frac{1}{\varsigma}\frac{C}{Y},$$

where $\varsigma \equiv \frac{\gamma\beta}{1-f^*-m^*}\frac{1}{1-\Sigma}\frac{\theta}{P}$. This differential equation indicates that the C/Y ratio has a unique steady state. In addition, becasue $\varsigma>0$ it is also unstable, implying that an initial condition different form the steady state value will result in a tendency for the ratio to accelerate or decelarate and eventually violate the transversaility condition. Therefore the equilibrium c must jumpt immediately to the constant value

$$c^*_{n>0} = \varsigma(\rho-\lambda)+1-\theta,$$

which is the bottom line of (28).

When $n=0$ assets market equilibrium still requires $A = NV\frac{1}{1-\Sigma}$ but it is no longer true that $NV = \left(\beta\frac{\theta}{P}/\left(1-f^*-m^*\right)\right)\cdot Y$ since by definition the free-entry condition does not hold. This means that the wealth ratio A/Y is not constant. However, the relation

$$r = \frac{(\Pi_i-I_i)}{V_i}+\frac{\dot{V}_i}{V_i}$$

holds, since it is the arbitrage condition on equity holding that characterizes the value of an existing firm regardless of how it came into existence in the first place. Imposing symmetry and inserting (8), the expression above for the return to equity, and (44) into the household budget (2) yields

$$\begin{aligned}
0 &= N\ \left[(P-1)\,X-\phi Z-I\right]+(1-\theta)\,Y-C\\
&= NZ\ \left[(P-1)\,\frac{X}{Z}-\phi-z\right]+(1-\theta)\,Y-C\\
&= \frac{NZ}{Y}\ \left[(P-1)\,\frac{X}{Z}-\phi-z\right]+1-\theta-\frac{C}{Y}.
\end{aligned}$$

The definition of x allows us to rewrite this expression as the top line of (28).

7.3 Proof of Proposition 3

We start with the expressions for the returns to quality and variety innovation (entry), reproduced here for convenience

$$r_Z = \alpha\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x - \phi\right); \tag{45}$$

$$r_N = \frac{\Theta}{\gamma\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}}\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} - \frac{\phi+z}{x}\right) + z + \frac{\dot{x}}{x}. \tag{46}$$

Proposition 2 says that c is constant when there is entry, i.e., when $n > 0$, and that in such a case the return to saving (3) becomes $r = \rho - \lambda + \dot{Y}/Y$. Therefore, we can use the expression for the return to entry (46) and the definition of x in (25) to obtain

$$n = \frac{\Theta}{\gamma\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}}\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} - \frac{\phi+z}{x}\right) - \rho + \lambda, \quad z \geq 0, \tag{47}$$

which holds for positive values of the right-hand side. The Euler equation (3) and the reduced-form production function (24) yield

$$r = \rho - \lambda + \dot{Y}/Y = \rho + z + \sigma n.$$

Combining this expression with the return to quality (45) yields

$$\alpha\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x - \phi\right) = \rho + z + \sigma n.$$

Combining this expression with the rate of entry in (47) and solving for z yields (32) in the text of the proposition. Substituting (32) back into (47) yields (33) in the text of the proposition.

With these expressions in hand, we focus on the thresholds. The definition of firm size (25) and the reduced-form production function (24) yield

$$\frac{\dot{x}}{x} = \dot{Y}/Y - n - z = \lambda - (1-\sigma)\, n\,(x).$$

Suppose that the threshold for entry is smaller than the threshold for quality innovation. Then $n\,(x) > 0$ for

$$\frac{\Theta}{\beta}\left(P - 1 - \frac{\phi+z}{\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x}\right) - \rho + \lambda > 0,$$

since $z = 0$, which yields

$$x > x_N \equiv \frac{\phi\left(\frac{\theta}{P}\right)^{-\frac{1}{1-\theta}}}{P - 1 - \frac{\beta(\rho-\lambda)}{\Theta}}.$$

Assumption (29) in the text of the proposition guarantees that this value is finite. On the other hand, $z(x) > 0$ for

$$\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x - \phi\right)\left(\alpha - \frac{\sigma\Theta}{\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x}\right) > (1-\sigma)\rho + \sigma\lambda,$$

because entry is already active, which yields

$$x > x_Z \equiv \arg\text{solve}\left\{\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x - \phi\right)\left(\alpha - \frac{\sigma\Theta}{\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x}\right) = (1-\sigma)\rho + \sigma\lambda\right\}.$$

This equation has always a finite solution x_Z and thus we do not need a condition equivalent to (29). The assumption

$$z(x_N) = \frac{\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x_N - \phi\right)\left(\alpha - \frac{\sigma\Theta}{\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x_N}\right) - (\rho - \sigma\rho + \sigma\lambda)}{1 - \frac{\sigma\Theta}{\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x_N}} < 0,$$

moreover, ensures that $x_N < x_Z$ because it says that at x_N the value of z that agents would need to choose to equalize returns is negative. The non-negativity constraint thus binds and agents choose $z = 0$. This is assumption (30) in the text of the proposition.

To understand wheteher the solution just found is a stable Nash Equilibrium, we use (47) to rewrite (46) as

$$\begin{aligned} r_N &= \frac{\Theta}{\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}}\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} - \frac{\phi+z}{x}\right) + z + \lambda - (1-\sigma)\,n(x) \\ &= \frac{\sigma\Theta}{\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}}\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} - \frac{\phi+z}{x}\right) + z + \lambda + (1-\sigma)(\rho+\lambda). \end{aligned}$$

Given x, an equilibrium with both variety and quality innovation — that is stable in the Nash sense that agents have no incentives to deviate from it — exists if in the (z, r) space this line intersects the line given by (45) from below. This requires the the line just derived is positively sloped, that is, that $1 > \sigma\Theta/\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x$ for $x > x_Z$. A sufficient condition for this to be true is $1 > \sigma\Theta/\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x_N$, which is assumption (31) in the text of the proposition.

7.4 Proof of Proposition 4

For $x \le x_N < x_Z$ we have $\dot{x}/x = \lambda$ and the economy crosses the threshold for entry in finite time. For $x_N < x < x_Z$ we have, after rearranging terms,

$$\frac{\dot{x}}{x} = \sigma\lambda + (1-\sigma)\rho - (1-\sigma)\frac{\Theta}{\beta}\left((P-1) - \frac{\phi}{\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x}\right).$$

The economy, therefore, crosses the threshold for quality innovation in finite time since firm profitability is still growing at $x = x_Z$ in light of assumption (35). To guarantee that a solution $\Psi(x) = 0$ exists, we assume

$$\begin{aligned}
\lim_{x\to\infty}\Psi(x) &= (1-\sigma)\cdot\lim_{x\to\infty}\left[\frac{\lambda}{1-\sigma} - n(x)\right] \\
&= (1-\sigma)\cdot\lim_{x\to\infty}\left[\frac{\lambda}{1-\sigma} - \frac{\Theta}{\beta}\left((P-1) - \frac{\phi + z(x)}{\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x}\right) + (\rho-\lambda)\right] \\
&= (1-\sigma)\cdot\lim_{x\to\infty}\left[\rho + \frac{\sigma\lambda}{1-\sigma} - \frac{\Theta}{\beta}\left((P-1) - \frac{\phi}{\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x} - \frac{z(x)}{\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x}\right)\right] < 0.
\end{aligned}$$

Since

$$\begin{aligned}
\lim_{x\to\infty} z(x) &= \lim_{x\to\infty}\frac{\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x - \phi\right)\left(\alpha - \frac{\sigma\Theta}{\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x}\right) - (1-\sigma)\rho - \sigma\lambda}{1 - \frac{\sigma\Theta}{\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x}} \\
&= \lim_{x\to\infty}\frac{\left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x - \phi\right)\left(\alpha - \frac{\sigma\Theta}{\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x}\right) - (1-\sigma)\rho - \sigma\lambda}{1} \\
&= \alpha(P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x,
\end{aligned}$$

we have

$$\lim_{x\to\infty}\Psi(x) = \lim_{x\to\infty}\left[\rho + \frac{\sigma\lambda}{1-\sigma} - \frac{\Theta}{\beta}(1-\alpha)(P-1)\right] < 0.$$

7.5 Proof of Proposition 5

Let

$$\varphi_1 \equiv (P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}};$$

$$\varphi_2 \equiv \frac{\Theta}{\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}}.$$

Using (33), we write the law of motion of x as:

$$\begin{aligned}
\frac{\dot{x}}{x} &= (1-\sigma)\left[\frac{\lambda}{1-\sigma} - n(x)\right] \\
&= (1-\sigma)\left[\rho + \frac{\sigma\lambda}{1-\sigma} - \frac{\varphi_2}{x}(\varphi_1 x - \phi - z(x))\right].
\end{aligned}$$

Using (32), after some algebra, we rewrite this expression as

$$\begin{aligned}\dot{x} &= (1-\sigma)\left[\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)x-\varphi_2\left(\varphi_1 x-\phi-z\left(x\right)\right)\right]\\ &= (1-\sigma)\frac{\varphi_2\left[\phi\left(1-\alpha\right)-\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)\right]-\left[\varphi_2\varphi_1\left(1-\alpha\right)-\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)\right]x}{1-\frac{\sigma\varphi_2}{x}}.\end{aligned}$$

This differential equation is linear if we approximate

$$\frac{\sigma\Theta}{\beta\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}x}\cong 0$$

in the denominator. So, finally, we write

$$\dot{x}=(1-\sigma)\left[\varphi_2\varphi_1\left(1-\alpha\right)-\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)\right]\left[\frac{\phi\left(1-\alpha\right)-\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)}{\varphi_1\left(1-\alpha\right)-\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)\frac{1}{\varphi_2}}-x\right]$$

and define

$$x^*\equiv\frac{\phi\left(1-\alpha\right)-\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)}{\varphi_1\left(1-\alpha\right)-\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)\frac{1}{\varphi_2}}=\frac{\phi\left(1-\alpha\right)-\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)}{\left(1-\alpha\right)\left(P-1\right)-\frac{\beta}{\Theta}\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)}\left(\frac{\theta}{P}\right)^{-\frac{1}{1-\theta}};$$

$$\nu\equiv(1-\sigma)\left[\varphi_2\varphi_1\left(1-\alpha\right)-\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)\right]=(1-\sigma)\left[\left(1-\alpha\right)\left(P-1\right)\frac{\Theta}{\beta}-\left(\rho+\frac{\sigma\lambda}{1-\sigma}\right)\right].$$

This gives us the expression

$$\dot{x}=\nu\cdot\left(x^*-x\right),$$

and the solution

$$x\left(t\right)=x_0e^{-\nu t}+x^*\left(1-e^{-\nu t}\right).$$

To compute the utility flow we proceed in three steps. For simplicity we omit time arguments unless necessary. Consider first

$$\frac{C}{L}=\left[1-\theta+\frac{\left(\rho-\lambda\right)\beta}{1-f^*-m^*}\frac{\theta}{P}\right]\cdot\frac{Y}{L}=\left[1-\theta+\frac{\left(\rho-\lambda\right)\beta}{1-f^*-m^*}\frac{\theta}{P}\right]\left(\frac{\theta}{P}\right)^{\frac{\theta}{1-\theta}}\cdot N^{\sigma}Z.$$

Let

$$\left[1-\theta+\frac{\left(\rho-\lambda\right)\beta}{1-f^*-m^*}\frac{\theta}{P}\right]\left(\frac{\theta}{P}\right)^{\frac{\theta}{1-\theta}}\equiv\Lambda.$$

Then

$$\log\left(\frac{C}{L}\right)=\log\Lambda+\sigma\log N_0+\sigma\log\frac{N}{N_0}+\log Z.$$

From the definition of x we have

$$x=\frac{L}{N^{1-\sigma}}\Rightarrow N=\left(\frac{L}{x}\right)^{\frac{1}{1-\sigma}}.$$

Then, recalling our assumptions on population dynamics, we have

$$\begin{aligned}
\log\left(\frac{C}{L}\right) &= \log\Lambda + \sigma\log N_0 + \frac{\sigma}{1-\sigma}\log\left(\frac{x_0}{x}\frac{L}{L_0}\right) + \log Z \\
&= \log\Lambda + \sigma\log N_0 + \frac{\sigma}{1-\sigma}\log\left(\frac{L_0 e^{\lambda t}}{L_0}\right) + \frac{\sigma}{1-\sigma}\log\left(\frac{x_0}{x}\right) + \log Z \\
&= \log\Lambda + \sigma\log N_0 + \frac{\sigma\lambda}{1-\sigma}t - \frac{\sigma}{1-\sigma}\log\left(\frac{x}{x_0}\right) + \log Z.
\end{aligned}$$

Also, we approximate

$$z = \left((P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} x - \phi\right)\alpha - (1-\sigma)\rho - \sigma\lambda.$$

Adding and subtracting z^* from $z(s)$, we obtain

$$\begin{aligned}
\log Z(t) &= \log Z_0 + \int_0^t z(s)\,ds \\
&= \log Z_0 + z^* t + \alpha\int_0^t [z(s) - z^*]\,ds \\
&= \log Z_0 + z^* t + \alpha(P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} \int_0^t [x(s) - x^*]\,ds \\
&= \log Z_0 + z^* t + \alpha(P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} (x_0 - x^*)\int_0^t e^{-\nu s}ds \\
&= \log Z_0 + z^* t + \frac{\alpha}{\nu}(P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} (x_0 - x^*)\left(1 - e^{-\nu t}\right).
\end{aligned}$$

Approximating the log, we can write

$$\begin{aligned}
\log\left(\frac{x(t)}{x_0}\right) &= \log\left(1 + \left(\frac{x(t)}{x_0} - 1\right)\right) \\
&= \left(\frac{x(t)}{x_0} - 1\right) \\
&= \frac{x(t) - x_0}{x_0} \\
&= \frac{x^* - x_0}{x_0}\left(1 - e^{-\nu t}\right).
\end{aligned}$$

These results yield, after rearranging terms,

$$\begin{aligned}
\log\left(\frac{C}{L}\right) &= \log\Lambda + \sigma\log N_0 + \log Z_0 \\
&\quad + \left(\frac{\sigma\lambda}{1-\sigma} + z^*\right)t \\
&\quad + \left[\frac{\alpha x_0}{\nu}(P-1)\left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}} + \frac{\sigma}{1-\sigma}\right]\left(1 - \frac{x^*}{x_0}\right)\left(1 - e^{-\nu t}\right).
\end{aligned}$$

Without loss of generality we set

$$\sigma \log N_0 + \log Z_0 = 0.$$

This is just a normalization that does not affect the results. We then substitute the expression derived above into the welfare functional and integrate to obtain

$$\begin{aligned} U &= \frac{1}{\rho - \lambda} \log \left[1 - \theta + \frac{(\rho - \lambda) \beta}{1 - f^* - m^*} \frac{\theta}{P} \right] \left(\frac{\theta}{P} \right)^{\frac{\theta}{1-\theta}} \\ &\quad + \left(\frac{\sigma \lambda}{1 - \sigma} + z^* \right) \frac{1}{(\rho - \lambda)^2} \\ &\quad + \frac{\alpha x_0 (P - 1) \left(\frac{\theta}{P} \right)^{\frac{1}{1-\theta}} + \frac{\sigma \nu}{1 - \sigma}}{(\rho - \lambda)(\rho - \lambda + \nu)} \left(1 - \frac{x^*}{x_0} \right), \end{aligned}$$

which is the level of welfare associated to the transition from a generic initial condition x_0.