Distance to Frontier, Selection, and Economic Growth

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Abstract

We analyze an economy where entrepreneurs engage both in the adoption of technologies from the world frontier and in innovation activities. The selection of high-ability entrepreneurs is more important for innovation activities. As the economy approaches the technology frontier, selection becomes more important. As a result, countries at early stages of development pursue an investment-based strategy, with long-term relationships, high average size and age of firms, large average investments, but little selection. Closer to the world technology frontier, there is a switch to an innovation-based strategy with short-term relationships, younger firms, less investment and better selection of entrepreneurs. We show that relatively backward economies may switch out of the investment-based strategy too soon, so certain economic institutions and policies, such as limited product market competition, that encourage the investment-based strategy may be beneficial. However, societies that cannot switch out of the investment-based strategy fail converge to the world technology frontier. The likelihood of such non-convergence traps becomes greater when policies and institutions are endogenized, enabling beneficiaries of existing policies can bribe politicians to maintain these policies.

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1 Introduction

In his famous essay, *Economic Backwardness in Historical Perspective*, Gerschenkron argued that relatively backward economies, such as Germany and Russia during the nineteenth century, could rapidly catch up to more advanced economies by introducing "appropriate" economic institutions to encourage investment and technology adoption. He emphasized the role of long-term relationships between firms and banks, of large firms and of state intervention. Underlying this view is the notion that relatively backward economies can grow rapidly by investing in, and adopting, already existing technologies. If so, the institutions that are appropriate to such nations should encourage investment and technology adoption. The rapid growth of the Soviet economy until the 1970s as well as the growth of the Singaporean and Korean economy for much of the post-war era could be viewed as examples of such investment-based growth. For example, in the Korean case, the large family-run conglomerates, the *chaebol*, appear to have played an important role, especially in generating large investments and rapid technological development. A characteristic feature of the chaebol was their low managerial turnover: a large share of the top management was closely related to the founders and career was typically determined by age. Another distinctive trait was the entrenchment with the political system. During the 1950s, 1960s and 1970s, the chaebol received strong government support in the form of import-substitution policies, subsidized loans, anti-unions legislations and preferential treatments that sheltered them from both internal and external competition.

At the other extreme, we can think of the process of innovation-based growth, where the selection of successful entrepreneurs and firms, as well as a variety of other innovation-type activities, are more important. Many view the current U.S. economy, with market-based financing, an important role for venture capital and a relatively high rate of business failures, as approximating this type of innovation-based growth.

This paper constructs a simple model to evaluate the pros and cons of investment-based and innovation-based strategies of growth, and when such strategies will arise in equilibrium. Our basic model is founded on three ingredients:

1. Experienced entrepreneurs and firms can undertake larger investments, and everything else equal, achieve higher productivity growth.

2. Entrepreneurs copy and adopt well-established technologies from the world technology frontier, and entrepreneurial ability is not crucial for this type of copying and adoption activities.

3. Entrepreneurs also undertake innovations or adapt technologies to local conditions, and entrepreneurial ability is essential in these tasks. This last point makes the *selection* of high-ability entrepreneurs important for productivity growth.

The latter two ingredients imply that entrepreneurial selection becomes more important when an economy is close to the world technology frontier. Far from this frontier, rapid technological improvements can be realized even without high-ability entrepreneurs. Closer to the frontier, there is less room for copying, and high-ability entrepreneurs, and more generally selection of the appropriate firms and activities, become more important.

The first and the third ingredients, on the other hand, generate an important tradeoff: an economy can either rely on selection, by terminating less successful entrepreneurs, or sacrifice selection for experience. While the first strategy generates more innovation, the second takes advantage of the experience of entrepreneurs and ensures larger investments.

All three ingredients together imply that the importance of selection depends on *distance to frontier*: in relatively backward economies, selection is less important, so an investment-based strategy favoring experience and copying over selection and innovation is preferable. Closer to the frontier, the society needs selection, and therefore an innovation-based strategy.

We show that both the social optimum and the equilibrium involve the economy starting with an investment-based strategy, with long-term relationships, large average size and average age of firms, larger investments and little selection. At some later point, the economy switches to an innovation-based strategy, with short-term relationships, younger firms, less investment, but greater selection. We also show that, reminiscent to Gerschenkron's analysis, relatively backward economies may tend to invest too little (switch out of the investment-based strategy too soon). The reason is an appropriability effect: firms do not take into account the greater consumer surplus created by larger investments. Therefore, government intervention that introduces "appropriate institutions" and policies encouraging long-term relationships, large firms and large investments may be beneficial. In particular, policies that restrict competition may be useful as they will encourage the continuation of existing entrepreneurs and concentrate cash in the hands of firms, encouraging investment. This argument for appropriate institutions at early stages of development thus resembles the arguments for *infant industry* protection of firms.[1] When a society is relatively backward, the socially optimal allocation should involve rapid investment, and this may require "protection" for existing firms so that they can accumulate enough cash to undertake large investments.

Our model does more than formalize this notion, however. An immediate implication of our analysis is that while an investment-based strategy may be useful at early stages of development, closer to the frontier it becomes a burden. In fact, societies that do not switch from an investment-based strategy to an innovation-based strategy will *fail to converge* to the world technology frontier, despite the strong convergence forces created by copying and adoption of existing technologies. Intuitively, an economy that follows an investment-based strategy will not achieve a good selection of entrepreneurs, limiting productivity growth and creating a non-convergence trap. We show that such non-convergence traps never arise in the absence of incentive problems. However, with entrepreneurial incentive problems/moral hazard, equilibrium traps are possible. The reason is as follows: incentive problems create entrepreneurial rents both now and in the future. Incumbent entrepreneurs can then use their current rents as "retained earnings" in order to shield themselves from outside competition and achieve future rents.

In the last part of the paper, we discuss the political economy of appropriate institutions. When policies and institutions respond to lobbying activities, traps become more likely. In particular, "political economy traps", where lobbying prevents the economy from switching to a more competitive environment and an innovation-based strategy, emerge. The underlying idea is simple. In our model the "optimal" product market organization is less competitive when the society is far away from the frontier, but at some point the degree of competition should be increased. This creates a natural political economy problem: at a critical juncture, a policy that has enriched a given set of agents—here the "capitalists"— has to be reversed. But these agents, in no little part because they have been benefiting from this policy, will typically be politically

[1] There are obvious differences between our mechanism and the traditional infant industry literature, that focuses on trade regulations. Yet, the common ground is the policy implication that governments should shelter insider firms from competition, in order to promote investment and productivity growth.

powerful, and attempt to prevent the change in policy. We show that under certain circumstances societies may get trapped with "inappropriate institutions" and relatively backward technology, *precisely because* earlier they adopted appropriate institutions for their circumstances at the time.

The Korean case also illustrates the dangers of the investment-based strategy, and the political economy problems created by such a strategy. The close links between government officials and the chaebol appear to have been important for the early success of the Korean economy (e.g., Evans, 1995). The government favors were gratefully acknowledged by the families owning chaebol, in the form of generous bribes to major politicians.[2] Although this system proved successful in fostering industrialization and growth through large investment rates when Korea was a technologically backward economy, it suffered a severe disruption during the Asian crisis in the 90s. Some conglomerates went bust, others split, others, like Daewoo, were forced into restructuring. Interestingly, changes in managerial practices have been argued to be a key issue. Analysts have stressed the need of selecting capable managers who can generate profitable ideas, as opposed to loyal clerks who progress in the hierarchy according to age.

Our paper relates to a number of different literatures. First, the notion that entrepreneurial ability is more important for innovation than copying is reminiscent to the emphasis in Galor and Tsiddon (1997) and Hassler and Rodriguez (2001) on ability in times of economic change and turbulence. In this context, the paper by Tong and Xu (2000), which compares "multi-financier" and "single-financier" contractual relationships as a function of the stage of development, is also related; the main idea of their paper is that while single-financier relationships tend to dominate at early stages of development when countries incur high sunk costs of R&D, multi-financier relationships tend to dominate at later stages of development when selecting good R&D projects becomes more important. But this model of financial contracting and growth does not deal with dynamic convergence aspects, and does not develop the contrast between innovation-based and investment-based growth strategies.

Second, our paper is related to the literature on the relationship between growth and

[2] As an example, the patriarchs of Samsung, Daewoo and Jinro, three major chaebol, were convicted in the late 1990's of major bribing of two former presidents. Significantly, their jail sentences were pardoned in 1997. Koreans have coined the expression "jungkyung yuchak", literally, "adhesion of politics and business" to refer to the entrenchment of government and chaebol (see Asiaweek, October 10, 1997).

contracting, including Acemoglu and Zilibotti (1999), Martimort and Verdier (2001) and Francois and Roberts (2001), as well as more generally, to the literature on growth and finance, including the papers by Greenwood and Jovanovic (1990), King and Levine (1993), La Porta et al (1997), Acemoglu and Zilibotti (1997), Rajan and Zingales (1998), Carlin and Mayer (2002) and Tadesse (2002). For example, Acemoglu and Zilibotti (1999) develop a model where informational problems become less severe as an economy develops, and derive implications from this for the organizational firms and markets. Francois and Roberts (2001) show how a high rate of creative destruction may discourage long-term relationships within firms.

Third, our model also relates to work on technological convergence and growth, in particular, to the papers by Howitt (2000) and Howitt and Mayer (2002), which extend the growth framework of Aghion and Howitt (1992) to a multi-countries set up. Howitt and Mayer (2002), for example, analyze convergence clubs, prolonged stagnations, and twin-peak convergence patterns. But they do not provide an explicit treatment of institutions and contractual relations and they do not emphasize the trade-off between innovation-based and investment-based growth strategies.

Finally, our political economy section builds on the lobbying models by Grossman and Helpman (1997, 2001). While we simplify these models considerably in many dimensions, by introducing credit constraints on lobbies we also add a link between current economic power and political power. In this respect, our analysis is also related to Do (2002) who analyzes a lobbying model with credit-constrained agents, where income distribution affects policy.

Perhaps the most interesting link is between our approach and the existing debate on the necessary degree of government intervention in less developed countries. A number of authors including Stiglitz (1995) call for government intervention in situations where externalities and market failures are rampant. Less developed countries approximate these situations of market failure quite well. According to this reasoning, governments should be intervening more in less developed countries. A recent paper by Hausmann and Rodrik (2001) pushes this line further and argues that most of the growth related activities in less developed countries create externalities because of potential imitation by others and learning by doing, and suggest that successful less developed countries have to rely on government intervention and subsidies, as was this case in South Korea and Taiwan. They write: "the world's most successful economies during the last few decades prospered doing things that are more commonly associated with failure," and propose similar "infant-industry-type" intervention for other countries. The same point of view is developed by many political scientists, including those working in the literature on "State Autonomy", for example, Johnson (1982), and more nuanced versions of these, such as the thesis of "Embedded Autonomy" by Evans (1995). These arguments are criticized by many economist and political scientists, however, because they ignore the potential for government failure. For example, Shleifer and Vishny (2000), argue that governments are often captured by interest groups or by politicians themselves. This suggests that in less developed countries, where checks on governments are weaker, the case for government intervention should be weaker as well. Our model combines these two insights. We derive a reason for possible government intervention at the early stages of development, while also highlighting why such intervention can be counterproductive or even "disastrous" because of political economy considerations.

The rest of the paper is organized as follows. Section 2 outlines the basic model. Section 3 characterizes the equilibrium refinancing policy, analyzes its implications for growth and the convergence or non-convergence to the technological frontier, and compares it to the welfare-maximizing outcome. Section 4 discusses government policy may be useful in creating "appropriate institutions" for convergence, but also how such policies may be captured by groups that are their main beneficiaries, creating political economy traps. Section 5 concludes.

2 The model

2.1 Agents and production

The model economy is populated by a continuum of overlapping generations of two-period lived agents. The population is constant. Each generation consists of a mass $1/2$ of "capitalists" with property rights on "production sites", but no entrepreneurial skill, and a mass $(L+1)/2$ of workers who are born without any financial asset but are endowed with entrepreneurial skills. Property rights are transmitted within dynasties, but parents have no explicit altruistic concern. Each worker is endowed with one unit of labor per unit of time, which she supplies inelastically without disutility. Each worker can be high ability, probability λ, or low ability, probability $1-\lambda$. Workers can be either employed in the final good production, or as entrepreneurs in the intermediate sector. Ability, which affects productivity only in entrepreneurship, is unknown at birth, and becomes publicly revealed after the first period of entrepreneurial activity. All agents are risk neutral and discount the future at the rate r.

There is a unique final good in the economy, which can be also used as an input to produce intermediate inputs, and which we take as the numeraire. The productive technology for the final good uses labor and a continuum one of intermediate goods as inputs with production function:

$$y_t = \frac{1}{\alpha} L^{1-\alpha} [\int_0^1 (A_t(\nu))^{1-\alpha} x_t(\nu)^{\alpha} \ d\nu], \tag{1}$$

where $A_t(\nu)$ is the productivity in sector ν at time t, $x_t(\nu)$ is the flow of intermediate good ν used in final good production again at time t, and $\alpha \in [0,1]$.

In each intermediate sector ν, one production site at each date has access to the most productive technology, $A_t(\nu)$, and so, this "leading firm" enjoys monopoly power.

At any point in time, there will be a mass $1/2$ of young firms and a mass $1/2$ of mature firms. Each leading firm employs an entrepreneur, for production as well as for innovation, and incurs a setup cost, as will be described below. It then has access to a technology to transform one unit of the final good into one unit of intermediate good of productivity $A_t(\nu)$. A fringe of additional firms can also imitate this monopolist, and produce the same intermediate good, with the same productivity $A_t(\nu)$, but without using the production site or an entrepreneur. They are correspondingly less productive, and need χ units of the final good to produce one unit of the intermediate, where $1/\alpha \geq \chi > 1$ (naturally, these firms will not be active in equilibrium). We will think of the parameter χ as capturing both technological factors, and also government regulation regarding competitive policy. A higher χ corresponds to a less competitive market, with the upper bound, $\chi = 1/\alpha$, corresponding to the situation of unconstrained monopoly. The fact that $\chi > 1$ implies that imitators are less productive than the incumbent producer in any intermediate good sector, while $\chi \leq 1/\alpha$ implies that this productivity gap is sufficiently small for the incumbent to be forced to charge a limit price to prevent competition from imitators (e.g., Grossman and Helpman, 1991). This limit price is equal to the marginal cost of imitators:

$$p_t(\nu) = \chi, \tag{2}$$

so as to deter entry from the competitive fringe.

The final good sector is competitive so that any input is paid its marginal product. Thus, each intermediate good producer ν at date t faces the inverse demand schedule:

$$p_t(\nu) = (A_t(\nu) L / x_t(\nu))^{1-\alpha}, \tag{3}$$

Equations (2) and (3) together imply:

$$x_t(\nu) = \chi^{-\frac{1}{1-\alpha}} A_t(\nu) L, \tag{4}$$

with equilibrium monopoly profits correspondingly equal to:

$$\pi_t(\nu) = (p_t(\nu) - 1) x_t = \delta A_t(\nu) L \tag{5}$$

where $\delta \equiv (\chi - 1) \chi^{-\frac{1}{1-\alpha}}$ is monotonically increasing in χ (since $\chi \leq 1/\alpha$). Thus, a higher δ corresponds to a less competitive market, and implies higher profit for monopolistic firms.

>From (1) and (4), it follows that:

$$y_t = \alpha^{-1} \chi^{-\frac{\alpha}{1-\alpha}} A_t L. \tag{6}$$

where

$$A_t \equiv \int_0^1 A_t(\nu) \, d\nu. \tag{7}$$

is the average level of technology in this society. The market clearing wage level is, in turn, given by:

$$w_t = (1-\alpha) \alpha^{-1} \chi^{-\frac{\alpha}{1-\alpha}} A_t. \tag{8}$$

Finally, let net output, y_t^{net}, denote final output minus the cost of intermediate production. Then,

$$y_t^{net} = y_t - \int_0^1 x_t(\nu) \, d\nu = \zeta A_t L, \tag{9}$$

where $\zeta \equiv (\chi - \alpha) \chi^{-\frac{1}{1-\alpha}} / \alpha$ is monotonically decreasing in χ. Notice that for given average technology A_t, both total output and net output are decreasing in the extent of monopoly power, i.e., in χ, because of standard static distortions.

2.2 Technological progress and productivity growth

In every period and in each intermediate good sector, the leading firm can improve over the existing technology. A mass 1/2 of the innovating firms are young and a mass 1/2 are mature. Entrepreneurs, and entrepreneurial ability, are crucial for improvements in technology. Each entrepreneur selected to run a production site must make an investment of a fixed amount. These costs can be financed either through retained earnings, or through borrowing from a set of competitive intermediaries ("funds"), who collect earnings from one set of agents and lend them to entrepreneurs. We assume that these intermediaries function without any costs. Then, returns are realized and shared between entrepreneurs, intermediaries and capitalists according to the contractual arrangements between the three parties that are described in the next subsection.

We now make three important assumptions on the process of technological progress:

1. Experienced entrepreneurs can run larger projects and create correspondingly bigger technological improvements. This assumption captures the notion that, everything else equal, it is beneficial to have agents who have already acted as entrepreneurs continue in these tasks.

2. Entrepreneurs *adopt* technologies from the frontier. Entrepreneurial ability plays a minor role in their success in technology adoption. This assumption captures the notion that relatively backward economies can grow by adopting already well-established technologies, and the adoption of these technologies is often relatively straightforward.

3. Entrepreneurs also engage in *innovation* or *adaptation* of existing technologies to their local conditions. Entrepreneurial ability matters for success in this activity. This assumption builds in the notion that ability is important for technological improvements, and selection of high-ability entrepreneurs is important for growth.

First, let us denote the growth rate of the world technology frontier, $\overline{A}_t$, by g, i.e.,

$$\overline{A}_t = (1+g)^t \overline{A}_0. \tag{10}$$

We return to the determination of this growth rate below. All countries have a state of technology $A_t \leq \overline{A}_t$. We formulate the three above assumptions as follows: the productivity of intermediate good ν at time t is given by

$$A_t(\nu) = \varepsilon_t(\nu)\left(\eta \bar{A}_{t-1} + \gamma_t(\nu) A_{t-1}\right), \tag{11}$$

where $\varepsilon_t(\nu)$ is a term that depends on the experience of the entrepreneur and the match between the entrepreneur and the firm; $\gamma_t(\nu)$ denotes the ability of the entrepreneur running this firm, and η is a positive constant. This equation states that all intermediate goods benefit from the state of world technology in the previous period, $\bar{A}_{t-1}$, by copying or adopting existing technologies, irrespective of the ability of the entrepreneur. They also "innovate" over the existing body of local knowledge, A_{t-1}, and success in innovation depends on ability. Experience and match-specific elements, $\varepsilon_t(\nu)$, affect the productivity of both adoption and innovation activities.

Rearranging equation (11), we obtain a simpler equation

$$\frac{A_t(\nu)}{A_{t-1}} = \varepsilon_t(\nu)\left(\eta \frac{\bar{A}_{t-1}}{A_{t-1}} + \gamma_t(\nu)\right). \tag{12}$$

Equation (12) shows the importance of *distance to technology frontier*, as captured by the term $A_{t-1}/\bar{A}_{t-1}$. When this term is small, the country is substantially behind the technology frontier, and the major improvements in technology come from adoption. When $A_{t-1}/\bar{A}_{t-1}$ is high and the country is close to the frontier, innovations matter more. This feature that innovation and adaptation of less-well-established technologies, and hence ability, become more important when the country is closer to the frontier, implies that *entrepreneurial selection* becomes more important as the country develops and approaches the technology frontier.

For simplicity, we assume that the innovation component is equal to 0, i.e., $\gamma_t(\nu) = 0$, when the entrepreneur is low ability, and denote the productivity of a high-ability entrepreneur by $\gamma > 0$, i.e., $\gamma_t(\nu) = \gamma$ when entrepreneur in sector ν is high ability. Recall that a proportion λ of entrepreneurs within each cohort are high ability. To guarantee a decreasing speed of convergence to the world technology frontier, we assume throughout that $\lambda\gamma < 1$.

The term $\varepsilon_t(\nu)$ in (12) specifies the importance of experience in technological improvements. First, for simplicity, we assume that old entrepreneurs are not productive in the technology used by young firms, so $\varepsilon_t(\nu) = 0$ if a young firm hires an old entrepreneur. Therefore, young firms will always employ young workers as entrepreneurs.

Next, more importantly, we assume that $\varepsilon_t(\nu) = 1$ if a mature firm is run by an experienced entrepreneur. If the entrepreneur is not experienced, then we have $\varepsilon_t(\nu) = \varepsilon < 1$. The interpretation is that an experienced entrepreneur can run a larger project, and hence generate greater technological improvements and revenues.

This feature introduces a trade-off between experience and selection: everything else equal, more experienced entrepreneurs run larger projects, and generate more innovation and higher profits. However, some of the more experienced entrepreneurs will have been revealed to be low ability, and high-ability entrepreneurs are more productive. So a society might either choose to have greater selection, and on average younger and smaller firms, or less selection and on average older and larger firms. The trade-off between experience and selection effects will vary over the process of development because the importance of innovation vs. adoption of well-established technologies changes, as captured by equation (12).

Finally, $k_t(\nu)$ denotes the investment that the entrepreneur in sector ν must make in order to undertake the project, and we assume:

$$k_t(\nu) = \varepsilon_t(\nu)\,\kappa A_{t-1}, \tag{13}$$

where $\varepsilon_t(\nu) = 1$ for mature firms run by an experienced entrepreneur, and $\varepsilon_t(\nu) = \varepsilon$ otherwise. This introduces the assumption mentioned above that experienced entrepreneurs run larger projects. In addition, in order to guarantee balanced growth, the investment requirements are assumed to increase in proportion to the productivity of the aggregate technology, A_{t-1}.

The state of local knowledge in the economy simply reflects the average of the productivity in various intermediate product sectors. To specify the law of motion of A_t note three things: (1) half of the firms will be young and the other half old; (2) average productivity among young firms is simply $A_{Yt} = \varepsilon\left(\eta\bar{A}_{t-1} + \lambda\gamma A_{t-1}\right)$, since they will hire young entrepreneurs, a fraction λ of these will be high ability, with productivity $A_t(\nu) = \varepsilon\left(\eta\bar{A}_{t-1} + \gamma A_{t-1}\right)$, and the remainder will be low ability, with productivity $A_t(\nu) = \varepsilon\eta\bar{A}_{t-1}$ (recall equation (11)); (3) clearly, all entrepreneurs revealed to be high ability will be retained, and average productivity among mature firms will depend on their decision whether to refinance low-ability entrepreneurs. Denote the decision to refinance a low-ability experienced entrepreneur by $R_t \in \{0, 1\}$, with $R_t = 1$ corresponding to refinancing. Then, average productivity among mature firms is:

$$A_{Ot} = \begin{cases} \eta \bar{A}_{t-1} + \lambda\gamma A_{t-1} & \text{if } R_t = 1 \\ (\lambda + (1-\lambda)\varepsilon)\,\eta\bar{A}_{t-1} + (1 + (1-\lambda)\varepsilon)(\lambda\gamma A_{t-1}) & \text{if } R_t = 0. \end{cases}$$

The first line has exactly the same reasoning as for the average productivity of young firms. The second line simply follows from the fact that a fraction λ of the entrepreneurs were revealed to be high ability, are retained, and have productivity $A_t(\nu) = \eta\bar{A}_{t-1} + \gamma A_{t-1}$, and the remaining $1-\lambda$ of entrepreneurial posts are filled with young entrepreneurs, who have average productivity $\varepsilon\left(\eta\bar{A}_{t-1} + \lambda\gamma A_{t-1}\right)$. Combining the productivity of young and old entrepreneurs, we have that

$$A_t = \begin{cases} \frac{1+\varepsilon}{2}\left(\eta\bar{A}_{t-1} + \lambda\gamma A_{t-1}\right) & \text{if } R_t = 1 \\ \frac{1}{2}\left((\lambda + \varepsilon + (1-\lambda)\varepsilon)\,\eta\bar{A}_{t-1} + (1 + \varepsilon + (1-\lambda)\varepsilon)\,\lambda\gamma A_{t-1}\right) & \text{if } R_t = 0. \end{cases} \quad (14)$$

In line with our discussion in the introduction, when $R_t = 1$, the average firm size is larger, firms are on average older, relationships are longer (all entrepreneurs are refinanced), there is more investment (experienced entrepreneurs run larger projects), but less selection. We think of this case as an economy pursuing an *investment-based strategy* of growth. In contrast, when $R_t = 0$, there is less investment, firms are smaller and younger, but there are shorter relationships and more selection. We refer to this case as *an innovation-based strategy* of growth.

2.3 Incentive problems

The final element of the environment is the incentive problems faced by firms. Entrepreneurs engaged in innovative activities, or even simply entrusted with managing firms, are difficult to monitor. This creates a standard moral hazard problem, often resulting in rents for entrepreneurs, or at the very least, in lower profits for firms. We formulate this problem in the simplest possible way, and assume that after output, innovations and profits are realized, the entrepreneur can run away with a fraction μ of the returns, and will never be caught. We think of the parameter μ as a measure of the importance of incentive problems, or equivalently, a measure of credit market imperfections resulting from these incentive problems.

Since entrepreneurs are never caught and entrepreneurial performance (hence ability) is revealed even when the entrepreneur runs away with returns, old entrepreneurs will be rewarded according to their revealed ability, irrespective of whether they have run away or not in the first period of their lives. Therefore, in order to prevent entrepreneurs from running away, entrepreneurs have to be paid a fraction μ of the profits.[3]

Below we will analyze both the case of no moral hazard, i.e., $\mu = 0$, and the economy with moral hazard where $\mu > 0$.

2.4 Financial intermediation, contracts and equilibrium

We now specify the contractual relations between capitalists (firms), intermediaries and entrepreneurs, and define an equilibrium.

Production requires a production site (owned by a capitalist), an entrepreneur, and financing to pay for the set-up cost of the project. Production sites are a scarce factor in this economy, since they allow the use of a superior technology. So the capitalists who own them will appropriate rents subject to satisfying the individual rationality and/or incentive constraints of intermediaries and entrepreneurs.

Capitalists make contractual offers to a subset of workers selected to become entrepreneurs and to intermediaries. Investments are financed either through the retained earnings of entrepreneurs, or through borrowing from intermediaries (recall that young capitalists and entrepreneurs have no wealth to finance projects). There is free entry into financial intermediation, and no cost of financial intermediation.

Omitting time subscripts when this causes no confusion, we use P^s_{fe}, W^s_{fe} and V^s_{fe} to denote, respectively, the contractual payments to intermediaries, entrepreneurs and firms, conditional on the firm's age ($f \in \{Y, O\}$), entrepreneur's age-experience ($e \in \{Y, O\}$) and entrepreneur's revealed ability ($s \in \{H, L\}$). The sum of the payments to the three agents involved in each relation cannot exceed the total profits of the firm:

$$P^s_{fe} + W^s_{fe} + V^s_{fe} \leq \pi^s_{fe}, \tag{15}$$

where π^s_{fe} is a profit level of the leading firm of age f with an entrepreneur of age-experience e, with ability s.

Free entry into intermediation implies that intermediaries have to make zero (expected) profits. In addition, we assume that financial intermediation takes place within

[3] We assume that investments are publicly observable, hence, entrepreneurs cannot steal the investments; they can only run away with the profits/cash-flow from the project.

a period, so that there are no interest costs to be covered. Thus, we need the following free entry conditions for intermediaries:

$$\begin{aligned} E\left(P^s_{Ye,t}\right) &= k_{Ye,t}, \\ E\left(P^s_{Oe,t}\right) &= k_{Oe,t} - (1+r)\,RE^s_{t-1}, \end{aligned} \tag{16}$$

where E is the expectations operator, $k_{fe,t}$ is required investment in a firm of age f, entrepreneur of age e, at time t defined as in (13), and RE^s_{t-1} denotes the fraction of costs financed by an old entrepreneur through retained earnings (the term $1+r$ is there since these are retained earnings carried from the previous period, so earn interest). By assumption, young firms have to run smaller projects, and will be run by young entrepreneurs who have no wealth, hence have to borrow the full cost of the project. Mature firms may be run by old entrepreneurs, who may have some retained earnings. The amount of retained earnings (invested in the firm) is decided by the entrepreneur.

In the presence of moral hazard, the payment to an entrepreneur must satisfy the following incentive constraint:

$$IC^s_{fe} = W^s_{fe} - \mu\pi^s_{fe} \geq 0. \tag{17}$$

There are also individual rationality constraints for entrepreneurs, who must prefer entrepreneurship to becoming workers. Each entrepreneur can be employed as a worker, and receive w_t. Thus for old entrepreneurs, we need:

$$IR^s_{OO,t} = W^s_{OO,t} - w_t - (1+r)\,RE^s_{t-1} \geq 0.$$

Both types of entrepreneurs have to be paid at least the market wage. In addition, if they decide to inject any of their own retained earnings from the previous period, they have to be compensated for the discounted value of these retained earnings as well. Given this constraint and risk neutrality, without loss of any generality, we can set $RE^s_{t-1} = W^s_{YY,t-1}$, thus, in equilibrium we have entrepreneurs putting in all their earnings from the previous periods for financing investments. In addition, for young entrepreneurs working in a mature firm, we need $IR^s_{OY,t} = E\left(W^s_{OY,t}\right) - w_t \geq 0$. Here what matters is the expected wage, since the ability of a young entrepreneur is unknown. Also because the entrepreneur is young, there are no retained earnings.

The individual rationality constraint for a young entrepreneur working in a young firm is more complicated, since such an entrepreneur might receive rents in the second period of his life. To capture this, we write the individual rationality constraint as

$$IR_{YY,t} = E\left(W_{YY,t}^{s}\right) - w_t + \frac{1}{1+r} E\left(IR_{OO,t+1}^{s}\right) \geq 0, \tag{18}$$

where the final term is the expectation of rents in the second period of entrepreneurship, if any.

Individual rationality (and incentive compatibility) constraints for old entrepreneurs might be slack, because of competition between capitalists. More specifically, consider an old entrepreneur who has been revealed to be high ability. Since this entrepreneur can be productively employed by any mature firm, all mature capitalists will compete for his services. This competition will stop only when mature capitalists make the same profits with or without such an high-ability entrepreneur. In other words, we need:

$$V_{OO}^{H} = \max\left\langle V_{OO}^{L}, E\left(V_{OY}^{s}\right)\right\rangle, \tag{19}$$

that is, the profits from hiring an high-ability old entrepreneur must be equal to the profits from the next-best option, which is either hiring a low-ability experienced entrepreneur, or the expected value of hiring a young entrepreneur.

As for low-ability experienced entrepreneurs, two cases are possible. First, mature firms may find it profitable to employ them. Recall that the variable $R_t \in \{0, 1\}$ denotes the retention decision of mature firms for low-ability entrepreneurs. We will have $R_t = 1$ when $V_{OO}^{L} > E\left(V_{OY}^{s}\right)$. In this case, the distribution of rents between entrepreneurs and firms is indeterminate, because the demand for experienced low-ability entrepreneurs would exactly match supply. To avoid such indeterminacy, we assume that an infinitesimal proportion of young firms cease to be productive after one period. This implies that the supply of low-ability entrepreneurs exceeds the demand, so that either the incentive compatibility or the individual rationality constraint of low-ability experienced entrepreneurs is binding when they are rehired. Formally, we have the following complementary slackness condition:

$$\min\left\langle IC_{OO}^{L}, IR_{OO}^{L}\right\rangle = 0. \tag{20}$$

Alternatively, mature firms may prefer $R_t = 0$, i.e., to hire young entrepreneurs, instead of low-ability experienced entrepreneurs, and run smaller innovative projects, which will be the case when $V_{OO}^L < E\left(V_{OY}^s\right)$. In this case, the old low-ability entrepreneurs are fired and become workers in the second period of their lives. Whether employed by young or by mature firms, young entrepreneurs are "abundant". Competition drives their returns to the minimum level that is allowed by incentive compatibility and individual rationality constraints. Formally:

$$\min \left\langle IC_{YY}^s, IR_{YY} \right\rangle = \min \left\langle IC_{OY}^s, IR_{OY} \right\rangle = 0 \tag{21}$$

for $s \in \{H, L\}$, i.e., at least one of the incentive productivity and individual rationality constraints have to hold.

Finally, we focus on economies where young firms find it profitable to innovate. Namely, $E\left(V_{YY}^s\right) \geq 0$. If this condition failed, there would be no-activity in equilibrium (other than by the competitive fringe).[4]

We can now formally define an equilibrium in this economy. Before doing so, it is useful to introduce the notation of a_t to denote the distance to frontier, i.e.,

$$a_t \equiv \frac{A_t}{\bar{A}_t}. \tag{23}$$

This variable is the key state variable in our analysis below, and we start with the definition of the "static equilibrium" for a given state of the economy, a_t:

Definition 1: (Static Equilibrium) Given a_t, an equilibrium is a set of intermediate good prices, $p_t(\nu)$, that satisfy (2), a wage rate, w_t, given by (8), profit levels given by (5), and a set of payments to intermediaries, entrepreneurs and capitalists, $\left\{P_{fe}^s, W_{fe}^s, V_{fe}^s\right\}$ and a continuation decision with low-ability entrepreneurs, R_t, such that the feasibility equation, (15), and the free entry equation for intermediaries, (16), are satisfied, the incentive compatibility and individual rationality constraints for young and low-ability old for entrepreneurs hold with complementary slackness, i.e., (20) and (21) hold, competition among capitalists ensures (19) and we have $R_t = 1$ when $V_{OO}^L > E\left(V_{OY}^s\right)$, and $R_t = 0$ when $V_{OO}^L < E\left(V_{OY}^s\right)$.

[4]The following parameter restriction is sufficient to rule out the no-activity equilibrium:

$$\delta L(\eta + \lambda\gamma) > \max\left\langle \frac{\kappa + (1-\alpha)(\alpha\varepsilon)^{-1}\chi^{-\frac{\alpha}{1-\alpha}}}{(\lambda + (1-\lambda)(1-\mu))}, \frac{\kappa}{(1-\mu)} \right\rangle \tag{22}$$

This condition is also sufficient for old firms to the active, since old firms have the option to hire a young entrepreneur and run a small project.

Definition 2: (Dynamic Equilibrium) A dynamic equilibrium is a sequence of static equilibria such that the law of motion of the state of the economy is given by:

$$a_t = \begin{cases} \frac{1+\varepsilon}{2(1+g)} \left(\eta + \lambda\gamma a_{t-1}\right) & \text{if } R_t = 1 \\ \frac{1}{2(1+g)} \left(\left(\lambda + \varepsilon + (1-\lambda)\,\varepsilon\right)\eta + \left(1 + \varepsilon + (1-\lambda)\,\varepsilon\right)\lambda\gamma a_{t-1}\right) & \text{if } R_t = 0. \end{cases} \tag{24}$$

Notice that the law of motion of a_t is obtained simply by using (10), (12), (14), and (23).

3 Equilibrium

We now characterize the decentralized ("laissez-faire") equilibrium of the economy as defined in the previous section. Throughout, the emphasis will be on whether the economy pursues an investment-based strategy or an innovation-based strategy, i.e., whether $R_t = 1$ or $R_t = 0$, and how this decision varies with the state of the economy/distance to frontier, a_t.

3.1 The case of no moral hazard.

We start with the case of no moral hazard ($\mu = 0$). Since there is no incentive problem, only experienced entrepreneurs who were revealed to be high ability can extract rents. So the individual rationality constraints of both young entrepreneurs and experienced low-ability entrepreneurs have to hold, and they will all earn the market wage w_t given by (8).

As a result, mature firms will refinance low ability entrepreneurs, i.e., $R_t = 1$, if and only if

$$V^L_{OO,t} \geq E\left(V^s_{OY,t}\right) \Leftrightarrow \pi^L_{OO,t} - w_t - \kappa A_{t-1} \geq E\left(\pi^s_{OY,t}\right) - w_t - \varepsilon\kappa A_{t-1}$$

where κA_{t-1} is the level of investment with an old entrepreneur, while $\varepsilon\kappa A_{t-1}$ is the smaller level of investment when the mature firm hires an inexperienced young entrepreneur. Using (5)-(12) and (13) as well as the definition of a_t from (23), and simplifying terms, we can rewrite the inequality above as

$$\delta L\eta - \kappa > \delta\varepsilon L\left(\eta + \lambda\gamma a_{t-1}\right) - \varepsilon\kappa,$$

Therefore, the equilibrium without moral hazard will have a "threshold property". It will feature an investment-based strategy (refinancing of unsuccessful entrepreneurs) if and only if

$$a_{t-1} < a_r(\mu = 0) \equiv \frac{(1-\varepsilon)\eta}{(1-\varepsilon)\kappa/\delta L + \varepsilon\lambda\gamma}, \tag{25}$$

where $a_r(\mu = 0)$ is the threshold of the distance the frontier such that mature firms are indifferent between $R_t = 1$ and $R_t = 0$.

For future reference, we state this as a short proposition:

Proposition 1 In the economy with no moral hazard, i.e., $\mu = 0$, the equilibrium has $R_t = 1$ and an investment-based strategy for all $a_{t-1} < a_r(\mu = 0)$, and $R_t = 0$ and an innovation-based strategy for all $a_{t-1} > a_r(\mu = 0)$ where $a_r(\mu = 0)$ is given by (25).

Countries farther away from the world technology frontier follow an investment-based strategy, and are characterized by long-term relationships between firms and entrepreneurs, larger and older firms, more investment and less selection. As an economy approaches the world technology frontier and passes the threshold $a_r(\mu = 0)$, it switches to an innovation-based strategy with shorter relationships, on average younger firms, and more selection. The intuition for this result is that the selection of entrepreneurs becomes more important as the economy approaches the world technology frontier, since there remains less room for technological improvements simply based on copying and adoption.

Notice that this equilibrium, like the one with moral hazard in the next subsection, already has a flavor of some of the issues raised by Gerschenkron. When the economy is relatively backward, there will be a very different set of (equilibrium) arrangements compared to an economy close to the technology frontier. However, Gerschenkron's emphasis was on policies that relatively backward economies ought to pursue, which is a topic we will revisit in the next section.

Finally, we note that the equilibrium allocation characterized in Proposition 1 also applies to a range of positive μ's, for $\mu \leq \underline{\mu}$, such that the incentive compatibility constraints of both young and old low-ability entrepreneurs are not binding for all $a \in [0, 1]$. See the Appendix for the characterization of $\underline{\mu}$.

3.2 The case with moral hazard

In this section, we characterize the equilibrium allocation for levels of μ sufficiently high so that the individual rationality constraints of both young and old low-ability entrepreneurs are slack, and their incentive compatibility constraints are binding. Typically, this case requires μ to be greater than some threshold $\bar{\mu}$. However, it is straightforward to check that as we consider large economies where population, L, and investment costs, k, are large, all individual rationality constraints will be slack, while incentive constraints will bind (this is because the wage rate, w_t, does not depend on the population, L, while profits do). In other words, in this case both $\underline{\mu}$ and $\bar{\mu}$ will become arbitrarily small. Here we focus on such large economies where incentive constraints are binding and individual rationality constraints are slack.

As before, the interesting question is whether low-ability entrepreneurs are refinanced. Since, if refinanced, entrepreneurs can extract rents, they are willing to use their first-period retained earnings to cover part of the investment cost. The retained earnings of an entrepreneur who was revealed to be of low ability at the end of period $t-1$ are given by:

$$RE_{t-1} = (1+r)\,\mu\pi^L_{OO,t-1} = (1+r)\,\mu\delta L\varepsilon\eta\bar{A}_{t-2} = \frac{1+r}{1+g}\mu\delta L\varepsilon\eta\bar{A}_{t-1}, \qquad (26)$$

where r denotes the net interest rate.

Since the incentive compatibility constraint of a low-ability entrepreneur is binding, the entrepreneur receives a fraction μ of the profits. Thus, the value of a mature firm retaining a low-skill entrepreneur at date t can then be expressed as:

$$\begin{aligned} V^L_{OO,t} &= (1-\mu)\,\pi^L_{OO,t} - E\left(P_{OO,t}\right) \\ &= \left((1-\mu)\,\delta L\eta + \frac{1+r}{1+g}\mu\delta L\varepsilon\eta - \kappa a_{t-1}\right)\bar{A}_{t-1}, \end{aligned}$$

where the last line makes use of the fact that $E\left(P_{OO,t}\right) = \kappa A_{t-1} - RE_{t-1}$ as specified in equation (16).

In contrast, the expected value of a mature firm employing a young entrepreneur of unknown ability is equal to:

$$\begin{aligned} E\left(V^s_{OY,t}\right) &= (1-\mu)\,E\left(\pi^s_{OY,t}\right) - \varepsilon\kappa A_{t-1} \\ &= \left((1-\mu)\,\delta L\varepsilon\left(\eta + \lambda\gamma a_{t-1}\right) - \varepsilon\kappa a_{t-1}\right)\bar{A}_{t-1}. \end{aligned}$$

where $\lambda\gamma$ denotes the expected ability of a young entrepreneur. This expression incorporates the fact that the entrepreneur will be paid a fraction μ of the profits she generates irrespective of her revealed ability.

Again, mature firms will continue their relationship with experienced low-skill entrepreneurs, i.e., $R_t = 1$, if and only if $V^L_{OO,t} \geq E\left(V^s_{OY,t}\right)$ or, equivalently, whenever:

$$a_{t-1} \leq a_r(\mu, \delta) \equiv \frac{\left((1-\mu)(1-\varepsilon) + \frac{1+r}{1+g}\mu\varepsilon\right)\eta}{(1-\mu)\varepsilon\lambda\gamma + \kappa(1-\varepsilon)/\delta L}, \tag{27}$$

where a_r is the threshold for the distance to frontier such that mature firms are indifferent between $R_t = 1$ and $R_t = 0$. The sequence of the economy moving from an investment-based strategy to an innovation-based strategy is the same as in the case of no moral hazard. It is important to note that the threshold $a_r(\mu, \delta)$ in (27) limits to the no-moral hazard threshold $a_r(\mu = 0)$ in (25) as $\mu \to 0$, i.e., as incentive problems disappear.

Next observe that a_r is increasing with δ. This implies that when product markets are less competitive (higher δ), the switch to an innovation-based strategy occurs later (i.e., the threshold $a_r(\mu, \delta)$ is greater). This reflects two effects. First, a higher δ implies greater profits and greater retained earnings for old unsuccessful entrepreneurs, making refinancing more likely. Second, a higher δ affects the profit differential between hiring a young and an experienced entrepreneur. The sign of this differential is, in general, ambiguous. However, in the relevant range this latter effect also makes an investment-based strategy more likely. The reason is that refinancing existing entrepreneur corresponds to "greater investment", since the amount of investment is κ as opposed to $\varepsilon\kappa$ with a new entrepreneur. While the capitalist pays the full cost of the investment, because of the standard appropriability effect, some of the returns go to consumers in the form of consumer surplus. This discourages the strategy with a greater investment. A higher δ enables the capitalists to capture more of the surplus, encouraging refinancing.

The effect of the extent of incentive problems/credit market imperfections, μ, is ambiguous, however. On the one hand, a higher μ increases the earnings retained by young entrepreneurs, thereby "shielding" these insiders from outside competition, and encouraging refinancing. On the other hand, a higher μ reduces the profit differential between hiring a young and an old low-ability entrepreneur. If

$$\frac{\kappa}{\delta L} < \frac{\varepsilon^2\lambda\gamma}{((1+\varepsilon)(1+g)/(1+r) - \varepsilon)(1-\varepsilon)}, \tag{28}$$

then, the former effect dominates and a_r is increasing in μ, and more severe moral hazard/credit market problems encourage the investment-based strategy. In contrast, when (28) does not hold, these problems encourage the termination of low-ability entrepreneurs.

We summarize our discussion in this subsection with the following:

Proposition 2 In the economy with moral hazard, the equilibrium has $R_t = 1$ and an investment-based strategy for all $a_{t-1} < a_r(\mu, \delta)$, and $R_t = 0$ and an innovation-based strategy for all $a_{t-1} > a_r(\mu, \delta)$ where $a_r(\mu, \delta)$ is given by (27). Also the threshold of distance to frontier, $a_r(\mu, \delta)$, is increasing in δ, so the switch to an innovation-based strategy occurs later when the economy is less competitive.

4 Growth and convergence patterns

In this section, we first contrast the growth path of a laissez-faire economy with that of an economy in which refinancing decisions maximize growth. Then, we analyze the possibility of *non-convergence traps* where productivity and output per capita never converge to the world technology frontier. In the last subsection, we compare the equilibrium allocation to the welfare-maximizing allocation, which differs from the growth-maximizing one, since greater growth may come at the cost of greater investments and lower current consumption. We will see that the comparison of the equilibrium to the welfare-maximizing allocation is the same as the comparison of the equilibrium to the growth-maximizing allocation. Since the latter comparison is simpler, we start with that one.

4.1 Growth-maximizing strategies

Consider an allocation where prices $p_t(\nu)$ satisfy (2), the wage rate, w_t, is given by (8), high-ability old entrepreneurs are refinanced, exactly as in an equilibrium allocation. However, suppose that the decision to refinance low-ability old entrepreneurs, R_t, is made to maximize the growth rate of the economy. What is this growth-maximizing refinancing decision, $R_t^{\max}$? The answer is straightforward: simply compare the two branches of equation (24) corresponding to $R_t = 1$ and $R_t = 0$, and pick whichever is greater. This immediately implies that the growth-maximizing decision will be $R_t^{\max} = 1$

if:

$$a_{t-1} < \widehat{a} \equiv \frac{\eta(1-\varepsilon)}{\lambda\gamma\varepsilon}. \tag{29}$$

Just like the equilibrium, the growth-maximizing strategy also has a threshold property: the investment-based strategy is pursued until the economy reaches a certain distance to frontier, $\widehat{a}$, and then the innovation-based strategy maximizes growth.

So far, there is nothing to guarantee that this threshold, $\widehat{a}$, is less than 1. If it were greater than 1, then the growth-maximizing allocation would never feature a switch to an innovation-based strategy. We assume that $\widehat{a} < 1$, so that the growth-maximizing strategy will involve both refinancing and no-refinancing of low-ability entrepreneurs over the different stages of the development process.

Assumption 1: $\gamma > \eta(1-\varepsilon)/\lambda\varepsilon$.

If $\hat{a} < a_r$ the laissez-faire economy generates excess refinancing, or spends too much time with an investment-based strategy: there is a range of states, $a_{t-1} \in [\hat{a}, a_r]$, where all entrepreneurs are refinanced in equilibrium whereas, from a growth maximization standpoint, it would be better not to refinance entrepreneurs who were revealed to be of low ability. In contrast, when $\hat{a} > a_r$, the laissez-faire economy generates insufficient refinancing: there is a range of states, $a_{t-1} \in [a_r, \hat{a}]$, where only high-ability entrepreneurs are refinanced in equilibrium whereas, from a growth maximization standpoint, it would be better to refinance all entrepreneurs, even the low-ability ones.

Figure 1 HERE

Whether the growth-maximizing cut-off $\hat{a}$ is larger or smaller than the laissez-faire no-refinancing threshold, a_r, depends on the level of competition (δ) and on the degree of capital market imperfection (μ). First, we have that $a_r(\mu = 0) < \hat{a}$: the economy with no moral hazard switches to an innovation-based strategy too quickly. To see this, simply observe that

$$\hat{a} = \frac{\eta(1-\varepsilon)}{\lambda\gamma\varepsilon} > \frac{\eta(1-\varepsilon)}{(1-\varepsilon)\kappa/\delta L + \lambda\gamma\varepsilon} = a_r(\mu = 0).$$

The same result carries on to economies with sufficiently small μ's. Intuitively, the investment-based strategy involves greater investments, and as discussed above, because of the appropriability effect, capitalists are biased against greater investments. This makes the equilibrium switch to the innovation-based strategy with smaller investments too soon relative the growth-maximizing allocation.

While the economy without any moral hazard always switches to an innovation-based strategy too soon, i.e., $a_r(\mu = 0) < \hat{a}$, the economy with moral hazard might have $a_r(\mu > 0, \delta) > \hat{a}$. This is because moral hazard generates a high salary for young entrepreneurs, and they can use these as retained earnings to "shield" themselves from competition. In other words, severe moral hazard problems might protect low-ability insiders, and make the economy remain in an investment-based strategy with little entrepreneurial selection for an excessively long duration. The possibility of staying too long in this regime will play an important role in our discussion below.

In addition, we can see that the degree of competition also affects the comparison between the equilibrium and the growth-maximizing allocations. Recall that a less competitive environment, i.e., a lower δ, encourages the investment-based strategy (cfr., equation (27)), while the growth-maximizing allocation does not depend on δ (cfr., equation (29)). Greater competition may close or reduce the gap between the equilibrium and the growth-maximizing allocations, however, depending on whether we start from a situation where $\hat{a} > a_r(\mu, \delta)$ or $\hat{a} < a_r(\mu, \delta)$. More specifically, given μ, there exists a unique level of competition δ, denoted by $\widehat{\delta}(\mu)$, such that $\hat{a} = a_r(\mu, \delta)$, where simply comparing equations (27) and (29), we have:

$$\widehat{\delta}(\mu) = \frac{(1-\varepsilon)^2 (1+g)\kappa}{L\varepsilon^2 \lambda \gamma \mu (1+r)}.$$

If product market competition is lower than this threshold, namely, if $\delta > \widehat{\delta}(\mu)$ (see upper panel in Figure 1), then $\hat{a} < a_r$, and the laissez-faire economy generates excess refinancing relative to the growth-maximizing allocation (that there is a set of parameter values where $\hat{a} < a_r$ can be seen by taking μ and δL large and comparing (27) and (29)). In this case, greater competition would close the gap. Conversely, if product market competition is high, namely if $\delta < \widehat{\delta}(\mu)$ (see lower panel in Figure 1), then $\hat{a} > a_r$ and the economy switches to an innovation-based strategy too quickly, and now lower competition would close the gap between the equilibrium and the growth-maximizing allocations.

We summarize this discussion with the following:

Proposition 3 The laissez-faire economy with sufficiently small μ switches to an innovation-based strategy ($R_t = 0$) too soon, i.e., $a_r(\mu = 0) < \hat{a}$ relative to the growth-maximizing allocation. An economy with sufficiently high μ and δL, on the other hand, switches to an innovation-based strategy too late.

4.2 Non-convergence traps

We now discuss how an economy that fails to switch to an innovation-based strategy might not converge to the world technology frontier. Before doing so, we need to specify the relationship between country growth and the growth rate of the world technology frontier, g. The analysis so far applies without specifying this relationship, but it is natural to think that an economy that pursues an innovation-based strategy and is close to the world frontier should grow approximately at the same rate as the world frontier. In other words, we can think of endogenizing the growth rate of the world technology frontier, g, as resulting from the most advanced economy pursuing an innovation-based strategy. The next assumption imposes this restriction:

Assumption 2: $1 + g = \left[\left(\lambda + \varepsilon + (1 - \lambda)\varepsilon\right)\eta + \left(1 + \varepsilon + (1 - \lambda)\varepsilon\right)\lambda\gamma\right]/2.$

Figure 2 depicts the relationships between a_t and a_{t-1} under refinancing (REF curve) and no-refinancing ($NOREF$ curve) of old low-ability entrepreneurs. The fact that both curves are linear simply follows from the expressions in equation (24). The two lines intersect at $a_{t-1} = \widehat{a}$, defined by equation (29), since by construction at this point they generate the same amount of growth (that $\widehat{a} < 1$ is guaranteed by Assumption 1). When a is greater than $\hat{a}$, refinancing reduces growth, and for a less than $\hat{a}$, it increases growth, as discussed in the previous section. Furthermore, Assumption 2 implies that the $NOREF$ curve hits the 45 degree line at $a = 1$. This immediately implies that the REF curve is below the 45 degree at $a = 1$. Therefore, an economy that always pursues an investment-based strategy (i.e., refinances low-ability entrepreneurs) will *not* converge to the frontier. This result is simply implied by the structure of our model and

Assumption 1.[5]

Since the REF curve starts above the 45 degree line, and ends below it at $a = 1$, it must intersect it at some

$$a_{trap} = \frac{(1+\varepsilon)\,\eta}{2\,(1+g) - \lambda\gamma\,(1+\varepsilon)} < 1. \tag{30}$$

This is the value of the distance to frontier at which an economy pursuing an investment-based strategy will get trapped: it is a fixed point of equation (24) for $R_t = 1$.

The existence of this point, a_{trap}, does not imply that there will be equilibrium traps, since the economy may switch to an innovation-based strategy before a_{trap}. Therefore, the necessary and sufficient condition for an equilibrium trap is $a_{trap} < a_r$. When is this condition likely to be satisfied?

>From (30), a_{trap} is an increasing function of $\lambda\gamma$, and is independent of $\kappa/\delta L$ and μ. Also, recall that a_r is a decreasing of $\kappa/\delta L$ and of $\lambda\gamma$, and, if condition (28) holds, it is an increasing function of μ, see equation (27). These observations imply that smaller values of $\kappa/\delta L$ and $\lambda\gamma$ make it more likely that $a_{trap} < a_r$. Furthermore, if condition (28) holds, then traps are more likely in economies with severe incentive problems/credit market imperfections.

These comparative statics are intuitive. First, smaller values of κ and greater values of δL make it easier for low-ability entrepreneurs to get refinanced. Since a trap can only arise due to excess refinancing, a greater $\kappa/\delta L$ reduces the possibility for traps. Second, large values of $\lambda\gamma$ increase the opportunity cost of refinancing low ability entrepreneurs, and make it less likely that the a trap can emerge due to lack of selection. Finally, when condition (28) holds, more severe credit market imperfections (incentive problems) favor insiders by raising retained earnings, and increase the probability of a trap due to excess refinancing.

An implication of this discussion, combined with the discussion in the previous subsection, is that less competitive environments may foster growth at early stages of development (farther away from the technology frontier), but will later become harmful to growth, and prevent convergence to the frontier. In particular, there exists a cut-off competition level, say, $\delta^* = \delta^*(\mu)$ such that $a_r\,(\mu, \delta^*\,(\mu)) = a_{trap.}$. Then, an economy with a sufficiently high level of competition, $\delta < \delta^*(\mu)$, will never fall into a non-convergence

[5] As long as Assumption 1 holds, the only way to have the refinancing economy converge to frontier is to have the no-refinancing economy grow *faster* than the frontier, which is logically inconsistent.

trap. Too high competition may cause a slowdown in the process of technological convergence at earlier stages of development, but does not affect the long-run equilibrium.[6]. Low competition, instead, has detrimental effects in the long-run. An immediate implication of this is that when $a_r < \hat{a}$, an economy with more competitive product markets will initially grow slower than a less competitive economy, but later "leapfrog" it, when the less competitive economy becomes stuck in a non-convergence trap.

4.3 Welfare analysis

In this subsection, we compare the laissez-faire equilibrium with the refinancing policy that maximizes social welfare. We will see that the economy with no moral hazard pursues an investment-based strategy (refinancing of low-ability entrepreneurs) for too long, while an economy with moral hazard may have too much or too little refinancing relative to the social optimum.

More formally consider a planner who maximizes the present discounted value of the consumption stream, with a discount factor $\beta \equiv 1/(1+r)$, i.e., she maximizes $C_t + \sum_{j=1}^{\infty} \beta^t C_{t+j}$, where $C_t = \zeta L A_t - \int_0^1 k_t(\nu)\, d\nu$ is equal to net output minus investment at date t with

$$\int_0^1 k_t(\nu)\, d\nu = \begin{cases} \left(\frac{1+\varepsilon}{2}\right) \kappa A_{t-1} & \text{if } R_t = 1 \\ \frac{\lambda + \varepsilon(2-\lambda)}{2} \kappa A_{t-1} & \text{if } R_t = 0. \end{cases}$$

As before, we start with an allocation where prices $p_t(\nu)$ satisfy (2), the wage rate, w_t, is given by (8), high-ability old entrepreneurs are refinanced, exactly as in an equilibrium allocation, but we now suppose that the decision to refinance low-ability old entrepreneurs, R_t, is made to maximize welfare. In other words, the planner only controls the refinancing decision, R_t.

To gain some intuition, it is useful to start by characterizing the choice of a "myopic planner" who disregards future generations, i.e., $\beta = 0$. The myopic planner chooses the refinancing policy at t so as to maximize total consumption at t. The myopic planner refinances low ability entrepreneurs if and only if $a_{t-1} < a_{mfb}$, where the threshold a_{mfb}

[6] If competition were so low that even financing young entrepreneurs were not profitable, then high competition might also lead to non-convergence. The condition in footnote 4 rules out this possibility.

is such that $R_t = 0$ and $R_t = 1$ yield the same consumption, i.e.,

$$a_{mfb} \equiv \frac{\eta(1-\varepsilon)}{(1-\varepsilon)\frac{\kappa}{\zeta L} + \varepsilon\lambda\gamma}.$$

Note here that the expression of a_{mfb} is identical to the expression of $a_r(\mu = 0)$ (see equation (25)), except that here ζ replaces δ in (25). Recall that because of the appropriability effect, $\zeta > \delta$. This implies that $a_{mfb} > a_r(\mu = 0)$, i.e., the planner puts more weight on the benefits of innovation than the equilibrium allocation. Therefore, the planner will choose refinancing (an investment-based strategy) over a larger range of a's. The planner's choice can also be compared with the growth-maximizing policy. Since the planner takes into account the cost of innovation, ignored by the growth-maximizing strategy, we have $a_{mfb} < \hat{a}$. Thus the myopic planner sets $a_{mfb} \in (a_r(\mu = 0), \hat{a})$.

Now, consider a non-myopic planner who also cares about future consumption, i.e., she has $\beta > 0$. The non-myopic planner realizes that, by increasing the no-refinancing threshold on a_{mfb}, she can increase future consumption at the expense of current consumption. For any positive β, small increases of the threshold starting at a_{mfb} involve no first-order loss in current consumption, while generating first-order gains in productivity (A_t) and in the present discounted value of future consumption. Thus, the non-myopic planner will choose a threshold, $a_{fb} > a_{mfb}$, therefore, a fortiori, $a_{fb} > a_r(\mu = 0)$, proving that the equilibrium switch to an investment-based strategy occurs too soon. Moreover, we can see that a_{fb} cannot exceed the growth-maximizing threshold, $\hat{a}$. Any candidate threshold larger than $\hat{a}$, say $\tilde{a} > \hat{a}$, can be improved upon, since any threshold in the range $(\tilde{a}, \hat{a}]$ increases both current and future consumption relative to $\tilde{a}$. Thus, the optimal threshold cannot be to the right of $\hat{a}$. In summary, we have

$$a_r(\mu = 0) < a_{mfb} < a_{fb} < \hat{a}.$$

By continuity, the same inequality holds in economies with sufficiently low μ's. The analysis establishes, then:

Proposition 4 The laissez-faire economy with sufficiently small μ switches to an innovation-based strategy ($R_t = 0$) too soon, i.e., $a_r(\mu = 0) < a_{fb}$ relative to the welfare-maximizing allocation. An economy with sufficiently high μ and δL, on the other hand, switches to an innovation-based strategy too late.

The last part of the proposition simply follows from the second part of Proposition 3, where we show that with sufficiently high μ and δL, we have $a_r > \hat{a}$, combined with the observation that $a_{fb} < \hat{a}$.

Finally note that the same argument as in Proposition 4 applies if we were to compare the laissez-faire economy to the unconstrained first best, where the planner also controls pricing decisions. The unconstrained planner would set monopoly distortions to zero, so ζ would reach its highest possible value, $(1-\alpha)/\alpha$, and the planner would have a greater incentive to choose an investment-based strategy.

5 Policy, appropriate institutions and political economy traps

The analysis in the previous section established that:

1. The equilibrium allocation, the growth-maximizing allocation and the social optimum all involve an investment-based regime with high investment, long-term relationships, and larger firms, followed by an innovation-based regime with lower investment, shorter relationships, younger firms and more selection as the economy moves closer to the technology frontier.

2. Unless incentive/credit market problems are very severe and the economy is highly non-competitive, the equilibrium switch to an innovation-based strategy will happen too soon. In other words, economies farther away from the frontier might have a tendency to "invest too little" and grow "too slowly".

These observations raise the possibility of useful policy interventions along the lines suggested by Gerschenkron: relatively backward economies intervening to increase investment in order to ensure faster adoption of technologies and development. In this section, we discuss possible policies to foster growth, how they can be interpreted as corresponding to "appropriate institutions" for countries at different stages of development, and how endogenizing policy might also turn appropriate institutions into "inappropriate institutions" because of political economy considerations, and generate traps.

5.1 Policy and appropriate institutions

Consider an equilibrium allocation with $a_r(\mu, \delta) < a_{fb}$. A policy intervention that encourages greater investment will increase welfare and growth over a certain range.

There are a number of different policies that can be used for this purpose. Probably the most straightforward is an investment subsidy. Imagine the government subsidizing a fraction s of the cost of investment. If s is chosen appropriately, the economy can be induced to switch from an investment-based strategy to an innovation-based strategy exactly at a_{fb} or (at $\hat{a}$, depending on the purpose of policy). However, investment subsidies are difficult to implement, especially in relatively backward economies where tax revenues are scarce. In addition, it may be difficult for the government to observe exactly the level of investment made by firms.

Other instruments which affect the equilibrium threshold $a_r(\mu, \delta)$ include the degree of anti-competitive policies, such as entry barriers, merger policies etc.. These policies are captured by the parameter χ in our model, and recall that δ is monotonically increasing in χ. Thus high values of χ or δ correspond to a less competitive environment. Starting from a situation where $a_r(\mu, \delta) < a_{fb}$, policies that restrict competition will close the gap between the equilibrium threshold and the social optimum (or the growth-maximizing point). Although restricting competition creates static losses, in the absence of feasible tax/subsidy policies this may be the best option available for encouraging faster growth and technological convergence.

The situation where the government chooses a less competitive institutional environment in a relatively backward economy in order to encourage more investment, long-term relationships and faster technological convergence is reminiscent to Gerschenkron's analysis. Appropriate institutions for relatively backward economies may then be thought to correspond to those that create a less competitive and perhaps "less fluid" environment, and encouraging longer-term relationships and greater investment. This is also, in some sense, similar to the famous "infant-industry" arguments that call for protection and government support for industries at early stages of development.

But our analysis also reveals that such institutions limiting competition are harmful for economies closer to the world technology frontier. Appropriate institutions for early stages of development are *inappropriate* for an economy close to the world technology frontier. Therefore, any economy that adopts such institutions must then abandon them at some point; otherwise, it will end up in a non-convergence trap.

A sequence of optimal policies whereby certain interventions are first adopted and then abandoned raises important political economy considerations, however. Groups that benefit from anti-competitive policies will become richer while these policies are implemented, and will oppose the change in policy. To the extent that economic power buys political power, they will be quite influential in opposing such changes. Therefore, the introduction of appropriate institutions to foster growth also raises the possibility of "political economy traps", where certain groups oppose the change in policy, and the economy ends up in a non-convergence trap because, at early stages of development, it adopted appropriate institutions.

We now build a simple political economy model where special interest groups, depending on the economic power, may capture politicians. Our basic political-economy model is a simplified version of the special-interest-group model of Grossman and Helpman (1997, 2001) combined with our growth setup.

5.2 Political economy traps

Suppose that competition policy (the "institutional" environment), χ , is determined in each period by a politician (or government) who cares about the welfare of living agents, but is also sensitive to bribes—or campaign contributions. For tractability, we adopt a very simple setup: the politician's pay-off is equal to PA_{t-1}, where $P > 0$, if she behaves honestly and chooses the socially desirable policy, and to B_t otherwise, where B denotes a monetary bribe the politician might receive in order to pursue a different strategy.[7] P may be interpreted as a measure of the aggregate welfare concerns of politicians or, more interestingly, as the quality of the system of check-and-balances that limit the ability of special interest groups to capture politicians. We will refer to P as the "honesty parameter" of politicians. When P is greater, the political system is less corruptible. This formulation is similar to that in Grossman and Helpman (1997, 2001), but simpler since in their formulation, the utility that the politician gets from adopting various policies is a continuous function of the distance from the ideal policy. As in their setup, the politician is assumed to have perfect commitment to deliver the competition policy promised to an interest group in return for bribes.

At any point in time, there are young and old agents. Young agents have no wealth, so they cannot bribe politicians. We also assume that only capitalists can organize

[7] The utility of pursuing the right policy is assumed to be linearly increasing in A in order to ensure stationary policies in equilibrium, since bribes will be increasing in A.

as interest groups, so the only group with the capability to bribe politicians are old capitalists.

To simplify the analysis further, we assume that the institutional choice facing the politician is between high and low competition, i.e., $\chi_t \in \{\underline{\chi}, \bar{\chi}\}$ where $\alpha^{-1} \geq \bar{\chi} > \underline{\chi}$. We set, by analogy, $\delta_t = (\chi_t - 1)\chi_t^{-\frac{1}{1-\alpha}} \in \{\underline{\delta}, \bar{\delta}\}$ and $\zeta_t = \frac{1}{\alpha}(\chi_t - \alpha)\chi_t^{-\frac{1}{1-\alpha}} \in \{\underline{\zeta}, \bar{\zeta}\}$. The assumption that χ is a discrete rather than a continuous choice variable is reasonable, since the ability of the politicians to fine-tune institutions is often limited (i.e., they can either impose entry barriers or not, etc.).

We start our analysis by characterizing the policy that would be chosen by an *honest politician* who will never be influenced by bribes (i.e., $P = \infty$). First, note that the honest politician will not choose low competition ($\chi = \bar{\chi}, \delta = \bar{\delta}$) for $a_{t-1} \leq a_r(\mu, \underline{\delta})$, since over this range, even with high competition there is refinancing, i.e., $R_t = 1$, so low competition would simply create static distortions without affecting equilibrium refinancing decisions (see Figure 3).

Figure 3 HERE

Will the honest politician choose low competition for any $a > a_r(\mu, \underline{\delta})$? It is straightforward to verify that in this case she prefers low competition if and only if $a_{t-1} \leq a_{wm}$, where a_{wm} is such that:[8]

$$a_{wm} \equiv \frac{\left(\bar{\zeta}(1+\varepsilon) - \underline{\zeta}(\lambda + \varepsilon(2-\lambda))\right)\eta}{\left(\underline{\zeta}(\lambda\gamma(1+\varepsilon(2-\lambda))) - \bar{\zeta}(\lambda\gamma(1+\varepsilon)) + (1-\varepsilon)(1-\lambda)\kappa/L\right)}. \tag{31}$$

a_{wm} is the threshold of the distance to frontier such that low competition and $R_t = 1$ give the same level of current consumption as greater competition and $R_t = 0$. Honest politicians will prefer low competition when $a \in [a_r(\mu, \underline{\delta}), a_{wm}]$, when this set is

[8] a_{wm} is derived by equating consumption under (i) refinancing and low competition, $\bar{\zeta}$, and (ii) no refinancing and high competition, $\underline{\zeta}$. Formally, we set:

$$\bar{\zeta}L\left(\frac{1+\varepsilon}{2}(\eta + \lambda\gamma a_{wm})\right) - \frac{1+\varepsilon}{2}\kappa a_{wm}$$
$$= \underline{\zeta}L\frac{1}{2}\left((\lambda + \varepsilon + (1-\lambda)\varepsilon)\eta + (1+\varepsilon+(1-\lambda)\varepsilon)\lambda\gamma a_{wm}\right) - \frac{\lambda + \varepsilon(2-\lambda)}{2}\kappa a_{wm},$$

Simplifying this expression gives (31).

nonempty. The reason why low competition ceases to be desirable when $a > a_{wm}$ is that the benefits from low competition decline as the economy gets closer to the frontier.

In the rest of the section, we restrict attention to economies where $a_{wm} > a_r(\mu, \underline{\delta})$, implying that there exists a non-empty range, $a \in [a_r(\mu, \underline{\delta}), a_{wm}]$ (see, again, Figure 3) where the honest politician chooses low competition in order to enhance growth and welfare. We show in the Appendix that the set of parameters such that this range exists is non-empty.

Next consider the competition policy set by a politician who responds to bribes (i.e., P finite). Clearly, capitalists always prefer low to high competition, as this increases their profits. Let $B^W(a_{t-1}, \bar{A}_{t-1})$ denote the maximum bribe that capitalists are *willing* to pay in order to induce the low competition policy, $\chi_t = \overline{\chi}$, rather than the high competition policy, $\chi_t = \underline{\chi}$.[9]

We assume that agents cannot borrow to pay bribes, so the amount of bribes that they can pay will be also limited by their current income. This assumption introduces the link between economic power and political power in our context: richer agents can pay greater bribes. Let $B^C(\delta_{t-1}, a_{t-1})$ denote the maximum bribe that they *can* pay, where $\delta_{t-1} \in [\underline{\delta}, \bar{\delta}]$ was the level of competition at date $t-1$. This is equal to the share of the profits generated by young firms in period $t-1$ that accrues to capitalists:

$$B^C(\delta_{t-1}, a_{t-1}, \bar{A}_{t-1}) = \frac{1+r}{1+g}\left(\delta_{t-1}(1-\mu)\varepsilon(L\eta + \lambda\gamma a_{t-1}) - \kappa a_{t-1}\right)\bar{A}_{t-1}. \tag{32}$$

The maximum bribes capitalists will pay are therefore:

$$B(\delta_{t-1}, a_{t-1}, \bar{A}_{t-1}) = \min\left\langle B^W(a_{t-1}, \bar{A}_{t-1}), B^C(\delta_{t-1}, a_{t-1}, \bar{A}_{t-1})\right\rangle.$$

We focus on economies where capitalists are credit constrained in the range of interest. Sufficiently small values of ε guarantee that this is the case. Thus, from now on,

[9] Let $R(\delta, a_{t-1}) \in \{0,1\}$ denote the refinancing decision conditional on the policy δ and distance from frontier a_{t-1}. Then, the maximum bribe that capitalists are willing to pay is given by

$$\begin{aligned}B^W(a_{t-1}, \bar{A}_{t-1}) &= \left(\bar{\delta}\left(1 - R(\bar{\delta}, a_{t-1})\right) - \underline{\delta}\left(1 - R(\underline{\delta}, a_{t-1})\right)\right) \\ &\times (1-\mu)L\left((\lambda + (1-\lambda)\varepsilon)\eta + (1 + (1-\lambda)\varepsilon)\lambda\gamma a_{t-1}\right)\bar{A}_{t-1} + \\ &\left(\bar{\delta}R(\bar{\delta}, a_{t-1}) - \underline{\delta}R(\underline{\delta}, a_{t-1})\right)(1-\mu)L(\eta + \lambda\gamma a_{t-1})\bar{A}_{t-1} - \\ &- \left(R(\bar{\delta}, a_{t-1}) - R(\underline{\delta}, a_{t-1})\right)\left(1 - (\lambda + (1-\lambda)\varepsilon)\right)\kappa a_{t-1}\bar{A}_{t-1}.\end{aligned}$$

It can be shown that $B^W(a_{t-1}, \bar{A}_{t-1}) / (a_{t-1}\bar{A}_{t-1})$ is a continuous decreasing function of a_{t-1}.

$B\left(\delta_{t-1}, a_{t-1}, \bar{A}_{t-1}\right) = B^C\left(\delta_{t-1}, a_{t-1}, \bar{A}_{t-1}\right)$. This is in the spirit of capturing the notion that economic and political power are related. If capitalists were not credit constrained, this link would be absent.

The politician will be induced to change the policy to competition level $\underline{\chi}$ if and only if

$$B^C(\delta_{t-1}, a_{t-1}, \bar{A}_{t-1}) \geq PA_{t-1}.$$

Using (32), we can rewrite this inequality as

$$\frac{1+r}{1+g}\left(\delta_{t-1}(1-\mu)\varepsilon L(\eta+\lambda\gamma a_{t-1}) - \kappa a_{t-1}\right)/(1+g) \geq Pa_{t-1} \tag{33}$$

We define a_L and a_H as the unique values of a_{t-1} such that (33) holds with equality for, respectively, $\delta_{t-1} = \bar{\delta}$ and $\delta_{t-1} = \underline{\delta}$. We have:

$$a_L \equiv \frac{\eta\bar{\delta}(1-\mu)\varepsilon L}{P\frac{1+g}{1+r} + \kappa - \lambda\gamma\bar{\delta}(1-\mu)\varepsilon L} \text{ and } a_H \equiv \frac{\eta\underline{\delta}(1-\mu)\varepsilon L}{P\frac{1+g}{1+r} + \kappa - \lambda\gamma\underline{\delta}(1-\mu)\varepsilon L}$$

The politicians will be bribed to maintain low competition as long as $a_{t-1} \leq a_H$. Similarly, they will be bribed to switch to low competition when $a_{t-1} \leq a_L$.

It is immediate to see that $a_H \geq a_L$, since capitalists make greater profits with low competition and have greater funds to bribe politicians. This formalizes the idea that once capitalists become economically more powerful, they are more likely to secure the policy that they prefer. Note that both cut-offs, a_L and a_H, are non-increasing functions of P, which captures the fact that more honest politicians will be harder to convince to pursue the policy preferred by capitalists.

Figure 4 HERE

Now consider Figure 4. For $a \leq a_H$, the politician is successfully bribed (if necessary) and low competition prevails. If $a \geq a_L$, there is no bribe, and the politician chooses the welfare-maximizing policy. Finally, if $a \in (a_H, a_L)$, the outcome is *history-dependent.* If competition is initially low, capitalists enjoy greater monopoly profits and are sufficiently wealthy to successfully lobby to keep competition low. If competition is initially high, capitalists do not make as much profits and do have not enough funds to buy politicians. As a result, there is no effective lobbying activity in equilibrium.

Next consider the evolution of the economy described in Figure 4, where we assume that $a_H > a_{wm}$. This economy starts with a technological level a_0. Irrespective of past competition policies, the lobby of capitalists is wealthy enough to buy the anti-competitive policy $\bar{\chi}$, and correspondingly, $\bar{\delta}$. In earlier stages of development $(a < a_L)$, the only effect of the lobbying activity is a static distortion that reduces consumption, but it has no effect on innovation and growth. In some intermediate stage of development, the anti-competitive policy actually become growth-enhancing. When $a > a_{wm}$, however, the industrial policy resulting from lobbying activities becomes harmful for consumption and growth. Growth slowdowns and the economy may even get stuck into a non-convergence trap.

It is interesting to investigate when such a "political economy trap" can arise. Two conditions are necessary and sufficient for a non-convergence trap to arise:

1.
$$\underline{\delta} < \delta^*(\mu) < \overline{\delta}, \tag{34}$$

   where, recall, $\delta^*(\mu)$ was defined as the cut-off competition level such that $a_r(\mu, \delta^*(\mu)) = a_{trap.}$. Under this assumption, the anti-competitive policy, $\overline{\chi}$, leads to a non-convergence trap, where low-ability entrepreneurs are always refinanced and the economy pursues an investment-based strategy. The high competition policy, $\underline{\chi}$, would have instead ensured convergence to the world technology frontier.

2.
$$a_{trap} < a_{\overline{x}}, \tag{35}$$

   This condition implies that when the economy reaches a_{trap}, and convergence comes to a halt, the anti-competitive lobby continues to prevent the switch of policy that would be necessary to induce further convergence.

These two conditions, (34) and (35), are more likely to be satisfied when P is low, i.e., when the political system is more corruptible. Therefore, political economy traps are more likely in societies with weak political institutions, and such institutions might have to be more careful in pursuing government interventions.

Figure 5 HERE

Figure 5 describes how the trap arises diagrammatically. The policy choice is endogenous, and the lobbying activity implies low competition for all $a \leq a_L$. If the economy ever reached a state $a = a_L$, it would switch to high competition and an innovation-based strategy, and would eventually attain full convergence to the world technology frontier. But this stage is never reached since convergence stops at $a = a_{trap}$. We refer to this case as a "political economy trap", since the reason why the non-convergence trap emerges is the ability of the capitalist lobby to bribe politicians.

Another, possibly more interesting, case is when the economy starts with $a_{t_0} \in (a_H, a_r(\mu, \underline{\delta}))$ and $\chi = \underline{\chi}$, i.e., high competition. In this case, initially capitalists not have enough funds to bribe politicians to reduce competition. However, as a increases above $a_r(\mu, \underline{\delta})$, and as long as $a_{wm} > a_r(\mu, \underline{\delta})$ as we assumed above, politicians will choose to reduce competition *in order* to create welfare gains for the citizens. However, once competition is reduced, capitalists become richer, and now they have enough funds to successfully bribe politicians to keep competition low. This case, therefore, illustrates how a well-meaning attempt to introduce appropriate institutions may lead to a political economy trap.

Finally, note also that when $a_{\overline{x}} < a_{trap}$, a temporary improvement in policy might have long-run policy and economic benefits. In particular, if the adverse effects of lobbying activity could be prevented for even just one period (e.g., by the election of an exceptionally honest politician), the economy could escape from the trap. The honest politician would choose high competition, and this would destroy the ability of capitalists to lobby against competition in the future. So, even a temporary improvement in "political institutions" would lead to permanent changes in "economic institutions" (here the degree of competition in the product market).[10]

[10] Note that this extreme result hinges on the two-period nature of our model. If agents live for more periods, and the capitalists own other assets, other reforms may be necessary to curb the power of insiders. Redistribution and reduction of income or wealth inequality may be necessary to make the reform sustainable. Nevertheless, the feature that current policies affect profits and therefore the capitalist lobby's ability to influence policy in the future is more general than the 2-period model here

This discussion establishes:

Proposition 5 Suppose that competition policy is decided by a sequence of politicians with honesty parameter P, and bribes by the lobby of capitalists. Then, there exists a cut-off level a_L, which is decreasing in P, such that the politician will always be bribed into maintaining a low level of competition if $a < a_L$. When parameters are such that (i) $\delta^*(\mu) < \overline{\delta}$ and (ii) $a_L < a_{trap}$, then an economy starting at $a_0 < \max \langle a_r(\mu, \underline{\delta}), a_L \rangle$ will be locked-in into a no-convergence trap, characterized by low competition and bribes to politicians from the capitalist lobby. Such political economy traps are more likely in economies where P is small.

6 Conclusion

There are often marked differences in the economic organization of technological leaders and technological followers. While technological leaders often feature younger firms and greater churning, technological followers emphasize investment and long-term relationships. In other words, while technological leaders follow an innovation-based strategy, technological followers adopt an investment-based strategy of growth.

In this paper, we have proposed a model which accounts for this pattern, and also evaluates the pros and cons of investment and innovation-based strategies. In our economy, entrepreneurs engage both in copying and adopting technologies from the world frontier and in innovation activities. The selection of high-ability entrepreneurs is more important for innovation activities. As the economy approaches the technology frontier, selection becomes more important. As a result, countries that are far away from the technology frontier pursue an investment-based strategy, with long-term relationships, high average size and age of firms, large average investments, but little selection. Closer to the technology frontier, there is less room for copying and adoption of well-established technologies, and consequently, there is an equilibrium switch to an innovation-based strategy with short-term relationships, younger firms, less investment and better selection of entrepreneurs.

The sequence of investment-based strategy followed by an innovation-based strategy is not only a feature of the equilibrium, but also of the socially-planned economy. However, we also show that societies at early stages of development may switch out of the investment-based strategy too soon. This is because of a standard appropriability effect:

firms do not internalize the greater consumer surplus that they create by investing more. This inefficiency implies that economic institutions policies, such as those limiting product market competition, may be useful because they encourage the investment-based strategy.

Equally interesting, we find that societies that do not switch out of the investment-based strategy fail to converge to the world technology frontier. The reason is that these societies failed to take advantage of the innovation opportunities that require entrepreneurial selection. This means that policies encouraging investment-based strategies might also lead to non-convergence traps.

The optimal policy sequence in this economy is therefore a set of policies encouraging investment and protecting insiders, such as anti-competitive policies at the early stages of development, followed by more competitive policies. Such a sequence of policies creates obvious political economy problems. Beneficiaries of existing policies can bribe politicians to maintain these policies. Moreover, these groups, in our model the capitalists, will be politically powerful precisely because they have economically benefited from the less-competitive policies in place. Therefore, the model illustrates how a well-meaning attempt to speed up convergence may lead to a political economy trap. Interestingly, such traps are more likely when the underlying political institutions are weak, making politicians easier to capture. In this context, the model also sheds some light on the debate about whether government intervention should be more prevalent in less developed countries. The answer suggested by the model is that, abstracting from political economy considerations, there is a greater need for government intervention when the economy is relatively backward. But unless political institutions are sufficiently developed to impose effective constraints on politicians and elites, such government intervention may lead to the capture of politicians by groups that benefit from government intervention, paving the way for political economy traps.

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6.1 Appendix: determination of $\underline{\mu}$

Since $a_r(\mu = 0) < \hat{a}$, the IC of the old unsuccessful starts binding before the IC of the young employed in old firms.

The condition for the IC of the old unsuccessful to bind is:

$$\mu\delta L\eta\bar{A}_{t-1} > (1-\alpha)\,\alpha^{-1}\chi^{-\frac{\alpha}{1-\alpha}}A_t = w_t \tag{36}$$

where the wage, w_t, depends on $R_t \in \{0,1\}$.

If $R_t = 1$, then (36) reads (after dividing both terms of the inequality by $\bar{A}_{t-1}$):

$$\mu\delta L\eta > (1-\alpha)\,\alpha^{-1}\chi^{-\frac{\alpha}{1-\alpha}}\frac{1+\varepsilon}{2}\left(\eta + \lambda\gamma a_{t-1}\right) \tag{37}$$

If $R_t = 0$, then (36) reads

$$\begin{aligned} &\mu\delta L\eta \\ > \quad &(1-\alpha)\,\alpha^{-1}\chi^{-\frac{\alpha}{1-\alpha}}\frac{1}{2}\left(\left(\lambda+\varepsilon+(1-\lambda)\,\varepsilon\right)\eta + \left(1+\varepsilon+(1-\lambda)\,\varepsilon\right)\lambda\gamma a_{t-1}\right) \end{aligned} \tag{38}$$

The two equations, (37) and (38) define, respectively the following threshold

$$\begin{aligned} a_{R=1} &= \frac{\mu\delta L - (1-\alpha)\,\alpha^{-1}\chi^{-\frac{\alpha}{1-\alpha}}\frac{1+\varepsilon}{2}}{\lambda\gamma\,(1-\alpha)\,\alpha^{-1}\chi^{-\frac{\alpha}{1-\alpha}}\frac{1+\varepsilon}{2}}\eta \\ a_{R=0} &= \frac{\mu\delta L - (1-\alpha)\,\alpha^{-1}\chi^{-\frac{\alpha}{1-\alpha}}\frac{(\lambda+\varepsilon+(1-\lambda)\varepsilon)}{2}}{\lambda\gamma\,(1-\alpha)\,\alpha^{-1}\chi^{-\frac{\alpha}{1-\alpha}}\frac{(1+\varepsilon+(1-\lambda)\varepsilon)}{2}}\eta \end{aligned}$$

No IC binds as long as $a_r(\mu = 0) > \max\{a_{R=1}, a_{R=\mathbf{0}}\}$, in which case the allocation is as in the case where $\mu = 0$. Since $a_r(\mu = 0) < \hat{a}$, then $a_{R=1} > a_{R=\mathbf{0}}$. The threshold $\underline{\mu}$ is therefore given by equating $a_r(\mu = 0) = \hat{a}$. This yields

$$\frac{\mu\delta L - (1-\alpha)\,\alpha^{-1}\chi^{-\frac{\alpha}{1-\alpha}}\frac{1+\varepsilon}{2}}{\lambda\gamma\,(1-\alpha)\,\alpha^{-1}\chi^{-\frac{\alpha}{1-\alpha}}\frac{1+\varepsilon}{2}}\eta = \frac{(1-\varepsilon)\,\eta}{(1-\varepsilon)\frac{\kappa}{\delta L} + \varepsilon\lambda\gamma}$$

and, solving

$$\underline{\mu} = (1-\alpha)\,\chi^{\frac{\alpha}{-1+\alpha}}\left(\frac{1+\varepsilon}{2}\right)\frac{\lambda\gamma\,(1-2\varepsilon) - \frac{\kappa}{\delta L}(1-\varepsilon)}{\alpha\left(\kappa\,(1-\varepsilon) + \varepsilon\lambda\gamma\delta L\right)}$$

Note that, when $\mu < \underline{\mu}$, the IC of the old entrepreneurs may bind at some low levels of a_{t-1} such that $a_{t-1} < a_r(\mu = 0)$. But this has no effect on the refinancing threshold, since when the economy approaches such threshold all IC are slack.