Growth, Selection and Appropriate Contracts*

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Abstract

We study a dynamic model where growth requires both long-term investment and the selection of talented managers. When ability is not ex-ante observable and contracts are incomplete, managerial selection imposes a cost, as managers facing the risk of being replaced tend to choose a sub-optimally low level of long-term investment. This generates a trade-off between selection and investment that has implications for the choice of contractual relationships. Our analysis shows that rigid long-term contracts sacrificing managerial selection may be optimal at early stages of economic development and when access to information is limited. As the economy grows, however, knowledge accumulation increases the return to talent and makes it optimal to adopt flexible contractual relationships, where managerial selection is implemented even at the cost of lower investment. Better institutions, in the form of a richer contracting environment and less severe informational frictions, speed up the transition to short-term relationships.

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1 Introduction

Economic growth requires both incentives to undertake projects that pay out in the future and an efficient mechanism to select the best managers to run them. There is no need to stress that avoiding myopic strategies is often crucial for economic success. To motivate long-term investment, it is thus important that managers have sufficient prospects to be among those who will enjoy the future returns. At the same time, however, it is well documented that bad managerial quality can impose large costs. Having the flexibility to remove incompetent managers and workers may thus be essential too. The role of contracts and institutions regulating production relationships is to strike a balance between these possibly conflicting goals.

To study these issues, this paper proposes a model where economic performance depends both on long-term investment and the selection of managerial talent. When ability is not ex-ante observable and contracts are incomplete, managerial selection imposes a cost, as managers facing the risk of being replaced tend to choose a sub-optimally low level of investment. This introduces a trade-off between selection and investment. The aim of this paper is to study this trade-off, how it evolves with the level of development and the availability of information, and its implications for the design of appropriate contractual institutions. It will offer an explanation for why countries at early stages of economic development may start with rigid, long-term, contractual arrangements which sacrifice managerial selection, but will eventually switch to more flexible short-term relationships. Thus, the paper will show how appropriate contractual relationships may change endogenously over the development process.

Our analysis is motivated by both empirical and theoretical considerations. There is ample evidence that contractual institutions and production relationships differ markedly across countries and time. For example, state-owned and family firms, which are typically characterized by long-term relationships and very low managerial turnover, tend to prevail at earlier stages of economic development. While some authors have emphasized the inefficiencies of such rigid arrangements, others have suggested that they may reflect the need for different institutional forms at various stages of development.[1] In particular, Kuznets (1966, 1973) and Gerschenkron (1962) have

[1]See, for example, Burkart, Panunzi and Shleifer (2003), Caselli and Gennaioli (2005) and references therein.

forcefully stressed that economic growth is accompanied by a process of structural transformation that includes changes in production relationships and an increasing importance of skills. In this spirit, we propose a theory where long-term production relationships may be a second-best arrangement in countries at early stages of development and with limited access to information. As the productive capacity of an economy grows, however, skills become more important and more flexible short-term contracts arise.

In our baseline model, firms and agents last for two periods and produce output by combining a broad form of knowledge capital (productivity) with managerial skill. In the first period of the life of a new firm, investors hire a manager to run it. The manager has access to an investment technology that raises productivity in the next period at the expense of current production. Managers differ in ability, which is initially unknown. Motivated by our desire to study countries at different stages of development, we assume that contracts between investors and managers are incomplete and can only take a simple form. In particular, they cannot be made contingent on outcomes, which is assumed to be non-verifiable, and managerial compensation is determined through ex-post bargaining. Investors, however, have the choice between offering either one-period or two-period employment contracts.

At the end of the first period, investors observe the level of production, which depends on (1) the investment decision, (2) managerial ability and (3) an idiosyncratic shock (noise), and form expectations on the ability of the manager. Next, if investors have signed a one-period contract, they may decide whether to confirm the manager or replace her with a new random draw. In the second period, past investment pays out and production takes place. After that, a new cycle starts again. In sum, investors try to retain managers of above average ability, but only observe a noisy signal of ability. Managers, on the other hand, choose long-term investment in order to maximize their own payoff, that depends positively on the cash flow and the probability of not being fired.

With this simple model, we first study the determinants of long-term investment. Under flexible one-period contracts, there are two distortions inducing managers to choose a sub-optimally low level of investment. First, the mere possibility of being fired implies that managers may not be able to enjoy future returns and this reduces their expected benefit from investment. Second, as in models of career concern, if investors only observe current economic performance, managers have an incentive to give up some long-term investment in favor of activities with an immediate payoff in an effort to manipulate the perception of their ability and increase the probability of being retained.[2] Both distortions depend on the fact that managers face a non-zero probability of being replaced. Hence, they represent the costs of being able to keep good managers and replace bad ones. The benefit of selection, on the other hand, is that it ensures on average higher managerial ability.

Next, we turn to study how this trade-off between selection and investment shapes the optimal choice of contracts. More precisely, we ask under what circumstances long-term (two period) contracts sacrificing managerial selection may be more efficient. We find that rigid contracts are optimal when information is very noisy, ability is concentrated and the productive capacity of the economy is low. These are cases in which selection is either difficult or not very useful, while investment is relatively more valuable. It is then desirable to maximize investment, even at the cost of lower managerial quality. The model thus suggests long-term contracts to prevail in developing countries with low levels of phisycal and human capital, and poor access to information.[3] Yet, as the productive capacity of the economy grows endogenously, managerial ability, which is a complementary input, becomes relatively more important and short-term contracts implementing selection become optimal. Interestingly, we find that this transition is faster in countries with better institutions in the form of a richer menu of contracts and less severe informational frictions.

This paper contributes to the theoretical literature, still in its infancy, on appropriate institutions and growth.[4] In particular, the evolution of contractual relationships along the process of development has so far received little attention. Closest to ours is the influential paper by Acemoglu, Aghion and Zilibotti (2006). In their model, skill is assumed to be more important for innovation than for the adoption of foreign technologies. As a result, selecting talent becomes more useful as countries get closer to the technology frontier. Our analysis is both complementary and has a different focus. First, we provide a micro-foundation for the trade-off between investment

[2] See Stein (1989), Holmstöm (1999) and Dewatripont, Jewitt and Tirole (1999) for models of career concerns.

[3] However, long-term contracts may also be optimal in societies that are very homogeneous. Japan may provide an interesting example.

[4] This literature has been pioneered by the works of Douglas North (see, for example, North, 1994). Among others, recent contributions focusing on economic institutions are Rodrik (2007), Acemoglu, Aghion and Zilibotti (2006) and Acemoglu and Zilibotti (1999 and 1997), and Aghion and Howitt (2005).

and selection. Second, we study its implications for the choice between contracts of different rigidity, while they analyze the effect of competition policy at various stages of development. The trade-off between selection and investment is also the subject of Aghion, van Reenen and Zingales (2008). They argue, both theoretically and empirically, that institutional ownership reduces managerial turnover in case of bad performance and promote investment in innovation. However, their paper does not study the optimality of institutional ownership.[5]

Our paper is also related to the relatively small literature on incomplete contracts and growth. Acemoglu, Antras and Helpman (2007), and Francois and Roberts (2003) study how contractual frictions affects technology adoption and innovation, respectively. Hemous and Olsen (2010) argue that repeated interaction may help to overcome the static costs associated with limited contractibility, but at the cost of dynamic inefficiencies. Differently from these papers, we are interested in studying how growth affects the form of contracts, rather than the opposite. Closer to our spirit, Acemoglu and Zilibotti (1999) study how information may be accumulated along the process of economic development and how this affects risk sharing, managerial effort and economic performance. Yet, they do not consider alternative contractual forms, while we abstract from the issues related to risk sharing.

Finally, the literature on law and economics documents the prevalence of family firms and rigid contractual relationships in developing countries and in particular where enforcement is weak. Theoretical papers explaining this fact argue that family firms arise in the presence of weak institutions (see Mork, Wolfenzon and Yeung, 2005 for a survey). None of the existing papers, however, study the endogenous evolution of optimal contractual arrangements. We instead abstract from enforcement problems and issues related to firm ownership and organization. The corporate finance literature addresses various aspects of the contracts between managers and shareholders. For instance, Gabaix and Landier (2008) and Edmans, Gabaix and Landier (2009) study the equilibrium level of executive compensation and its performance sensitivity in advanced countries. Giannetti (2011) considers the optimal compensation scheme when the outside option of an executive is misaligned with the performance of the firm. Other contributions (see Benmelech, Kandel and Veronesi, 2007, and references therein) focus on the optimal CEO pay structure, and investigate which instruments

[5] Thesmar and Thoenig (2000) study the trade-off between efficiency and adaptability in a model of organization choice and growth. We instead abstract from organizational structures.

better align the interest of managers and shareholders. Our aim is to embed some of these ideas into a growth model and study how optimal contracts change with economic development. For this reason, we depart from the corporate finance literature by focusing on simple and incomplete contracts that are more likely to be used in developing countries.[6]

The rest of the paper is organized as follows. Section 2 lays down a simple growth model, describing the set-up and the choices that agents face, and illustrates the main trade-off between selection and investment. Section 3 solves the model under symmetric information and studies how the optimal contractual arrangement (long- versus short-term contract) varies with the level of development and with other parameters. We also consider how the choice between a richer set of contracts may speed-up the transition to flexible relationships. Section 4 introduces an additional informational friction by assuming investment to be unobservable and show how this may delay the transition from long- to short-term contracts. Section 5 provides a discussion of our main assumptions and empirical implications. Section 6 concludes.

2 The Model

We propose a simple growth model designed to study the agency problem between investors and managers in a world where managerial ability is not perfectly observable and contracts are incomplete. The model gives rise to a trade-off between selection and investment, with implications for the choice of contracts between the principal (investors) and the agent (the manager).

2.1 Agents, Preferences and Technology

The economy is populated by overlapping generations of two-period lived agents. Similarly to Acemoglu, Aghion and Zilibotti (2006), each generation consists of a mass $L/2$ of *investors*, who are endowed with ownership claims on new firms, and a mass L of *managers*, who have no wealth but are endowed with heterogeneous skills required to run firms. All agents are risk-neutral and discount the future at the rate $\beta \in (0, 1)$. In every period, a mass $L/2$ of new firms –equal to the new cohort of

[6]The literature on optimal manegerial compensation argues that managers should be given a long-term contract specifying state-contingent payments. In the absence of commitment, Clementi et al. (2006) show how stock grants may substitute for state-contingent contracts. In the present paper, we assume that contractual inefficiencies prevent the use of complex compensation schemes.

investors– enters.[7] Firms run for two peridos and produce a single final good, which is taken as the numeraire. Therefore, at any period t, there is a mass L of active firms (young and old) and total output is given by:

$$Y_t = \int_0^L y_{jt} dj,$$

where y_{jt} is production of firm j at time t.

New firms start out with an initial level of productivity, which we call "knowledge capital" and we denote k_{jt}, randomly drawn from a distribution with positive support and mean equal to the average knowledge capital of existing old firms. We assume that k_{jt} is observed by all agents upon realization. The level of knowledge capital is the key state variable of the model, capturing the broad productive capacity of the economy, and it will grow endogenously over time. Besides k_{jt}, each firm requires one manager to be operated. Hence, when a new firm starts, a manager is chosen randomly from the population of young managers.[8] The manager of a young firm has access to an investment technology that converts units of current output into new knowledge capital at $t+1$. In particular, i_{jt} units of current-period production invested at t yield $f(i_{jt})$ units of additional knowledge capital at $t+1$, where the function $f(\cdot)$ satisfies the regularity conditions: $f'(\cdot) > 0$, $f''(\cdot) < 0$ and $f'(0) = \infty$. Investment in knowledge capital by firms will be the only source of growth in the model.

Managerial ability, θ_j, which is assumed to be unknown, is drawn from a normal distribution with mean θ and variance σ_θ^2:

$$\theta_j \sim N\left(\theta, \sigma_\theta^2\right).$$

Ability affects production, it is manager-specific and persistent. Production is also affected by a random idiosyncratic shock, ε_{jt}, drawn from a normal distribution with zero mean and variance σ_ε^2:

$$\varepsilon \sim N\left(0, \sigma_\varepsilon^2\right).$$

We assume the shock ε to be independent of ability and uncorrelated across projects

[7] The exact allocation of property rights on new firms among new investors is irrelevant. The fact that the number of firms is exogenous has no bearings on the main results.

[8] As it will be clear later on, hiring an old manager to run a new firm is never optimal.

and time, so that it captures an unpredictable component. Both the distribution of θ_j and ε are common knowledge, but their actual realizations are not directly observable.

Thus, production of a young firm at time t is:

$$y_{jt} = (\theta_j + \varepsilon_{jt})\, k_{jt} - i_{jt}.$$

Note that y_{jt} can be thought of as the cash-flow generated by the firm.[9] This cash-flow is then distributed between managerial compensation, as specified below, and dividends to investors and it is consumed (there is no storage). Upon observing y_{jt}, which is a noisy signal of managerial ability, and depending on the type of contract offered (one-period or two-period employment), investors will form expectations on the ability of the manager and may decide whether to replace her with a new random draw or not. Given that fired managers are expected to have a low ability, they will never be hired by other firms and all new managers will be drawn from the pool of previously idle managers (recall that there are twice as many potential managers than firms).

At time $t+1$, the knowledge capital of a firm born at t is equal to the initial level plus the return from investment:

$$k_{jt+1} = k_{jt} + f\left(i_{jt}\right).$$

Since firms terminate after the second period, old firms do not make any further investment and their production is simply:

$$y_{jt+1} = (\theta_{t+1} + \varepsilon_{jt})\, k_{jt+1},$$

where θ_{t+1} is the ability of the previous manager or, if replaced, a new random draw from the distribution $N\left(\theta, \sigma_\theta^2\right)$. At the end of the second period, the firm exits and the manager is dismissed.

[9] One possible interpretation for i_{jt} is intra-period borrowing from old firms. Alternatively, it could capture resources taken from the manager's time endowment, which is normalized to zero. In an earlier version of the paper, we consider the case in which i_{jt} substracts from k_{jt}, so that production is $y_{jt} = (\theta_j + \varepsilon_{jt})\,(k_{jt} - i_{jt})$.

Finally, the total stock of kowledge capital of new and old firms at time t is:

$$\begin{aligned} K_t &= \int_{j\in S_t} k_{jt} + \int_{j\in S_{t-1}} \left[k_{jt-1} + f\left(i_{jt-1}\right)\right] \\ &= K_{t-1} + 2\int_{j\in S_{t-1}} f\left(i_{jt-1}\right), \end{aligned} \tag{1}$$

where S_t denotes the set of new firms at time t. The second line make use of the assumption that k_{jt} for new firms is drawn from a distribution with mean equal to the average knowledge capital of existing old firms, so that $\int_{j\in S_t} k_{jt} = \int_{j\in S_{t-1}} k_{jt}$. Equation (1) is the key law of motion of the economy.

We now discuss the managerial contract. First, we assume that contracts are incomplete in that they cannot be made contingent on outcomes, such as i_{jt} or y_{jt}. This may be due to the inability of the legal system to verify output and investment. As a consequence, every period the project cash flow is split between managers and investors through ex-post Nash bargaining. For the time being, we assume that managerial bargaining power is exogenous and equal to $\lambda \in (0,1)$. This means that managerial compensation is a fraction λ of the cash flow, y_{jt}.[10] The fraction λ is public information. As an extension, in section 3.6 we let λ vary over the lifetime of the firm and be chosen optimally.

Second, the contract may grant investors the option to replace the manager before the termination of the firm. In particular, under flexible short-term contracts, the manager is evaluated at the end of the first period and is replaced if the expectation of her ability, conditional on observing the noisy signal y_{jt}, is too low. Alternatively, managers and investors may sign binding long-term contracts that do not allow for this type of managerial turnover. In the remainder of the paper, we study and compare the properties of these alternative contractual arrangements. Before doing so, however, we formally describe the investment choice by mangers and the inference problem that investors face.

[10] This assumption is relatively standard in the literature on incomplete contracts.

2.2 Managers and Investors

The manager chooses investment i_{jt} in order to maximize her expected life-time utility, which is a fraction λ of the discounted cash-flow of the firm:

$$\max_{i_{jt}} U_{jt} = \lambda \left[\mathbb{E}\left(y_{jt}\right) + \beta p_{jt} \mathbb{E}\left(y_{jt+1}\right) \right], \tag{2}$$

where $\mathbb{E}$ is the expectation operator and p_{jt} is the perceived probablity that the manager running firm j at time t will be not be fired at $t+1$. The maximization is subject to the constraints:

$$\begin{aligned} y_{jt} &= \left(\theta_j + \varepsilon_{jt}\right) k_{jt} - i_{jt} \\ k_{jt+1} &= k_{jt} + f\left(i_{jt}\right). \end{aligned}$$

Substituting these into (2) we can rewrite the problem as:

$$\max_{i_{jt}} U_{jt}/\lambda = \theta k_{jt} - i_{jt} + \beta p_{jt} \left(\theta + \delta_{jt}\right) \left[k_{jt} + f\left(i_{jt}\right)\right], \tag{3}$$

where we have used the fact that $\mathbb{E}\left(y_{jt}\right) = \theta k_{jt} - i_{jt}$ and $\mathbb{E}\left(\theta_{jt+1} \mid \theta_{jt+1} = \theta_{jt}\right) = \theta + \delta_{jt}$ is the expected ability of a manager confirmed in the second period. The term δ_{jt} will be positive if managers that are retained are expected to have a higher ability than the average. This will happen if short-term contracts are chosen and will represent the benefit of being able to select managers. As we will see shortly, δ_{jt} will also depend on the dispersion of managerial talent and the precision of the signal of ability observed by investors. Note that, when making the investment choice, the manager ignores her ability, but knows the distributions of θ and ε, and the equilibrium expressions for p_{jt} and δ_{jt} (to be derived later).[11]

The first order condition for i_{jt} is:

$$p_{jt}\beta\left(\theta + \delta_{jt}\right) f'\left(i_{jt}\right) = 1 - \beta\left[k_t + f\left(i_{jt}\right)\right]\left[\frac{\partial p_{jt}}{\partial i_{jt}}\left(\theta + \delta\right) + \frac{\partial \delta_{jt}}{\partial i_{jt}} p_{jt}\right]. \tag{4}$$

[11] For simplicity, we have normalized the outside option of idle managers to zero. Alternatively, we could have assumed that idle managers can be employed as "workers" in a final sector that uses labor and Y as inputs, or that ability is firm-manager specific and that fired managers are re-hired by other firms. These alternative assumptions would only make the notation more cumbersome. Without loss of generality, we also do not allow managers to compete for contracts.

The left-hand side of (4) is the expected marginal benefit of investment for the manager in terms of higher production at $t+1$. This is equal to the marginal product of investment, $(\theta + \delta_{jt}) f'(i_{jt})$, multiplied by the discount factor and the probability that the manager will be retained. The right-hand side of (4) is the marginal cost of investment. The first term is foregone production today. The second term is the marginal impact of investment on the probability of being retained $(\partial p_{jt}/\partial i_{jt})$ and on the selection premium $(\partial \delta_{jt}/\partial i_{jt})$, multiplied by the discounted value of running the firm in the second period. As we discuss more in details later on, the term $\partial p_{jt}/\partial i_{jt}$ will be negative if investors do not observe i_{jt}. In this case, the manager has an incentive to invest less so as to inflate the current cash flow in an attempt to appear more competent and therefore increase the probability to be confirmed at $t+1$. By distorting the signal observed by investors, the manager may also in principle affect their ability to select efficiently good managers. Yet, an envelope condition guarantees that this effect is nil so that $\partial \delta_{jt}/\partial i_{jt} = 0$.[12]

Investors face an inference problem. They must form expectations on the ability of the manager conditional on observing the noisy signal $y_{jt} = (\theta_j + \varepsilon_{jt})(k_{jt} - i_{jt})$. Investors know the initial knowledge capital and either observe the investment made by the manager or can infer its equilibrium level, so that they effectively observe the sum $\theta_j + \varepsilon_{jt}$. Given the distributions of θ and ε, that are assumed to be common knowledge, we can compute the "posterior" expectation of θ_j, conditional on observing $\theta_j + \varepsilon_{jt}$:

$$\widehat{\theta}_{jt} = \mathbb{E}[\theta_j \mid \theta_j + \varepsilon_{jt}] = \frac{\sigma_\varepsilon^2}{\sigma_\theta^2 + \sigma_\varepsilon^2}\theta + \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\varepsilon^2}(\theta_j + \varepsilon_{jt}). \tag{5}$$

That is, the posterior expectation on managerial ability is a weighted average of the "prior", θ, and the observed signal, $\theta_j + \varepsilon_{jt}$, with weights that depend on the precision of the signal: as the variance of the noise (σ_ε^2) increases relative to the variance of ability (σ_θ^2), the signal becomes less and less informative and the posterior expectation converges to the unconditional mean θ. Note also that the distribution of the posterior belief on the manager's ability is normal:

$$\widehat{\theta}_{jt} \sim N\left(\theta, \frac{\sigma_\theta^4}{\sigma_\theta^2 + \sigma_\varepsilon^2}\right). \tag{6}$$

[12]More details on this are provided in section 4, where we consider the case of unobservable investiment.

Intuitively, $\widehat{\theta}_{jt}$ has the same mean but a smaller variance than θ.

Finally, investors want to maximize the expected present discounted value of their share of the firm, $V(k_{jt})$, given the available contracts. This is given by the present value of expected production, net of the managerial compensation, $(1-\lambda)\,\mathbb{E}\left[y_{jt}+\beta y_{jt+1}\right]$:

$$\frac{V(k_{jt})}{1-\lambda}=\theta k_{jt}-i_{jt}+\beta\left(\theta+p_{jt}\delta\right)\left[k_{jt}+f\left(i_{jt}\right)\right]. \tag{7}$$

3 Symmetric Information

We now characterize the equilibrium outcome under alternative contractual arrangements assuming that investment is observable to all agents. We relax this assumption in section 4. To start with, we focus on symmetric equilibria where all new firms have the same amount of knowldge capital, $k_{jt}=k_t$. In section 3.5, we consider the cross-sectional implications of our model when k_{jt} is instead drawn from a non-degenerate distribution.

3.1 Long-Term Contracts

Suppose that a two-period contract is signed. Then, investors are not allowed to replace the manager at the end of the first period. In this case, we have $p_{jt}=1$, $\delta=0$ and $\partial p_{jt}/\partial i_{jt}=\partial\delta_{jt}/\partial i_{jt}=0$ so that the first order condition for investment (4) becomes:

$$\beta f'\left(i^L\right)=\frac{1}{\theta}, \tag{8}$$

where the superscript L denotes long-term contracts. Intuitively, investment is increasing in patience (β) and in average ability (θ), because the return to investment is proportional to the expected ability of the manager who will run the firm at $t+1$. Note that under long-term contracts there is no selection so that the ex-ante expected managerial ability in the second period is just the unconditional mean θ.

3.2 Short-Term Contracts

We now consider the case in which investors sign one-period contracts and are thus free to replace the manager. The optimal strategy for the investors is to fire the manager if her expected ability, conditional on observing y_{jt} and i_{jt}, is below the population average. Thus, the probability that a manager is retained is equal to the probability that the posterior belief $\widehat{\theta}_{jt}$ is greater than θ, or equivalently, the probability that the signal is above its mean:

$$p_{jt} = \Pr\left(\widehat{\theta}_{jt} \geq \theta\right) = \frac{1}{2}.$$

Since information is symmetric and i_{jt} observable, managers cannot manipulate the signal of ability by reducing investment. It follows that $\partial p_{jt}/\partial i_{jt} = 0$ and $\partial \delta_{jt}/\partial i_{jt} = 0$. In equilibrium, the first order condition (4) for $i_{jt} = i_t^S$ becomes:

$$\beta f'\left(i^S\right) = \frac{2}{\theta + \delta}. \tag{9}$$

Before discussing the determinants of investment under short-term contracts, we first need to solve for the equilibrium value of δ, i.e., the difference between the expected ability of a confirmed manager and a new draw. Confirmed managers tend to be of above average ability ($\delta > 0$) because a realization of y_{jt} above the mean is more likely to come from a high ability manager, although there is always a chance that it comes from low-θ type with a lucky realization of the shock ε_{jt}. Formally, given that a manager is retained whenever her ability is expected to be above θ, the average ability of a confirmed manager is equal to the mean of the distribution of the posterior belief $\widehat{\theta}_{jt}$ truncated below at θ. Using the properties of the normal distribution we obtain:

$$\mathbb{E}\left[\theta_j \mid \widehat{\theta}_{jt} \geq \theta\right] = \frac{1}{1 - H(\theta)} \int_{\theta}^{\infty} \widehat{\theta} dH\left(\widehat{\theta}\right) = \theta + \frac{2\sigma_\theta^2}{\sqrt{2\pi\left(\sigma_\theta^2 + \sigma_\varepsilon^2\right)}},$$

where H is the c.d.f. of the posterior belief $\widehat{\theta}_{jt}$ (6).

Thus, the "selection effect", i.e., the expected ability premium of a confirmed manager, is:

$$\delta = \frac{2\sigma_\theta^2}{\sqrt{2\pi\left(\sigma_\theta^2 + \sigma_\varepsilon^2\right)}}. \tag{10}$$

Note that selection is more effective (high δ) when the signal is not too noisy (low σ_ε^2) and ability very dispersed (high σ_θ^2). Intuitively, when there is little noise, the probability of keeping (replacing) by mistake a bad (good) manager is low, thereby raising the benefit of selection. On the contrary, when talent is very concentrated, there is little to gain in confirming a manager, even when she is expected to be of above average ability. High heterogeneity in ability makes instead selection a powerful tool.

3.2.1 Incentives and Investment

We now study the determinants of investment, i^S. Since $f''\left(i^S\right) < 0$, the left hand side of (9) is decreasing in i^S. It is then easy to characterize investment as a function of the model parameters.

Lemma 1 *Investment under short-term contracts is an increasing function of heterogeneity in managerial ability (σ_θ^2), average ability (θ) and patience (β); it is decreasing in the variance of noise (σ_ε^2).*

$$\frac{\partial i^S}{\partial \sigma_\theta^2} > 0; \quad \frac{\partial i^S}{\partial \beta} > 0; \quad \frac{\partial i^S}{\partial \theta} > 0; \quad \frac{\partial i^S}{\partial \sigma_\varepsilon^2} < 0$$

Proof. *See Appendix* ■

Not surprisingly, investment increases with patience, β. Heterogeneity in ability, σ_θ^2, increases investment since it raises the manager's expected ability conditional on being confirmed in the second period (δ) and thus the marginal return from i^S, which is proportional to $\mathbb{E}\left(\theta_{jt+1}\right)$. Similarly, for given σ_θ^2, a higher average ability also raises the marginal return to investment, thereby inducing a higher i^S. An increase in the variance of the shocks, σ_ε^2, makes selection less effective (δ falls), thereby inducing a lower investment.

Comparing the first order conditions under alternative contractual arrangements, (9) and (8), we see that the benefit of selection under short-term contracts may come at the cost of a lower investment. This is because of two contrasting forces. On the one hand, we have just seen that the selection premium δ increases the value of investment. On the other hand, the manager will benefit from investment with probability $p = 1/2$ only. More precisely, we have that investment under short-term contracts is lower than under long-term contracts ($i^S < i^L$) as long as the selection effect does not outweighs average ability ($\delta < \theta$). When $\delta > \theta$, instead, short-term contracts entail higher investment because the expected ability of a confirmed manager (hence productivity) is so high that the manager prefers to increase second period production (through higher investment) even if she only has a 50% chance to enjoy the returns. In this case, short-term contracts do not impose any trade-off between investment and selection. For this reason, from now on we focus on the more interesting case $\delta < \theta$.

3.3 The First Best

Before comparing the relative performance of short- and long-term contract, it is useful to characterize the first-best solution that would be attained if investment were verifiable and thus contractible. In this case, investment i_t^{FB} would be chosen so as to maximize the expected present discounted value of the firm. Moreover, to maximize second-period productivity, investors would keep the right to replace managers if they produce less than the expected average $\theta k_t - i_t^{FB}$. This happens with probability one-half since ability is symmetrically distributed around its mean and shocks are i.i.d.. Thus, the first best investment solves:

$$\max_{i_{jt}} \ \theta k_t - i_{jt} + \beta \left(\theta + \frac{\delta}{2} \right) [k_t + f(i_{jt})] .$$

The first order condition is:

$$\beta f'\left(i^{FB}\right) = \frac{1}{\theta + \delta/2} \tag{11}$$

where δ is still given by (10).

From conditions (8), (9) and (11) it is immediate to see that $i^L < i^{FB}$ and $i^S < i^{FB}$. Thus, contract incompleteness always implies underinvestment relative to the first best equilibrium. The reason is that long-term contracts exclude the beneficial effect of selection on the return to investment, while short-term contracts introduce myopia in managerial behavior. Moreover, in the benchmark case $\delta < \theta$, we have $i^S < i^L < i^{FB}$.

3.4 Appropriate Contracts and Economic Development

We now compare the relative performance of short- and long-term contracts and study how the optimal contractual form changes along the process of economic development. As long as $\delta < \theta$, long-term contracts maximize investment, but sacrifice managerial selection; on the other hand, short-term contracts allow on average to replace bad managers, at the cost of underinvestment. Thus, the choice between alternative contracts poses a trade-off between investment and selection. To study it, we evaluate the expected present discounted value of new firms (7) in the two cases:

$$\text{Long-term:} \quad \frac{V^L(k_t)}{1-\lambda} = \theta k_t - i^L + \beta\theta\left[k_t + f\left(i^L\right)\right],$$

$$\text{Short-term:} \quad \frac{V^S(k_t)}{1-\lambda} = \theta k_t - i^S + \beta\left(\theta + \frac{\delta}{2}\right)\left[k_t + f\left(i^S\right)\right]$$

where δ is given by (10). Rearranging these expressions, we find that short-term, flexible, contracts are ex-ante optimal, i.e. $V^S(k_t) > V^L(k_t)$, when the following condition holds:

$$\left[\beta\theta f\left(i^L\right) - i^L\right] - \left[\beta\theta f\left(i^S\right) - i^S\right] < \beta\left(\delta/2\right)\left[k_t + f\left(i^S\right)\right]. \tag{12}$$

The left-hand side of (12) is equal to the additional surplus from investment generated by long-term contracts. This term is always positive because i^L is chosen precisely to maximize $[\beta\theta f(i) - i]$. The right-hand side is the benefit of selection. Condition (12) holds, i.e., short-term contracts are better, when selection is relatively more important than investment. In fact, it holds trivially when there is no investment, (e.g., $f(i_t) = 0$), while it is always violated when the benefit of selection is nil ($\delta = 0$).

We next ask how capital accumulation affects the optimal choice of contract. As formalized in Proposition 1, capital accumulation makes short-term contracts more attractive.

Proposition 1 *There exists k^* such that $V^S(k) \geq V^L(k)$ for any $k > k^*$.* ***Proof.*** *See Appendix* ■

Intuitively, ability becomes relatively more important as the economy grows because of its complementarity with the level of technological sophistication captured by knowledge capital. For this reason, the higher the productive capacity of the economy, the higher the value of selecting talent to operate new technolgies. Key to this property is the assumption that managerial ability has a multiplicative effect on technology, as in the majority of models designed to study the effect of managerial quality (e.g., Rosen, 1981, and Gabaix and Landier, 2008). It is also consistently with the large literature on capital-skill complementarity (e.g., Krusell et al. 2000) and skill-biased technical change (e.g., Nelson and Phelps, 1966, Caselli, 1999, Violante, 2002, and Acemoglu, Gancia and Zilibotti, 2011).

Since investment is non-negative and new firms start with the same knowledge of existing old firms, k_t grows continuously over time. In particular, in the symmetric case we focus on, the knowldedge capital of each existing firm at time $t+1$ is:

$$k_{t+1} = k_t + f(i), \tag{13}$$

where k_t and i_t are the knowledge capital and investment of a new firm at time t, respectively. This implies that, for any parameter value, the economy reaches k^* in finite time. Thus, Corollary 1 immediately follows.

Corollary 1 *For any parameter value, there exist a time t^* such that $V^S(k_t) \geq V^L(k_t)$ for all $t \geq t^*$.*

Our model thus predicts that countries starting from a low level of capital may go through an initial phase where long-term production relationships and low managerial turnover are optimal. Once k_t reaches a critical threshold, however, ability becomes more important and the economy will endogenously switch to flexible short-term contracts. Appropriate contractual institutions may thus evolve with economic development as suggested by Kuznets (1966, 1973), Gerschenkron (1962) and North (1994).

We now discuss the effects of other parameters on the choice of appropriate contracts, and hence the speed of transition, in the non-trivial case $\delta < \theta$.

Proposition 2 *The expected difference in the PDV of a firm under short-term relative to long-term contracts, $\Delta V \equiv \frac{V^S(k_t) - V^L(k_t)}{1-\lambda}$, is increasing in the variance of the ability distribution (σ_θ^2) and decreasing in the variance of the shock (σ_ε^2). The effect of average ability (θ) on ΔV is instead ambiguous, but it is necessarily positive for low values of θ:*

$$\frac{\partial \Delta V}{\partial \sigma_\theta^2} > 0; \quad \frac{\partial \Delta V}{\partial \sigma_\varepsilon^2} < 0 \quad \left.\frac{\partial \Delta V}{\partial \theta}\right|_{\theta \to \delta} > 0.$$

Proof. *See Appendix* ■

The intuition behind the results in Proposition 2 is as follows. A rise in the variance of managerial talent makes short-term contacts relatively more efficient because a high σ_θ^2 increases the selection premium δ in (10), which raises $V^S(k_t)$ both directly and indirectly through the rise in i^S. Moreover, it is easy to show that, if there is no heterogeneity in talent ($\sigma_\theta^2 \to 0$), the selection effect (δ) is nil, hence rigid contracts are always preferable. If ability is dispersed enough ($\sigma_\theta^2 \to \infty$) instead, the selection effect grows very large ($\delta \to \infty$) thereby making short-term contracts optimal. The latter result is formalized in a Corollary:

Corollary 2 *For any parameter value, there exists $\widehat{\sigma}_\theta^2 > 0$ such that short-term (long-term) contracts are optimal for all $\sigma_\theta^2 > \widehat{\sigma}_\theta^2$ ($\sigma_\theta^2 < \widehat{\sigma}_\theta^2$).* ***Proof.*** *See Appendix* ■

This suggests that more homogeneous societies (i.e., with a low σ_θ) will stay longer in the development phase characterized by long-term contracts. In turn, this result may help explain why relatively rigid production relationships may be common even in some advanced country where workers are less heterogeneous (an example could be lifetime employment policies in Japan) and in some traditional sectors where ability matters less.

The effect of σ_ε^2 (variance of noise) is to make it more difficult to separate good from bad managers, thereby reducing the benefit of selection δ and the managerial incentive to invest under one-period contracts. It is easy to show that, if the noise is high enough ($\sigma_\varepsilon^2 \to \infty$), there is no benefit from selection ($\delta \to 0$) so that long-term contracts must be optimal, regardless of the level of development. As noise tends to zero ($\sigma_\varepsilon^2 \to 0$), the benefit of selection converges to its maximum ($\delta \to \sqrt{2\sigma_\theta^2/\pi}$), thereby making (12) more likely to hold. Hence, improvements in the availability of information such as more transparency in business procedures or a better monitoring technology speed up the transition to flexible contractual institutions.

Finally, the possibly ambiguous effect of average ability (θ) is the resultant of two forces. On the one hand, the complementarity between k and θ means that investment is more valuable the higher ability is. This force tends to make long-term contracts optimal for high θ, because they maximize investment. On the other hand, due to the same complementarity, a higher θ raises investment and therefore also the value of selecting good managers, which is proportional to the knowledge capital they operate with. When ability converges to the lower bound of its relevant range ($\theta \to \delta$), investment is the same under both contracts so that the first effect disappears.

3.5 Firm Heterogeneity and the Transition to Short-Term Contracts

So far we have emphasized the implications of the model for cross-country comparison. By adding heterogeneity across firms and sectors, the model can shed light on cross-industry comparisons as well. To this end, we first relax the assumption that all new firms start with the same level of knowledge capital. Suppose then that k_{jt} is observable and it is drawn from a non-degenerate distribution, $Z(k)$, with mean equal to the average knowledge capital of existing old firms. Given that investment does not depend on the level of k_{jt}, we still have $i_{jt} = i$ so that the law of motion of the average knowledge capital in the economy, (13), is unaffected. Moreover, condition (12) and Propositon 1 also hold, meaning that the threshold level of knowledge capital, k^*, above which short-term contracts become optimal is the same as before. The difference is that in each period there will be a fraction $Z(k^*)$ of new firms who prefer to choose long-term contract. Yet, as the mean of $Z(k)$ grows over time with knowledeg accumulation, the fraction of firms below k^* will shrink, converging eventually to zero. Thus, the main novelty of this version of the model is that it generate a smooth transition along which flexible contcats are first chosen by the most productive firms and then gradually adopted by all the others.

Following the same logic, we can also assume that firms are grouped into different sectors, indexed by i, each characterized by a different volatility $\sigma^2_{\varepsilon i}$ and possible different investment technologies $f_i(k)$. In this case, investment will be sector-specific, but it is straightforward to see that the general properties of the model will still hold. Introducting this additional dimensions of heterogeneity allow us to obtain both cross-firm and cross-industry predictions. In particular, the modified model suggests that rigid contractual relationships should tend to prevail among less productive firms, in more traditional sectors where skills matter less, and in industries where ability is harder to observe.

3.6 Varying Bargaining Power

Although contract incompleteness precludes contingent contracts, a recent literature (e.g. Hart, 1995 and references therein) has argued that actions affecting the allocation of bargaining power between parties may improve incentives. In this spirit, we now consider a richer institutional framework that lets the bargaining power of managers and investors be allocated differently across the first and second period. In particular, we assume that λ still defines the minimum bargaining share of managers. For instance, this may be the fraction of cash flow that the manager can hide and appropriate without being prosecuted. However, investors may have the option to raise the managerial bargaining power associated to the age of the firm: $\lambda_1 \in [\lambda, 1]$ and

$\lambda_2 \in [\lambda, 1]$. We now study how this institutional improvement affects the efficiency of contracts and the transition studied above.

Under long-term contracts ($\delta = 0$), the level of investment that maximizes the PDV of a new firm must satisfy the condition $\beta f'\left(i^L\right) = 1/\theta$. This is precisely the investment chosen by a manager with a constant bargaining power, i.e., (8). It is therefore immediate to see that the optimal choice for firm owners is to set $\lambda_1 = \lambda_2 = \lambda$ so as to obtain the efficient level of investment and maximize their share of rents. Intuitively, in this case there is no reason to change managerial incentives because, conditional on no selection, long-term contracts already yield the optimal level of investment. Thus, the possibility to tilt the power of the manager has no impact on the performance of long-term contracts.

Under short-term contracts, the manager's problem (3) becomes:

$$\max_{i_t} \lambda_1 (\theta k_t - i_t) + \beta \frac{1}{2} \lambda_2 (\theta + \delta) [k_t + f(i_t)],$$

where we have already substituted $p_t = 1/2$. The first order condition is

$$\beta f'\left(i^{\lambda}\right) = \frac{\lambda_1}{\lambda_2} \frac{2}{\theta + \delta}. \tag{14}$$

Not surprisingly, investment is increasing (decreasing) in the second (first) period compensation, λ_2 (λ_1) and the comparative statics for the other parameters remains the same as in the previous sections.

If investors can choose λ_1 and λ_2, they may have an incentive to give up cash flow (by raising λ_2) in order to foster investment. In particular, they would set managerial bargaining power so as to maximize the expected present discounted value of their own share in the project:

$$\max_{\lambda_1, \lambda_2} (1 - \lambda_1) \left(\theta k_t - i^{\lambda}\right) + \beta (1 - \lambda_2) \left[k_t + f\left(i^{\lambda}\right)\right] \left(\theta + \frac{\delta}{2}\right), \tag{15}$$

subject to (14) and $\lambda_1 \in [\lambda, 1]$, $\lambda_2 \in [\lambda, 1]$.

Given that raising λ_1 reduces both current investors' share of cash flow and investment, it will always be set to its minimum λ. The first order condition for λ_2 is instead:

$$\beta\left(\theta+\frac{\delta}{2}\right)\left[k_t+f\left(i^{\lambda}\right)\right]\geq\left[\beta f'\left(i^{\lambda}\right)(1-\lambda_2)\left(\theta+\frac{\delta}{2}\right)-(1-\lambda)\right]\frac{\partial i^{\lambda}}{\partial\lambda_2}. \tag{16}$$

with equality if $\lambda_2 > \lambda$. The left-hand side of (16) represents the marginal cost of increasing second-period managerial bargaining power, which is proportional to the second-period cash flow. The right-hand side captures the net marginal benefit of higher λ_2 through the rise in investment that it generates. Obviously, if the solution is interior ($\lambda_2 > \lambda$), then investors' welfare must be higher than under the simpler short-term contracts of section 3.2 ($V^{\lambda S}(k_t) > V^S(k_t)$), because they could could have chosen $\lambda_2 = \lambda$. The interesting question is then to study under which conditions the optimal solution is the corner. This will be the case ($\lambda_2 = \lambda$) if the marginal cost of rising λ_2 above its minimum is higher than its marginal benefit, i.e., if (16) holds with inequality after using $\lambda_2 = \lambda$ and (14). As we show in the Appendix, this condition reduces to:

$$\beta\left[k_t+f\left(i^S\right)\right]\frac{\lambda}{1-\lambda}>\frac{\theta}{2\theta+\delta}\left(\frac{2}{\theta+\delta}\right)^2\left(-\frac{1}{\beta f''\left(i^S\right)}\right). \tag{17}$$

Inspection of (17) reveals that this condition will be satisfied, so that the solution with variable managerial bargaining power coincides to the simple short-term contract with $\lambda_2 = \lambda_1 = \lambda$, as knowledge capital grows, ability gets more dispersed and noise falls, i.e., when investment becomes relatively less important than selection. Moreover, varying the bargaining power is a less useful instrument when managers already have high control over the firm's cash flow (high λ). From (16), it is also possible to see that, starting from a situation in which the optimal λ_2 is higher than λ, λ_2 will converge monotonically to λ as k_t or σ_θ^2 grow, and σ_ε^2 falls.

This result is consistent with the notion that ex-ante efficiency requires that a higher bargaining power should be allocated to the party that makes the most important task (e.g., Hart, 1995). In the context of the present model, we can think of investment as a task performed by managers and selection as a task performed by firm owners. When investment is more important than selection, namely when knowledge capital is low, ability is homogeneous and noise is large, the manager should be given relatively more bargaining power, while the opposite happens when selection is more relevant.

In sum, we have shown that the choice of λ_1 and λ_2 does not affect long-term contracts, while it (weakly) improves short-term contracts ($V^{\lambda S} \geq V^S$). Moreover, the trade-off between investment and selection under alternative contracts is typically preserved and the economy converges necessarily to the benchmark case $\lambda_1 = \lambda_2 = \lambda$ as k grows. The new important result is that short-term contracts will become preferable to long-term contracts for a smaller level of knowledge capital than in section 3 and hence the transition will be faster.

4 Asymmetric Information

We now assume that investment is unobservable to the investors. This allows us to study the trade-off between short- and long-term contracts in an environment with more informational frictions. It is immediate to show that this asymmetry has no bearings on long-term contracts. Under short-term contracts, instead, asymmetric information introduces an additional distortion in the choice of investment due to a career-concern motive. In particular, managers will invest less in an attempt to manipulate the signal of their ability and hence their confirmation probability. In equilibrium, however, investors will correctly foresee the behavior of managers and p will still be one-half.

Unobservability implies that investors will rely upon equilibrium investment i_t^U, instead of observed investment, when extracting the ability signal from the firm's performance y_{jt}. Therefore, a manager will be retained if the project cash flow, y_{jt}, is higher than the expected cash flow generated by a manger with average ability doing the expected equilibrium investment, i_t^U:

$$(\theta_j + \varepsilon_{jt})\, k_t - i_{jt} \geq \theta k_t - i_t^U.$$

As before, the probability that the manager is confirmed is equal to the probability that the realization of the random variable $(\theta_j + \varepsilon_{jt})$ is high enough:

$$p_{jt} = \Pr\left[\theta_j + \varepsilon_{jt} \geq \theta + \frac{i_{jt} - i_t^U}{k_t}\right] = 1 - G\left(\theta + \frac{i_{jt} - i_t^U}{k_t}\right), \tag{18}$$

where G is the c.d.f. of $\theta_j + \varepsilon_{jt} \sim N\left(\theta,\ \sigma_\theta^2 + \sigma_\varepsilon^2\right)$. The new result is that, as (18) shows, the manager can deviate from the equilibrium strategy i_t^U in ways that are unobserved by investors and, by doing this, she will distort the signal extraction problem of investors and affect p_{jt}:

$$\frac{\partial p_{jt}}{\partial i_{jt}} = -\frac{1}{k_t} g\left(\theta + \frac{i_{jt} - i_t^U}{k_t}\right).$$

Intuityively, investing less than expected increases expected y_{jt} and thus the probability of confirmation in the second period.

In equilibrium, however, expectations are rational so that $i_t^U = i_{jt}$, $p_{jt} = p = \frac{1}{2}$ and:

$$\frac{\partial p_{jt}}{\partial i_{jt}} = -\frac{g(\theta)}{k_t} = -\frac{[2\pi(\sigma_\theta^2 + \sigma_\varepsilon^2)]^{-1/2}}{k_t}. \tag{19}$$

Note that $g(\theta)$ is just the density of $\theta_j + \varepsilon_{jt}$ at the mean. Given that investors correctly foresee the equilibrium choice of the manager, the signal extraction problem they face is unaffected by unobservability of i_{jt}. This means that they form the best possible estimate of θ_j, so that the selection premium δ_{jt} is still equal to (10). Given that, conditional on not observing $\theta_j + \varepsilon_{jt}$, the investors maximize managerial ability at $t+1$, any marginal deviation of i_{jt} from i_t^U only has second-order effects on selection and $\partial \delta_{jt}/\partial i_{jt} = 0$.

Using these results, the first order condition for i_t^U, (4), becomes:

$$\beta f'\left(i_t^U\right) = \frac{2}{\theta + \delta} + 2\beta\left[1 + \frac{f\left(i_t^U\right)}{k_t}\right] g(\theta). \tag{20}$$

Comparing (20) with the first order condition in (9) gives a measure of the distortion brought about by unobservability of investment. In this case, selection is more costly in terms of foregone investment since, with $\partial p_{jt}/\partial i_{jt} < 0$, managers are willing to give up some investment in favor of current production in an effort to manipulate the perception of their ability and increase the probability of being retained. Thus, the unsuccessful attempt to manipulate the signal of ability introduces a short-run bias in investment so that managers invest less under asymmetric information: $i_t^U \leq i^S$.[13] Equation (19) shows that this bias is strong when k_t, σ_θ^2 and σ_ε^2 are low, that is when y_{jt} is more sensitive to the choice of i_{jt}.

As in section 3.3, short-term contracts are more efficient if and only if condition (12) is satisfied after replacing i^S with i_t^U. Also here, we will focus on the non-trivial case in which long-term contracts yield higher investment than short-term

[13] See Holmstrom (1999) and Stein (1989) on how career-concers may laed to short-termism.

contracts: $i_t^U < i^L$. It is can be shown that the results in Proposition 1 and Corollary 1, stating that as capital is accumulated societies switch to short-term contracts, still holds. Moreover, since investment under short-term contracts is lower when i_{jt} is unobservable while δ is the same, we have that $V^U < V^S$ for any parameter value and capital is accumulated at a lower rate. This implies that asymmetric information unambiguously slows down the transition to short-term contracts (k^* and t^* are higher).

The effect of other parameters on the speed of the transition to short-term contracts is similar (but not identical) to the case of symmetric information. As before, heterogeneity in managerial talent improves the relative performance of short-term contacts. This happens because a high σ_θ^2 increases the selection premium δ and i_t^U, both raising $V^U(k_t)$. Moreover, it is easy to show that Corollary 2 still applies. The effect of σ_ε (noise) is instead now more complex. On the one hand, a higher noise reduces the incentive to underinvestment in an effort to manipulate the signal (see equation 19). This effect tend to increase i_t^U and $V^U(k_t)$. On the other hand, a high noise reduces the benefit of selection, δ. Given that $\lim_{\sigma_\varepsilon^2 \to \infty} \delta = 0$, it is straightforward to prove that long-term contacts must be optimal for sufficiently high noise. For lower values, however, the effect of changes in σ_ε^2 on $V^U(k_t)$ may be non-linear. Numerical analysis suggests that a lower noise (i.e., improvements in the availability of information) speeds up the transition to flexible contracts in countries with enough heterogeneity of talents, while they might slow down the transition in very homogeneous societies.

5 Discussion

Before concluding, we pause to briefly discuss some of the key assumptions maintained in our model and to draw some empirical implications of our theoretical results.

5.1 Assumptions

Following the incomplete contract literature, we have excluded contracts contingent on production due to a lack of verifiability, but we have abstracted from commitment issues too. That is, we have assumed that legal enforcement is imperfect, but sophisticated enough to make the choice of one or two period contracts binding. For the purpose of the paper, namely, to study the observed persistence of long-term production relationships in less developed countries, our approach seems a natural compromise. In fact, in the absence of any commitment technology, rigid contracts would be harder to implement. The reason is a time consistency problem. Even if investor would like to promise reappointment ex-ante, in order to induce the optimal investment, they may want to deviate ex-post. Once investment is realized and y_{jt} observed, investors will form expectation on the ability of the current manager. If this ability happens to be below the average, investors are better off in expectation by replacing the manager with a new draw. Thus, for long-term contracts to arise, there must be institutions that can enforce the original promise not to fire the manager.

To circumvent the problem, if private contracts are difficult to enforce, the government may provide commitment by choosing labor market institutions that impose long-term relationship. Examples of this might be policies of tenured or lifetime employment. Alternatively, if there is no enforcement mechanism to sustain long-term contracts, it is possible that family firms, where the manager is also the owner of the firm, could provide a solution to the commitment problem. Provided that managerial compensation is large enough, the owner of a family firm will keep its control unless his managerial talent is very low. Thus, family firms may arise when long-term contracts are optimal, but not enforceable.[14]

Second, in the interest of simplicity, we have restricted the investors' choice (and their ability to commit) to short- versus long-term contracts only. In a richer environment, investors may be willing to sign two-period contracts that specify a severance pay in case the manager is replaced. The effect would be to increase the probability of keeping a manager above one-half and thus the incentive to invest, at the cost of less selection. Our model captures the essence of this trade-off without the additional complications that this form of "limited commitment" would pose.

Third, we have assumed that managers choose investment without knowing their own ability to avoid some complications that can arise in signaling games. Our assumption is relatively standard in models of career concerns (e.g., Holmstrom, 1999) and can easily be relaxed in the benchmark case with symmetric information.

Finally, in modeling the growth process, we have chosen to use an investment technology which features diminishing returns to knowledge accumulation. For this reason, the long-run growth rate of the economy converges asymptotically to zero,

[14]More generally, our model suggests that lack of commitment may be more costly in less developed countries where long-term contracts would be optimal.

although it always remains positive. While none of the main results depends on this assumption, it is consistent with the abundant evidence on conditional convergence, i.e., the fact that *ceteris paribus* poor countries tend to grow faster than rich countries and it seems particularly appropriate to study economies at different levels of development. Interestingly, in the presence of a positive depreciation or obsolescence rate of knowledge capital, the model economy will converge to a stady-state level of k. In this case, the switch to short-term contracts will not be inevitable and will depend on whether the steady-state level of knowledge capital is above k^*. Countries converging to different steady state, for example because of differences in patience or in the accumulation technology, may therefore end up with persistent differences in contractual arrangements.

5.2 Empirical Implications

The main theoretical result of the paper is that short-term production relationships, whereby bad performance leads to managerial turnover, are more likely to prevail at higher stages of development, where transparency in corporate governance is higher, and managerial ability is more dispersed. Besides being consistent with the broad view by Kuznets (1966, 1973) and Gerschenkron (1962), which formed our original motivation, these preditions can be confronted with a number of cross-country and cross-firm empirical studies.

Cross-country data would lend support to the model predictions if: (1) higher economic development raised the likelyhood that bad firm performance leads to CEO termination; (2) controlling for development, better corporate law and practice (e.g., disclosure requirements, informativeness of stock prices) raised the likelyhood that bad performance leads to CEO termination. Several contributions in corporate finance study the determinants of managerial turnover. Among these, De Fond and Hung (2004) show that CEO termination is more performance sensitive in countries with better corporate governance and where stock market prices are more informative, which we can interpret as a lower σ_ε^2 in our model. Lel and Miller (2008) provide evidence that firms from weak investor protection regimes that are cross-listed on a major U.S. Stock Exchange, which are subject to severe disclosure requirements (low σ_ε^2, in our model), are more likely to terminate poorly performing CEOs. The same is not true for firms that cross-list in the London Stock Exchange, which has less severe requirements.

Moving to cross-firm data, the version of our model with heterogeneous knowledge capital and differences in other parameters across industries predicts that short-term contracts should prevail: (1) in larger firms, (2) where managerial ability is more dispersed, or production is more complex so that managerial ability matters more; and (3) idiosyncratic risk is lower, or investors have better control/information. Consistently, Zhou (2000) provides evidence that large Canadian firms are more likely to terminate their CEO after bad performance than small firms. Although measures of cross-sectional variation in complexity and idiosyncratic risk are available (e.g., Castro, Clementi and MacDonald, 2009), there are to our knowledge no studies relating them to the performance sensitivity of managerial turnover at the firm level. Finally, the basic trade-off between investment and selection, which lays at the heart of our theory, is consistent with the findings in Aghion, van Reenen and Zingales (2008), that increased institutional ownership is positively correlated with innovation and negatively correlated with the incidence of performance-driven replacement of managers in a panel of US firms.

6 Conclusions

In this paper, we have built a simple growth model where economic success requires both incentives to undertake investments that pay out in the future and managerial selection. Investment is relatively more important at early stages of development, when productive capacity is low. It is then optimal to choose long-term contracts that maximize the incentives to invest, even at the cost of no managerial selection. As knowledge capital grows, ability becomes more important and the economy endogenously switches to short-term contracts that maximize managerial talent, even at the cost of some underinvestment. We have also studied how other parameters affect the speed of the transition. Another result of our analysis is that countries with better institutions and less informational frictions will experience a faster transition to short-term contracts.

Our model can be used to analyze the effects of policies that improve the availability of information. For example, financial development may bring about a better monitoring technology that lowers the amount of noise in the economy. Likewise, financial openness may allow investors to hold claims on foreign firms and this may provide access to privileged information, such as balance sheets and investment reports. By comparing economic performance of firms in the same sector in different countries, investors may acquire information on global sectorial shocks and reduce the noise in the ability signals they observe from managers. Thus, by reducing uncertainty, financial development and financial openness may speed up the transition to flexible contracts, improve selection and increase managerial ability. These results can help rationalize the findings in Beck, Levine and Loayza (2000) and Bonfiglioli (2008) that financial development and liberalization spur productivity, particularly in developed countries, but not investment.

The results in this paper have been obtained with the help of a stylized model that abstracts from several potentially interesting issues. Given that the resulting framework has proven to be tractable, we hope it can serve as a building block for future extensions. Among these, two stand out as particularly prosiming. First, endogenizing the ability distribution may open the door to multiple equilibria and development traps. The reason is that with long-term contracts ability is less important so that managers may have a lower incentive to invest in activities, such as education, that could increase talent. At the same time, this may lead to a more compressed ability distribution that in turn justifies the adoption of long-term contracts. This may help explain why some countries appear to be trapped in a no-selection, low-human capital equilibrium.[15] Second, as already mentioned, an interesting extension is to include firing costs in the model, so as to nest the short-term and long-term contracts as special cases (corresponding to zero and prohibitive firing costs, respectively). This would allow us to study intermediate regimes where p can be increased continuosly at the cot of lowering δ. Although the model may lose some analytical tractability, it could be used for studying the optimal level of firing costs. Finally, the cross-country and cross-sectoral predictions discussed in the previous section may be the starting point of future empirical work.

[15] Hassler and Rodriguez-Mora (2000) make a related point using a different model.

7 Appendix

7.1 Proof of Lemma 1

Re-write the first order condition for optimal investment under short-term contracts, eq. (9), as

$$I \equiv \beta \frac{f'\left(i^S\right)}{2} - \frac{1}{\theta + \delta} = 0.$$

This equation defines investment as an implicit function of the other variables and parameters of the model. To prove Lemma 1, we compute the derivatives of investment with respect to patience (β), ability dispersion (σ_θ^2), noise (σ_ε^2) and average ability (θ):

$$\frac{\partial i^S}{\partial x} = -\frac{\partial I}{\partial x} \Big/ \frac{\partial I}{\partial i_t^S}$$

where

$$\frac{\partial I}{\partial i^S} = \frac{1}{2} \beta f''\left(i^S\right) < 0.$$

Lemma 1 follows from:

$$\frac{\partial I}{\partial \beta} = \frac{f'\left(i^S\right)}{2} > 0,$$

$$\frac{\partial I}{\partial \sigma_\theta^2} = \frac{1}{(\theta+\delta)^2} \frac{\partial \delta}{\partial \sigma_\theta^2} = \frac{1}{(\theta+\delta)^2} \frac{\sigma_\theta^2 + 2\sigma_\varepsilon^2}{2\sigma_\theta^2\left(\sigma_\theta^2 + \sigma_\varepsilon^2\right)} \delta \geq 0,$$

$$\frac{\partial I}{\partial \sigma_\varepsilon^2} = \frac{1}{(\theta+\delta)^2} \frac{\partial \delta}{\partial \sigma_\varepsilon^2} = -\frac{\sigma_\theta^2}{\left(\sigma_\theta^2 + \sigma_\varepsilon^2\right)^{\frac{3}{2}} 2\sqrt{\pi}} \leq 0,$$

$$\frac{\partial I}{\partial \theta} = \frac{1}{(\theta+\delta)^2} > 0.$$

7.2 Proof of Proposition 1

To prove Proposition 1, we only need to show that the difference between the PDV of the project under short-term and long-term contracts, $\Delta V \equiv \frac{V^S(k_t) - V^L(k_t)}{1-\lambda}$, is increasing in the stock of capital, k_t. The derivative of ΔV w.r.t. k_t is

$$\frac{\partial \Delta V}{\partial k_t} = \beta\left(\delta/2\right) > 0.$$

7.3 Proof of Proposition 2

To prove Proposition 2, rewrite ΔV as:

$$\Delta V = \left[\beta\theta f\left(i^S\right) - i^S\right] - \left[\beta\theta f\left(i^L\right) - i^L\right] + \beta\left(\delta/2\right)\left[k_t + f\left(i^S\right)\right].$$

Then, we study how ΔV changes with σ_θ^2, σ_ε^2 and θ. First:

$$\begin{aligned}\frac{\partial\Delta V}{\partial\sigma_\theta^2} &= \frac{\partial i^S}{\partial\sigma_\theta^2}\left[\beta\left(\theta+\frac{\delta}{2}\right)f'\left(i^S\right)-1\right]+\frac{\partial\delta}{\partial\sigma_\theta^2}\frac{\beta}{2}\left[k_t+f\left(i^S\right)\right]\\ &= \frac{\partial i^S}{\partial\sigma_\theta^2}\frac{\theta}{\theta+\delta}+\frac{\partial\delta}{\partial\sigma_\theta^2}\frac{\beta}{2}\left[k_t+f\left(i^S\right)\right]>0,\end{aligned}$$

where we have used the first order condition (9) and the sign follows from $\partial i^S/\partial\sigma_\theta^2 > 0$ and $\partial\delta/\partial\sigma_\theta^2 > 0$. Second, following the same steps as above we obtain:

$$\frac{\partial\Delta V}{\partial\sigma_\varepsilon^2} = \frac{\partial i^S}{\partial\sigma_\varepsilon^2}\frac{\theta}{\theta+\delta}+\frac{\partial\delta}{\partial\sigma_\varepsilon^2}\frac{\beta}{2}\left[k_t+f\left(i^S\right)\right]<0,$$

because $\partial i^S/\partial\sigma_\varepsilon^2 < 0$ and $\partial\delta/\partial\sigma_\varepsilon^2 < 0$. Finally:

$$\begin{aligned}\frac{\partial\Delta V}{\partial\theta} &= \beta\left[f\left(i^S\right)-f\left(i^L\right)\right]+\frac{\partial i^S}{\partial\theta}\left[\beta\left(\theta+\frac{\delta}{2}\right)f'\left(i^S\right)-1\right]\\ &= \beta\left[f\left(i^S\right)-f\left(i^L\right)\right]+\frac{\partial i^S}{\partial\theta}\frac{\theta}{\theta+\delta},\end{aligned}$$

where we have used the first order conditions (8) and (9). The first term in square brakets is negative, because $i^S < i^L$. Lemma 1 shows instead that the second term is positive. As $\theta \to \delta$ we have $i^S \to i^L$ so that the negative term converges to zero. Thus, for low values of θ (recall that we are focusing on the interesting range $\theta > \delta$) we obtain $\frac{\partial\Delta V}{\partial\theta} > 0$.

7.4 Proof of Corollary 1

For σ_θ^2 close to zero the selection effect (δ) tends to zero, hence

$$\lim_{\sigma_\theta^2\to 0}\Delta V = \left[\beta\theta f\left(i^S\right) - i^S\right] - \left[\beta\theta f\left(i^L\right) - i^L\right] < 0,$$

since $\beta\theta f(i) - i$ is maximized at i^L. At σ_θ^2 such that $\delta \to \theta$, we know that $i^L = i^S$ so that $\Delta V = \beta(\theta/2)\left[k_t + f\left(i^S\right)\right] > 0$. Then, since ΔV is increasing in σ_θ^2 and continuous, a value $\widehat{\sigma}_\theta^2 > 0$ must exist such that $\Delta V > 0$ for all $\sigma_\theta^2 \geq \widehat{\sigma}_\theta^2$.

7.5 Optimal managerial bargaining power

Take the first order condition for investment in the case of short term contracts:

$$\beta f'\left(i^\lambda\right) = \frac{\lambda_1}{\lambda_2}\frac{2}{\theta+\delta}.$$

Using implict differentiation yields:

$$\begin{aligned}
\frac{\partial i}{\partial \lambda_1} &= \frac{1}{\beta f''\left(i_t^\lambda\right)}\frac{1}{\lambda_2}\frac{2}{\theta+\delta} < 0 \\
\frac{\partial i}{\partial \lambda_2} &= -\frac{1}{\beta f''\left(i_t^\lambda\right)}\frac{\lambda_1}{\left(\lambda_2\right)^2}\frac{2}{\theta+\delta} > 0.
\end{aligned}$$

Next, take condition (16) and substitute (14):

$$\beta\left(1+\frac{\delta}{2\theta}\right)\left[k_t + f\left(i^\lambda\right)\right] > \frac{1-\lambda}{\theta+\delta}\frac{\partial i^\lambda}{\partial \lambda_2}.$$

Finally, substitute $\partial i/\partial \lambda_2$ to obtain (17) in the text.

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