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, 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 design of optimal contractual institutions. Our analysis shows that rigid long-term contracts sacrificing managerial selection may be optimal at early stages of economic development, when capital is scarce and access to information limited. As the economy grows, however, falling returns to accumulation and better access to information make it optimal to adopt flexible economic institutions, where managerial selection is implemented, even at the cost of lower investment. Thus, the paper shows that appropriate contractual relationships evolve endogenously along the process of economic development as argued, for example, by Kuznets (1966, 1973) and Gerschenkron (1962).

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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 may thus be essential too. The role of contractual institutions 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, 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 that has important implications for the design of optimal contractual institutions.

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 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 that sacrifice managerial selection, but will eventually switch to more flexible short-term relationships. Thus, the paper will show how appropriate contractual institutions 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, that 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 argued that such rigid arrangements are inefficient, because they imply a misallocation of talents, others have suggested that they may simply reflect the need for different institutional forms at various stages of development. ¹ In particular, Kuznets (1966, 1973) and Gerschenkron (1962) have forcefully stressed that economic growth is accompanied by a process of structural transformation that in-

¹See, for example, Burkart et al. (2003), Caselli and Gennaioli (2005) and reference therein.
cludes changes in production relationships and an increasing importance of skills. In this spirit, we propose a theory where rigid production relationships may be a second-best arrangement in countries with low levels of human and physical capital, and with limited access to information. As capital is accumulated, however, skills become more important and more flexible contracts arise.

In our baseline model, firms last for two periods and produce output by combining a broad form of capital with managerial skill. In the first period of the life of a new firm, investors hire a manager to run it. Ability is drawn randomly; it is specific to the firm-manager match and observed neither by the manager nor by the investors. The manager receives the existing capital stock and decides its allocation between current production and a long-term investment that produces new capital in the next period. At the end of the first period, investors observe the level of production, that depends on (1) the allocation of capital, (2) managerial ability and (3) an idiosyncratic shock (noise), and form expectations on the ability of the manager. Next, they decide whether to confirm the manager (if his expected ability is high enough) or to replace him with a 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 being confirmed.

With this simple model, we first study the determinants of long-term investment. There are two distortions inducing managers to choose a sub-optimally low level of investment. First, the mere possibility of being dismissed implies that managers may not be able to enjoy future returns and this reduces their expected benefit from long-term investment. Second, as investors can only imperfectly infer managerial ability from 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. This distortion is similar to the one arising in the agency model of Milgrom (1988), where an agent cares about some decisions that the principal can make (such as terminating the contract) and thus spends costly resources in trying to influence them. 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 retain
good managers and replace incompetent ones. The benefit of selection, on the other hand, is that it ensures an average higher managerial ability.

We then study how information and uncertainty on economic outcomes affect investment and selection. Perhaps surprisingly, we find that uncertainty unambiguously increases investment, while its effect on selection depends on whether uncertainty is due to the dispersion of managerial talent or to idiosyncratic noise. In all cases, when uncertainty is high, managers have little chance to influence the perception of their ability by increasing current production at the expense of investment with future payoffs. Thus, uncertainty alleviates the agency problem, as distorting investment becomes a less effective means to increase the probability of being confirmed. Regarding the effect on managerial quality, selection is a powerful tool when uncertainty is due to large dispersion in ability. On the contrary, when uncertainty is due to a large noise, inferring managerial ability is difficult, selection is highly imperfect and average quality low.

Next, we turn to study how the trade-off between selection and investment shapes optimal contractual institutions. More precisely, we ask under what circumstances long-term (two period) contracts sacrificing managerial selection may be welfare enhancing. We find that rigid contracts are optimal when information is very noisy, ability is concentrated, returns to investment are high and agents are patient. These are cases in which selection is either difficult or not very useful, while investment is relatively more valuable. It is then preferable to maximize investment, even at the cost of lower managerial quality. The model thus suggests long-term contracts to prevail in developing countries with a low capital stock and poor access to information. However, rigid contracts may also be optimal in societies that are very homogeneous (Japan may provide an interesting example). As capital is endogenously accumulated, diminishing returns imply that investment becomes relatively less important than managerial ability, and flexible contractual institutions implementing managerial selection become optimal. Better access to information and a higher skill dispersion also speed up the transition.

Our paper contributes to the theoretical literature, still in its infancy, on appropriate institutions.² To our knowledge, only a few papers study how contractual in-

²This literature has been pioneered by the works of Dougls 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 (2001,1999,1997). ADD MORE
stitutions change with economic development. The closest paper to our is Acemoglu, Aghion and Zilibotti (2006). They assume that skill is more important for innovation than for the adoption of foreign technologies and find that selection becomes more important as countries get closer to the technology frontier. They then use the model to study the effects of competition policy. Our analysis is complementary and has a different focus: we study a similar trade-off between investment and selection, but we do so under very different and possibly more general conditions. In another related paper, 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 issue of risk-sharing. Acemoglu et al. (2007), instead, study how information affects the decentralization of the firms and report some empirical results compatible with our paper. In their model, the decision to delegate authority depends on asymmetric information between the agent and the principal. On the contrary, we stress a very different agency problem where information is symmetric.

The rest of the paper is organized as follows. Section 2 lays down a simple model and describes the equilibrium under the benchmark cases of flexible contracts (renegotiated every period) and two-period contracts (the manager cannot be fired). It illustrates the main trade-off between selection and investment. Section 3 studies how the optimal contractual arrangement (long- versus short-term contract) varies with the level of development and with other parameters. It shows how, along the development process, countries may start with long-term contracts that maximize investment and endogenously switch to short-term contracts that maximized managerial ability. Section 4 studies the properties of a more complex state-contingent contract with commitment and generalizes the previous findings. Section 5 concludes.

2 The Model

We propose a simple growth model designed to study the agency problem between investors and managers in a world where both managerial ability and long-term investment are not perfectly observable. The model gives rise to a trade-off between selection and investment, with implications for optimal contractual institutions. To
isolate the agency problem and its consequences, we follow a minimalist approach. This will allow us to derive a rich set of results while preserving tractability.

2.1 AGENTS, PREFERENCES AND TECHNOLOGY

The economy is populated by a continuum of risk-neutral, infinitely lived, agents who discount the future at the rate $\beta \in (0,1)$. Agents own the capital stock of the economy and can work as managers. The capital stock is a broad measure of the total productive resources of the economy, including both physical and human capital. There is a single final good, produced through “projects” each requiring the combination of capital and one manager. In every period, there is a unit measure of active projects:  

$$Y_t = \int_0^1 y_{it} \, di,$$

where $y_{it}$ is production of project $i$ at time $t$. Projects run for two periods and, once expired, are replaced by an equal measure of new projects.

When a new project starts at time $t$, a manager is chosen randomly from the population of agents. At this stage, managerial ability at running the specific project is unknown. The manager receives a given capital stock $k_{it}$ from investors and decides how to allocate it between current period production and an investment activity that generates new capital at $t+1$. In particular, $i_{it}$ units of capital invested at $t$ produce $f(i_{it})$ units of additional capital at $t+1$, where the function $f(\cdot)$ satisfies the regularity conditions: $f'(\cdot) > 0$, $f''(\cdot) < 0$ and $f'(0) = \infty$. Once the investment decision is made, managerial ability, $\theta_i$, is drawn from a normal distribution with mean $\theta$ and variance $\sigma^2_{\theta}$:

$$\theta_i \sim N(\theta, \sigma^2_{\theta}).$$

Ability affects production and is project-manager specific. Hence, it does not change over the lifetime of a project and decays at its end. Production is also affected by a random shock $\varepsilon_{it}$ drawn from a normal distribution with zero mean and variance $\sigma^2_{\varepsilon}$:

$$\varepsilon \sim N(0, \sigma^2_{\varepsilon}).$$

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3. We take the number of available projects as an exogenous characteristic of technology. We also assume that the measure of agents has a higher order of infinity than the measure of projects.

4. The fraction of old and new project at any time is immaterial.
We assume that the shock $\varepsilon$ is independent of ability and uncorrelated across projects and time, so that it captures an unpredictable noise component. Thus, production during the first period of the project is:

$$y_{it} = (\theta_i + \varepsilon_{it})(k_{it} - i_{it}),$$

Production, minus managerial compensation, is distributed as dividends to investors and consumed. Upon observing $y_{it}$, i.e. a noisy signal of managerial ability, and depending on the type of contract offered to the manager (as described below), investors may decide whether to replace the manager with a new random draw or not.

At time $t + 1$, the capital stock is equal to the initial level plus the return from investment:

$$k_{it+1} = k_{it} + f(i_{it}).$$

Note that there is no depreciation and no new capital can be allocated in the second period, except for the realized past investment $f(i_{it})$. Moreover, given that the project terminates after the second period, at this stage new investment is not allowed and all capital is allocated to production:

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

where $\theta_{t+1}$ is the ability of the previous manager ($\theta_i$) or, if replaced, a new random draw from the distribution $N(\theta, \sigma_\theta^2)$. At the end of the period, the project expires, the manager is dismissed and the capital stock $k_{it+1}$ is returned to the pool of agents. At $t + 2$ new projects arise, capital is reallocated among them, and the cycle starts again. Figure 1 summarize the timing of events.

We now discuss the managerial contract more in details. It is characterized by two important features. First, managerial compensation is contingent on observables, in
that managers are paid a fraction $\lambda$ of the cash flow that their project generates, $y_{it}$. The fraction $\lambda$ is public information and might be determined through ex-post Nash bargaining.\footnote{It can be shown that such a linear compensation scheme is indeed optimal.} Note that managers also own a diversified portfolio of shares of all firms, like any other agent in the economy. As all investors, they also receive every period a fraction of the dividends distributed by firms.

Second, depending on the type of contractual institutions available in the country, the contract may grant investors the option to replace the manager before the termination of the project. 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 $y_{it}$, is too low. Alternatively, managers and investors might be able to sign binding long-term contracts that do not allow for this type of managerial turnover. Finally, agents might be able to write more complex contingent contracts specifying that the manager will be retained whenever production is above a certain threshold. In the remainder of the paper, we study and compare the properties of these alternative contractual arrangements, discussing explicitly the commitment technology that each of them requires. Before doing so, however, we formally describe the investment choice by managers and the inference problem that investors face.

### 2.2 Managers and Investors

The manager chooses investment $i_{it}$ in order to maximize her expected life-time utility:

$$\max_{i_{it}} \lambda E\left[y_{it} + \beta y_{it+1}\right] + \sum_{\tau=t}^{\infty} \beta^{\tau-t}E(D_{\tau})$$

subject to:

$$y_{it} = (\theta_t + \varepsilon_{it})(k_{it} - i_{it})$$
$$k_{it+1} = k_{it} + f(i_{it})$$

where $E$ is the expectation operator and $D_{\tau}$ represents the manager’s “dividend” from her portfolio of claims on production of all projects in the economy. Note that the manager takes the stream of dividends as given, for it is determined by
aggregate production and is thus independent of the outcome of any single project $i$. Therefore, only the first term in (1) is relevant for the investment choice. Substituting the constraints into the objective function and dropping the constant term, we can rewrite the maximization program as:

$$\max_{i_t} \theta (k_{it} - i_{it}) + \beta p_{it} \theta [k_{it} + f(i_{it})],$$

where we have used the fact that $\mathbb{E}(y_{it}) = \theta_i (k_{it} - i_{it})$ and $p_{it}$ is defined as the perceived probability of being confirmed in the second period, to be determined in equilibrium. Note that, when making the investment choice, ability is unknown to the manager. Moreover, we focus on symmetric equilibria when all new projects have the same amount of capital $k_{it}$ so that all managers make the same investment. The first order condition for $i_{it}$ is:

$$\beta p_{it} f'(i_{it}) + \beta \frac{\partial p_{it}}{\partial i_{it}} [k_{it} + f(i_{it})] = 1.$$

(2)

The first term on the left hand side is the expected marginal benefit of investment in terms of higher production at $t + 1$. This is equal to the marginal product of investment multiplied by the discount factor and the probability that the manager will be retained. The second term on the left hand side is the marginal impact of investment on the probability of being retained, multiplied by the discounted value of running the firm in the second period. The right hand side is instead the current period cost of investment in terms of foregone production.

Investors face an inference problem. They must form expectations on the ability of the manager conditional on observing the noisy signal $y_{it} = (\theta_i + \varepsilon_{it}) (k_{it} - i_{it})$. Investors know the initial capital stock $k_{it}$ and can rationally foresee the equilibrium investment made by the manager, so that they effectively observe the sum $\theta_i + \varepsilon_{it}$. Given the distributions of $\theta$ and $\varepsilon$, that are assumed to be common knowledge, we can calculate the “posterior” expectation on $\theta_i$, conditional on observing $\theta_i + \varepsilon_{it}$:

$$\hat{\theta}_{it} = \mathbb{E} [\theta_i \mid \theta_i + \varepsilon_{it}] = \theta + \frac{\sigma^2}{\sigma^2 + \sigma^2_{\varepsilon}} (\theta_i + \varepsilon_{it} - \theta).$$

(3)

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6It can be shown that allocating capital evenly across all the starting project is optimal, because it maximizes the expected present value of the project. We do not allow for competition for projects between managers. Adding an initial stage where potential managers offer lump sum payments to win the competition for project does not modify the results.
That is, the posterior expectation on managerial ability is a weighted average of the “prior”, $\theta$, and the observed signal, $\theta_i + \varepsilon_{it}$, with weights that depend on the precision of the signal: as the variance of the noise increases relative to the variance of ability, the signal becomes less and less informative and the posterior expectation converges to the unconditional mean. Note also that the distribution of the posterior belief on the manager’s ability is normal:

$$\hat{\theta}_{it} \sim N \left( \theta, \frac{\sigma^4_\theta}{\sigma^2_\theta + \sigma^2_\varepsilon} \right).$$

Intuitively, $\hat{\theta}_{it}$ has the same mean but a smaller variance than $\theta$.

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

$$\frac{V(k_{it})}{1 - \lambda} = \theta (k_{it} - i_{it}) + \beta (\theta + p_{it} \delta) [k_{it} + f(i_{it})],$$

where $\delta$ is the “selection effect”, that is, the expected ability difference between a manager that is confirmed (this event happening with probability $p_{it}$) and a random draw. Both $p_{it}$ and $\delta$ are endogenous, with $\delta > 0$ whenever selection implies that a confirmed manager is expected to have a higher than average ability. As we will see shortly, $\delta$ will generally depend on the dispersion of managerial talent and the precision of the signal observed by investors.

2.3 Long-Term Contracts

Suppose that investors were not allowed to replace the manager at the end of the first period. In this case, we have $p_{it} = 1$ and $\partial p_{it}/\partial i_{it} = 0$ so that the first order condition for investment (2) turns into:

$$f'(i^L) = \frac{1}{\beta},$$

where the superscript $L$ stands for long-term contracts. It is easy to see that $i^L$ maximizes $V(k_{it})$, meaning that investment is optimal for the project. However, there is no selection effect so that the ex-ante expected managerial ability at the
second period is just the unconditional mean $\theta$. Thus:

$$\delta^L = 0.$$ 

Note that, in order to implement such a rigid contract, some commitment technology is required. The reason is the presence of 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 $y_{it}$ observed, investors will form expectation on the ability level of the current manager, as for (3). If this ability happens to be below the average $\theta$, 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.

When 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. More generally, even in the absence of commitment problems, family firms with no managerial turnover are an example of long-term contractual relationships. Very low managerial turnover is also a typical feature of state owned firms.

2.4 Short-Term Contracts

We now consider the case in which investors are free to replace the manager after the first period (no-commitment). The optimal strategy for the investors is to fire the manager if her expected ability, conditional on observing $y_{it}$ is below the population average. Thus, the probability that a manager be confirmed is the probability that $\tilde{\theta}_{it} \geq \theta$, or equivalently, the probability that the signal is above its mean $\mathbb{E}(y_{it})$:

$$p_{it} = \Pr(\tilde{\theta}_{it} \geq \theta) = \Pr \left[ (\theta_i + \varepsilon_{it}) (k_{it} - i_t) \geq \theta (k_{it} - i_t^S) \right] = 1 - G \left( \frac{\theta k_{it} - i_t^S}{k_{it} - i_{it}} \right)$$

11
where $i_t^S$ is expected equilibrium investment under short-term contracts and $G$ is the c.d.f. of the signal $\theta_t + \varepsilon_t \sim N(\theta, \sigma^2_\theta + \sigma^2_\varepsilon)$.

Note that, by reducing current production, investment affects this probability:

$$\frac{\partial p_{it}}{\partial i_{it}} = -\theta \frac{k_{it} - i_t^S}{(k_{it} - i_t)^2} g\left(\theta \frac{k_{it} - i_t^S}{k_{it} - i_t}\right)$$

where $g$ is the density of $G$. In equilibrium, rational expectations imply $i_t^S = i_{it}$, so that we obtain:

$$p_{it} = p = \frac{1}{2} \quad (7)$$

$$\frac{\partial p_{it}}{\partial i_{it}} = -\frac{\theta g(\theta)}{k_{it} - i_t^S} \quad (8)$$

The first order condition for $i_{it}$ (2) becomes:

$$f'(i_t^S) - \left[\frac{k_t + f(i_t^S)}{k_t - i_t^S}\right] \theta g(\theta) = \frac{1}{\beta} \quad (9)$$

with

$$g(\theta) = [2\pi(\sigma^2_\theta + \sigma^2_\varepsilon)]^{-1/2}. \quad (10)$$

### 2.4.1 The Cost of Selection

Comparing (9) to (6), it is clear that $i_t^S < i_t^L$, meaning that short-term contracts induce an investment level below the one that maximizes the project value. This happens for two reasons. First, given that $p = 1/2$, managers only have a 50 percent probability of being able to enjoy future returns and this reduces their expected benefit from investing. Second, given that $\partial p_{it}/\partial i_{it} < 0$, managers are willing to give up some long-term investment in favor of current production in an effort to manipulate the perception of their ability and increase the probability of being retained. In equilibrium, given that all managers choose the same investment that is rationally foreseen by investors, we always have $p = 1/2$. That is, the probability of being retained is just the exogenous probability of having a higher than average ability. Yet, the unsuccessful attempt to manipulate the signal of ability introduces a short-run bias in investment. This distortion is similar to the one arising in the agency model of Milgrom (1988), where an agent cares about some decisions that the principal can
make (such as terminating the contract) and thus spends costly resources in trying to influence them. Note that these two distortions depend on the fact that managers face a non zero probability of being replaced and hence represent the costs of selection.

2.4.2 The Benefit of Selection

What is the benefit of selection? It is that fact that confirmed managers tend to be of above average ability. This happens because a realization of $y_{it}$ above the mean is more likely to come from a high ability manager, although there is always a chance that it comes from low-$\theta$ type who got a very lucky realization of the shock $\varepsilon_{it}$. Formally, given that a manager is retained whenever her ability is expected to be above $\theta$, the average ability of a confirmed manager is equal to the mean of the distribution of the posterior belief $\hat{\theta}_{it}$ truncated below at $\theta$:

$$E(\theta_i | \hat{\theta}_{it} \geq \theta) = \int_{\theta}^{\infty} \hat{\theta} dF(\hat{\theta}) = \theta + \frac{\sigma_{\theta}^2}{\sqrt{(\sigma_{\theta}^2 + \sigma_{\varepsilon}^2) \pi}},$$

where $F$ is the c.d.f. of the posterior belief $\hat{\theta}_{it}$ (4).

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

$$\delta = \frac{\sigma_{\theta}^2}{\sqrt{(\sigma_{\theta}^2 + \sigma_{\varepsilon}^2) \pi}}. \quad (11)$$

Note that selection is more effective (high $\delta$) when the signal is not too noisy (low $\sigma_{\varepsilon}^2$) and ability very dispersed (high $\sigma_{\theta}^2$). Intuitively, when there is little noise, the probability of keeping by mistake a bad 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. In sum, the effect of uncertainty on selection and managerial ability depends crucially on whether uncertainty is due to the dispersion of managerial talent or to idiosyncratic noise.

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7See Barr and Sherril (1999) on the properties of truncated Normal distributions.
2.4.3 Incentives and Investment

We now study the determinants of investment, \( i_t^S \). Since \( f''(i_t^S) < 0 \), the left hand side of (9) is decreasing in \( i_t^S \). It is then easy to show that:

\[
\frac{\partial i_t^S}{\partial \beta} > 0; \quad \frac{\partial i_t^S}{\partial k_t} > 0; \quad \frac{\partial i_t^S}{\partial \theta} < 0 \quad \frac{\partial i_t^S}{\partial \sigma_\theta^2} = \frac{\partial i_t^S}{\partial \sigma_\theta^2} > 0
\]

(12)

Proof. See Appendix.

Not surprisingly, investment increases with patience, \( \beta \). Capital accumulation, instead, affects investment in two ways. On one hand, it increases the value of being reconfirmed and this tends to bias investment downward, because the incentive to manipulate the signal, and thus \( p_{it} \), becomes stronger. On the other, (8) shows that a high capital stock lowers the marginal effect of a reduction in investment on the signal. It turns out that the latter effect dominates, so that capital accumulation increases investment.

Investment falls when average managerial ability, \( \theta \), rises. The reason is that the expected marginal impact of investment on the signal is proportional to expected ability, as can be seen from \( y_{it} = (\theta_i + \varepsilon_{it}) (k_{it} - i_{it}) \). In turn, this depends on the assumption that ability affects production, but not the return from investment.

More interestingly, investment increases with the two dimensions of uncertainty, i.e., the dispersion of managerial ability and the variance of the shocks. When \( \sigma_\theta^2 \) and/or \( \sigma_\varepsilon^2 \) are high, (10) shows that managers have little chance to influence the perception of their ability by increasing current production at the expenses of investment. Thus, perhaps surprisingly, uncertainty alleviates the agency problem, as distorting investment becomes a less effective means to increase the probability of being confirmed.

3 Appropriate Contractual Institution and Economic Development

In this section, we compare the welfare properties of short- and long-term contracts and study how the optimal contractual form changes along the process of economic development. Long-term contracts maximize investment, but sacrifice managerial selection; on the other hand, short-term contracts allow on average to replace bad

\(^8\)Thus, the result that average ability lowers investment may not be robust to alternative modelling choices.
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 projects (5) in the two cases:

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

\[ (13) \]

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

\[ (14) \]

where \( \delta \) is given by (11). Rearranging these expressions, we find that short-term, flexible, contracts are ex-ante optimal when the following condition holds:

\[ V^S(k_t) > V^L(k_t) \iff \frac{k_t + f \left( i^S_t \right)}{[\beta f (i^L_t) - i^L_t] - [\beta f (i^S_t) - i^S_t]} > \frac{2\theta}{\beta \delta}. \]

\[ (15) \]

This condition is satisfied when selection is relatively more important than investment. In fact, it holds trivially when \( f (i_t) = 0 \), while it is always violated when the benefit of selection is nil (\( \delta = 0 \)). The rest of this section is devoted to examining in detail how this condition changes with capital accumulation and other parameters.

3.1 Accumulation and Appropriate Contractual Institutions

We first ask how capital accumulation affects the optimal choice of contract. Recall from (12) that a higher capital stock is associated to more investment under short-term relationships. Also recall that \( i^S_t \) is always below the optimum, so that \( [\beta f (i^S_t) - i^S_t] \) increases with investment. It then follows that an increase in capital raises the left hand side of (15), both directly and through its impact on \( i^S_t \), while leaving the right hand side unaffected. Thus, capital accumulation makes short-term contracts more attractive. This is shown in Panel A of Figure 2, where the relative performance of flexible contracts, \( V^S(k_t) - V^L(k_t) \), is plotted against \( k_t \).

The reason for this result is that managerial ability becomes relatively more important as \( k_t \) grows because the marginal effect of ability is proportional to the capital stock, so that a good manager is more valuable for a larger firm. Key to this property is the assumption that managerial talent has a multiplicative effect, as in the majority of models designed to study the impact of managerial quality.\(^9\) Decreasing returns to

\(^9\)See for example Rosen (1981) and Gabaix and Landier (2008). Span of control models suggest
Figure 2: Short- versus Long-term contracts

accumulation instead imply that investment becomes less important relative to the capital stock, as the ratio \( i_S^t/k_t \) falls continuously over time.\(^{10}\)

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 may 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).

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\(^{10}\)Reacall that the optimal investment level is independent of \( k_t \), while capital is always growing.
We now discuss the effects of other parameters on the relative performance of short-versus long-term contracts. Patience, \( \beta \), increases the importance of investment and makes long-term contracts more efficient, as displayed in Panel B of Figure 2. Average ability, \( \theta \), has similar effects because, for a given variance \( \sigma_\theta \), a high \( \theta \) makes selection relatively less important. To see this, note that the benefit of selection, \( \delta \), is independent of ability, while its cost, in terms of lower \( k_{t+1} \), increases with \( \theta \). Moreover, a high \( \theta \) tends to reduce investment \( i^S_t \), thereby lowering \( V^S(k_t) \) even further. Thus, the relative value of rigid contracts grows with \( \theta \), as displayed in Panel C of Figure 2.

On the contrary, Panel D of Figure 2 shows that heterogeneity in managerial talent makes flexible contacts relatively more efficient. This happens because a high \( \sigma_\theta \) increases the selection premium \( \delta \) (11) and \( i^S_t \), both raising \( V^S(k_t) \). Moreover, it is easy to show that if there is no heterogeneity in talent, rigid contracts are always preferable, while the opposite is true if ability is dispersed enough:

\[
\lim_{\sigma_\theta \to 0} : V^S(k_t) < V^L(k_t)
\]
\[
\lim_{\sigma_\theta \to \infty} : V^S(k_t) > V^L(k_t).
\]

In sum, more patient and more homogeneous societies (i.e., with a low \( \sigma_\theta/\theta \)) will stay longer in the development phase characterized by long-term contracts. This may help explain why relatively rigid production relationships may be common even in some advanced country (Japan, for example) and in some traditional sectors where ability matters less.

The effect of \( \sigma_\varepsilon \) (noise) is instead more complex. On the one hand, a higher noise reduces the incentive to distort investment in order to manipulate the signal. This effect increases \( i^S_t \) and \( V^S(k_t) \). On the other, a high noise lowers the ability to separate good and bad managers, thereby reducing the benefit of selection \( \delta \). Given that \( \lim_{\sigma_\varepsilon \to \infty} \delta = 0 \), it is straightforward to prove that long-term contacts must be optimal for sufficiently high noise. When \( \sigma_\varepsilon = 0 \), however, flexible contracts are preferable only if ability has enough dispersion. Moreover, starting from a low level, more noise can either make short-term contract relatively more or less efficient, depending again on the degree of dispersion in ability. The different cases are depicted in Figure 3, showing how \( V^S(k_t) - V^L(k_t) \) varies with \( \sigma_\varepsilon \) for alternative values of \( \sigma_\theta \).
Note that, while $V^S(k_t) - V^L(k_t)$ must necessarily be below the zero line for high $\sigma_\theta$, it may converge from above, from below, or even non-monotonically.

Figure 4 displays the relative performance of short-term contracts, $V^S(k_t) - V^L(k_t)$, in the space of $\sigma_\theta$ and $\sigma_\varepsilon$, the two parameters capturing the degree of uncertainty in the economy. It is apparent that higher ability dispersion always makes short-term contracts more attractive, while more noise lowers the relative performance of short-term contracts, unless $\sigma_\theta$ is very small. Moreover, the figure suggests that $V^S(k_t) - V^L(k_t)$ can increase with $\sigma_\varepsilon$ only when rigid contracts are optimal. We conclude that improvements in the availability of information that lower the noise (e.g., more transparency in business procedures or a better monitoring technology) speed up the transition to flexible contractual institutions in countries with enough heterogeneity of talents, while they may slow down the transition in very homogeneous societies.
4 State-Contingent Contracts with Commitment

In this section, we study the case in which investors can commit by private contracts to confirm a manager if the posterior belief on her ability exceeds a certain threshold, $\bar{\theta}_t \geq \bar{\theta}^C$ or, equivalently, if production is above a minimum level. In order to implement such a contract, $y_{it}$ must be verifiable by a third party (e.g., a court) with enforcement power. As this is a strong requirement, this case is substantially less realistic than the previous ones. Yet, it is a useful benchmark because it corresponds to the constrained optimum.

As in the previous sections, a manager chooses investments so as to maximize her expected utility, given that her belief over the probability of being confirmed is now $p_{it} = \Pr\left(\hat{\theta}_t \geq \theta^C \right)$, i.e. the probability that the signal $y_{it} = (\theta_i + \epsilon_{it}) (k_t - i_t)$ exceeds a certain threshold $y^C = \theta^C (k_t - i^C_t)$:

$$p_{it} = 1 - G\left(\frac{k_t - i^C_t}{k_t - i_t \theta^C}\right),$$

Figure 4: Contracts and Uncertainty
where $\theta^C$ is the threshold ability, that is the minimum ability required to be confirmed when $\varepsilon_t = 0$. As before, $G$ is the c.d.f. of the signal $\theta_i + \varepsilon_{it} \sim N (\theta, \sigma^2_\theta + \sigma^2_\varepsilon)$. Using (3) and setting $\theta_i + \varepsilon_{it} = \theta^C$, we obtain:

$$\theta^C = \hat{\theta}^C + \frac{\sigma^2_\varepsilon}{\sigma^2_\theta} \left( \hat{\theta}^C - \theta \right).$$

Note that the noise, by biasing the perception of ability towards the mean, introduces a wedge between the minimum posterior belief $\hat{\theta}^C$ and the minimum signal $\theta^C$ that generates such a belief. Replacing the new $p_{it}$ and its derivative with respect to investment in the first order condition, and imposing symmetry delivers the following expression for equilibrium investment:

$$\beta f' (i_t^C) \left[ 1 - G (\theta^C) \right] - \beta \frac{k_t + f (i_t^C)}{k_t - i_t^C} \theta^C g (\theta^C) = 1$$

with

$$g (\theta^C) = \frac{1}{\sqrt{2\pi (\sigma^2_\theta + \sigma^2_\varepsilon)}} e^{-\frac{(\sigma^C - \theta)^2}{2(\sigma^2_\theta + \sigma^2_\varepsilon)}}.$$

In this case, the probability that a manager is confirmed, $p^C = 1 - G (\theta^C)$, is no longer one half, but varies with the moments of the ability distribution ($\theta$ and $\sigma^2_\theta$), the variance of the shock ($\sigma^2_\varepsilon$) and the threshold ability ($\theta^C$). First, $p^C$ is obviously decreasing in $\theta^C$. However, $G (\theta^C)$ also depends on $\theta$, $\sigma^2_\theta$ and $\sigma^2_\varepsilon$. Moreover, the density at the confirmation threshold, $g (\theta^C)$, now depends also on the mean and threshold of the signal, and not only on its variance. This multiplicity of effects leads to a more complicated comparative statics for investments that are reported in the appendix.

Given the threshold ability $\theta^C$, the expected ability of a manager in the second period is $\theta + p^C \delta^C$, with:

$$\delta^C = \sigma^2_\theta g (\theta^C) \left[ 1 - \Phi \left( \frac{(\theta^C - \theta)}{\sqrt{\sigma^2_\theta + \sigma^2_\varepsilon}} \right) \right]^{-1/2},$$

where $\Phi (x)$ is the c.d.f. of a standard Normal evaluated at $x$. The term $\delta^C$ is the difference between the average ability of confirmed managers, whose ability is

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11The expression for $\delta^C$ derives from the property of truncated Normal distributions (see Barr
expected to be above the threshold $\tilde{\theta}$, and the unconditional mean $\theta$. Note that, as the noise becomes overwhelming ($\sigma^2 \to \infty$), or the ability distribution collapses to its mean ($\sigma^2 \to 0$), expected ability of the second-period manager tends to the average, which means that selection is as effective as tossing a coin. As the signal becomes more precise ($\sigma^2 \to 0$), the expected ability premium of the confirmed manager tends to $\theta + \sqrt{\frac{\sigma^2}{\pi}}$. As the ability distribution spreads out ($\sigma^2 \to \infty$), the benefit of selection becomes infinite. Moreover, $\delta^C \to \delta$ as $\theta^C \to \theta$, and expected selection effect varies with the threshold as follows:

$$\frac{\partial \delta^C}{\partial \theta^C} = \delta^C \left[ \frac{g \left( \theta^C \right)}{1 - \Phi \left( \frac{\left( \theta^C - \theta \right)}{\sqrt{\sigma^2 + \sigma^2}} \right)} - \frac{\theta^C - \theta}{\sigma^2 + \sigma^2} \right].$$

The expected present discounted value of new projects is:

$$\frac{V^C (k_t)}{1 - \lambda} = \theta \left( k_t - i^C_t \right) + \beta \left( \theta + p^C \delta^C \right) \left[ k_t + f \left( i^C_t \right) \right].$$

Notice that the threshold ability $\theta^C$ affect the project value, hence welfare, through three channels: it affects investment ($i^C_t$), the probability of confirming a manager ($p^C$), and the premium from selection ($\delta^C$).

Finally, the optimal threshold ability is chosen so as to solve:

$$\max_{\theta^C} \theta \left( k_t - i^C_t \right) + \beta \left( \theta + p^C \delta^C \right) \left[ k_t + f \left( i^C_t \right) \right],$$

and Sherril, 1999):

$$\delta^C = \frac{\sigma^2}{\sqrt{\sigma^2 + \sigma^2}} \frac{1}{\sqrt{2\pi}} \frac{1 - \Phi \left( \frac{\theta^C - \theta}{\sqrt{\sigma^2 + \sigma^2}} \right)}{e^{-\left( \frac{\theta^C - \theta}{\sqrt{\sigma^2 + \sigma^2}} \right)^2}}$$

$$= \frac{\sigma^2}{\sqrt{\sigma^2 + \sigma^2}} \frac{1}{\sqrt{2\pi}} \frac{1 - \Phi \left( \frac{\theta^C - \theta}{\sqrt{\sigma^2 + \sigma^2}} \right)}{e^{-\left( \frac{\theta^C - \theta}{\sqrt{\sigma^2 + \sigma^2}} \right)^2}}.$$
subject to:

$$1 = \beta f'(i_t^C) p^C - \beta \frac{k_t + f(i_t^C)}{k_t - i_t^C} \theta^C g(\theta^C)$$

$$\delta^C = \frac{\sigma^2_\theta}{\sqrt{1 - \Phi \left( \frac{\theta^C - \theta}{\sqrt{\sigma^2_\theta + \sigma^2_\tau}} \right)}} g(\theta^C)$$

$$p^C = 1 - G(\theta^C).$$

Since the first order conditions for this maximization program are awkward to solve analytically, we proceed by numerical solution and illustrate graphically the main results.

Figure (5) reports the comparative statics for the main components of the optimal contract as a function of capital. Panel A shows that the minimum expected ability of a confirmed manager, $\theta^C$, increases with $k_t$, that is, over the development process.
This is in line with the results in the previous sections that selection becomes more important as a country grows, since the benefit of selection is proportional to the capital stock, while investment has diminishing returns. Consistently with this view, Panels B and C show that in the optimal contract both managerial turnover and expected quality increase with capital \( (p C^C \text{ falls while } \theta + p C^C \delta^C \text{ rises}) \). In particular, Panel C suggests that the rise in average ability of confirmed managers outweighs the drop in the probability that managers are retained. As selecting good managers becomes relatively more and more important along the growth path, the optimal contract lets investment fall, as reported in Panel D.

5 Conclusions

In this paper, we have built a simple growth model where economic success requires both incentive to undertake investments that pay out in the future and managerial selection. Due to diminishing returns, investment is relatively more important at early stages of development, when the capital stock is low. It is then optimal to choose long-term contracts that maximize the incentive to investment, even at the cost of no managerial selection. As the capital stock 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 such as the discount factor and uncertainty affect the speed of the transition.

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 (2007) that financial development and liberalization spur productivity, particularly
The results in this paper have been obtained with the help of a highly stylized model. To preserve transparency and to isolate the agency problem between investors and managers, we have adopted a minimalist approach that abstracts from many interesting issues. Given that the resulting model has proven to be very tractable, we hope it can serve as a building block for future extensions. For instance, although we have emphasized the implications of the model for cross-country comparison, its logic may shed light on cross-industry comparisons as well. It could then help explain why rigid contractual institutions tend to prevail in more traditional sectors where skills matter less. Second, the model abstracts from general equilibrium effects, because there are no prices. Extending the analysis in this direction may certainly uncover interesting interactions.

6 Appendix

TO BE WRITTEN

References


REFERENCE LIST TO BE COMPLETED