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This paper analyzes the implications of investors' legal protection on aggregate productivity and growth. We have two main results. First, that better investors' legal protection can mitigate agency problems between investors and innovators and therefore expand the range of high-tech projects that can be financed by non-bank investors. Second, investors' legal protection shifts investment resources from less productive (medium-tech) to highly productive (high-tech) projects and therefore enhances economic growth. These results stem from two forces. On one hand, private investors' moral hazard problems (in which entrepreneurs shift investors' resources to their own benefit), and on the other hand innovators' risk of project termination by banks due to wrong signals about projects' probability of success. Our results are consistent with recent empirical studies that show a high correlation between legal investors' protection and the structure of the financial system as well as the economic performance at industry and macroeconomic levels.

[1] We are grateful to Koresh Galil for helpful comments and discussions.

1. Introduction

There is a large body of literature that explores how legal investors' protection affects the structure of the financial system. The main findings of this literature are that the better legal investors' protection is, the lower is the concentration of ownership and control and the higher is the competition in the financial markets (See Zingales, 1994, La Porta et al., 1997 Nenova, 2003, Claessens et al., 2002; La Porta et al., 2002; Wurgler, 2000 and Shleifer and Wolfenzon (2002)). In recent years, a parallel line of research has emerged that explores how the structure of financial systems affects economic activity and performance both at the industry and at the macroeconomic level. The most important findings of this growing research is that financial development affects innovation and growth positively through their beneficial role in R&D investment as well as in the rising of new firms especially in the high-skill-intensive industries (see Demirguc-Kunt and Maksimovic (1998), Rajan and Zingales (1998), Carlin and Mayer (2003), Demirguc-Kunt and Maksimovic (2005)).[2]

In this paper we provide a theoretical contribution to this literature by linking investors' legal protection to the size of high-tech industry, productivity and growth. The paper has two main results. First, that better investors' legal protection can mitigate agency problems between investors and innovators and therefore expand the range of high-tech projects that can be financed through the financial markets. The second is that investors' legal protection shifts investment resources from less productive to highly productive projects and therefore enhances economic growth.

The paper results stem from two forces that derive from the supply and the demand sides for funds. From the perspective of fund suppliers, poor investors' legal protection leads

[2] The relation between financial institutions and economic performance has long been a subject for historical and empirical inquiry. Hicks (1969), for example, argued that the UK's financial system played a significant role in the Industrial Revolution. King and Levine (1993a and b) utilized data for 80 countries over the period 1960-1989 and found a robust relationship between growth and financial development.

to a moral hazard problem whereby entrepreneurs can shift investors' resources to their own benefit. This moral hazard reduces the willingness of private investors' to purchase firms' equity and therefore diminishes their supply for funds. Poor investors' protection thereby narrows the range of projects that can be financed directly through the financial market and widens the range of projects that can be financed by debt through financial intermediaries (e.g., banks).

From the perspective of fund seekers, however, raising funds from banks exposes innovators to the risk of unjustified termination of projects that emerge when banks obtain a wrong signal about a project's probability of success.[3] This threat of being prematurely liquidated might motivate innovators to undertake less productive projects in order to reduce the probability of wrong liquidation. The paper therefore concludes that, on one hand, better investors' legal protection expands the range of highly productive projects (high-tech) that can be financed by non-bank investors (projects that otherwise would not have been financed at all) and, on the other hand, narrows the range of less productive projects (medium-tech). This shift of investment resources from less productive to highly productive projects enhances productivity and growth.

The main idea of the paper is presented by an endogenous growth model in which a final good is produced by a variety of intermediate goods (see Romer (1990)). We assume that there are two types of intermediate goods in the economy: high-tech and medium-tech. These intermediate goods differ in their productivity rates such that high-tech goods are on average more productive than medium-tech goods and therefore generate higher economic growth. We also assume that at each period of time, entrepreneurial innovators can invent new products that can be employed in the production of the final good. However, in order

[3]The effect of liquidity risk (i.e., the risk that, a profitable project will have to be prematurely liquidateddue to wrong signals received by lenders) on firms' financing choices was studied in important works by Diamond (1991a, 1991b) and Von Thadden (1995).

to develop these products innovators need to raise funds either from banks or private investors. Both banks and non-bank investors are neither informed about projects investment requirements nor are they informed about their probability of success. However, unlike private investors, banks are equipped with costly monitoring and auditing technologies that enable them to reveal information about the projects they finance (see Greenwood and Jovanovic 1990 and King and Levine 1993(b)). Specifically, the monitoring technology enables banks to verify whether the innovators' reported amount of investment was actually invested in the project, while the auditing technology enables banks to observe a noisy signal about the project type. We assume that the signal noise is positively correlated with the project risk such that signals for high-tech projects are noisier than signals for medium-tech projects.

In the main text we show that when project investment requirements are lower or equal to some threshold value Ω, innovators of such projects do not have an incentive to extract perquisites from investment, since their expected earnings are already high and they do not want to damage the probability of the success of their projects. Therefore, they will report their true investment requirements (which are lower or equal to Ω), and non-bank investors will be ready to supply them with funds by purchasing their equity. Under such conditions, innovators will prefer to embark on high-tech projects that provide them with higher earnings.

The opposite logic is at work for innovators with projects whose investment requirements are higher than the threshold value Ω. Such innovators have an incentive to report extravagant investment requirements and to extract perquisites that eventually reduces their project's probability of success. Non-bank investors will therefore not be willing to supply funds to projects whose reported investment requirements are higher than Ω, and they will eventually be financed by banks only. Under such conditions, Innovators will prefer to embark on medium-tech projects (with relatively low liquidation risks) rather than high-tech projects (with high liquidation risks).

The results of the paper that investors' legal protection shifts investment resources from less productive to highly productive projects is manifested by the positive relation between the quality of investor legal protection and the threshold value Ω. The higher the quality of investor legal protection is, the lesser is the agency problem that exists between investors and innovators and therefore the higher is the threshold value Ω. Since an increase in Ω expands the range of high-tech projects that can be financed by non-bank investors and narrows the range of medium-tech projects that are financed by banks, we conclude that investors' legal protection enhances productivity and growth.

The theoretical literature on finance and growth is, surprisingly, very sparse, and mostly focuses on how financial intermediaries promote growth (See Greenwood and Jovanovic (1990) Bencivega and Smith (1991) and De la Fuente and Marin (1996)). In recent years, however, another research has emerged that explores the link between financial institutions and the composition of finance (i.e., financial intermediates versus financial markets). One branch of this research that is directly related to innovation and growth has focused on how institutions that promote credit market decentralization may lead creditors to commit not to refinance unprofitable projects that otherwise (in a centralized credit market) would have been financed and refinanced even when shown to be unproductive (see Maskin and Dewatripont (1995) and Huang and Xu (1999)). In another research, Chakraborty and Ray (2006) studied a bank-based versus market-based financial system in an endogenous growth model. Their paper is based on monitoring technology of banks that enables banks to resolve a moral hazard problem that emerges when managers reduce investment profitability to enjoy private benefits. The authors find that while efficiency of financial institutions positively affect growth, neither a bank-based nor a market-based system is unequivocally better for growth.[4]

Our paper has two important contributions to the theoretical literature on finance and growth. First, we provide a direct linkage between investors' legal protection, innovation and growth. Second, unlike the existing literature, our paper stresses the important role of investor legal protection on innovators' projects choice and financing decisions in the face of projects' termination risk by banks. Thus, the mechanism we suggest is not primarily based on the supply side for funds (as in the existing literature) but rather emphasizes the effect of legal protection on the interaction between the demand and the supply for funds.

The rest of the paper is organized as follows. Section 2 sets up the basic model; Section 3 describes the equilibrium; Section 4; Presents the results on economic growth; Section 5 concludes; and the mathematical proofs appear in an appendix.

[4] Another important study that is not directly related to economic growth but might have potential implications on economic growth, focuses on the effectiveness of financial markets and financial intermediaries in financing new industries and technologies in the presence opinion diversity. See Allen and Gale who demonstrate that innovative projects that investors have diverse believes about their probability of success might be more efficiently financed through the financial market rather than banks.

2. The Model

Consider a small open economy whose activities extend over an infinite discrete time. The economy consists of three types of goods: a final good Y that is used either for consumption or investment, and two types of continuum intermediate goods x_i and z_i which we denote by "medium" and "high," respectively. Formally, the final good production technology is given by the following Lebesgue integral which represents a constant return to scale production function:[5]

$$Y_t = L^{1-\alpha}\left[\int_{[0,M_t]}\theta_{x,i}\cdot x(i)^{\alpha}\,d\mu(i) + \int_{[0,H_t]}\theta_{z,i}\cdot z(i)^{\alpha}\,d\mu(i)\right] \qquad (1)$$

where $[0,M_t]$ and $[0,H_t]$ are the sets of intermediate goods of type x_i and z_i, respectively, and $\theta_{x,i}$ and $\theta_{z,i}$ are the parameters that reflect the productivity type of each product i of type x and z, respectively. We assume that:

(A-1) Each intermediate good i of type x and type z is either highly productive or poorly productive such that $\theta_{x,i}\in\{\theta_{x,low},\theta_{x,high}\}$ and $\theta_{z,i}\in\{\theta_{x,low},\theta_{x,high}\}$.

(A-2) Per productivity type, intermediate goods of type z are more productive than intermediate goods of type x. Specifically: $\theta_{x,low} < \theta_{z,low} < \theta_{x,high} < \theta_{z,high}$. However, as will be clarified later, intermediate goods of type z are much more risky than intermediate goods of type x.

[5] The reason we choose to present the production technology with a Lebesgue integral rather than the ordinary Riemann integral is that the productivity of each intermediate good is stochastic and therefore the upper and the lower Riemann summations do not converge. It is easy to verify, however, that under very weak assumptions (and without loss of generality) the integrand in equation (1) is Lebesgue measurable (and therefore according to the dominated convergence theorem it is also Lebesgue inferable) since it can be approached by simple functions.

The final good Y is assumed to be perfectly tradable, but the intermediate goods and labor are domestic. Capital is perfectly mobile. The world interest rate is r^*, and the gross investment rate is $R^*=1+r^*$.

2.1 Individuals

At each period t, a generation of two types of individuals is born: a set $[0,L]$ of individuals who we label as "households" and a set $(0,\nu]$ of individuals who we label as "innovators". Both types of individuals live for two periods each, but possess different skills and different preferences.

Households have identical standard additive and separable preferences over consumption in their first and second periods of life (c_t^t and c_{t+1}^t, respectively), such that:

$$u_t = u(c_t^t, c_{t+1}^t) = U(c_t^t) + \Theta \cdot U(c_{t+1}^t) \qquad (2)$$

We also assume that households supply one unit of labor in their first period of life and retire in their second period.

Unlike households, innovators do not work, however, they are gifted with an innovative skill that enables them to invent new products and consequently to extend the variety of intermediate goods that already operate in the final good sector. Specifically, we assume that at each period t, a generation of $(0,\nu]$ innovators is born. Each innovator $i \in (0,\nu]$ is matched to two new products prototypes — one of type x and one of type z, but can undertake one project only. The matching functions

$\tau_M(i)$ and $\tau_H(i)$ for product prototypes x and z are given by $\tau_M : (0,v] \to (M_{t-1}, \Gamma \cdot B_{t-1}]$ and $\tau_H : (0,v] \to (H_{t-1}, \Gamma \cdot B_{t-1}]$, respectively, such that:

$$\begin{aligned} \tau_M(i) &= M_{t-1} + \tfrac{(\Gamma-1)\cdot B_{t-1}}{v} \cdot i \\ \tau_H(i) &= H_{t-1} + \tfrac{(\Gamma-1)\cdot B_{t-1}}{v} \cdot i \end{aligned} \qquad (3)$$

where $M_{t\text{-}1}$ and $H_{t\text{-}1}$ denote the numbers of intermediate goods of type x and z that has been already engaged in the production of the final good Y at time t-1, B_{t-1} is the stock of knowledge that was accumulated until period t-1, and $\Gamma > 1$ is a constant parameter that represents potential growth of knowledge due to inventive activities (see Figure 1 below).[6] We assume that the stock of knowledge that was accumulated until period t-1 is positively correlated with the variety of intermediate goods of type x and z. Specifically, $B_{t-1} = M_{t-1} + H_{t-1}$.[7]

We further assume that:

(A-3) Each innovator j is characterize by an idiosyncratic, independently and identically distributed ability variable $A(j) \in [\underline{A}, \overline{A}]$ with a distribution function $F(a)$. The variable $A(j)$ reflects the j^{th} innovator's ability to reduce his projects' investment requirements. The lower $A(j)$ is, the higher is the innovator's ability to reduce investment requirements in the projects he might develop.

(A-4) The ability variable $A(j)$ is the innovator's j private knowledge.

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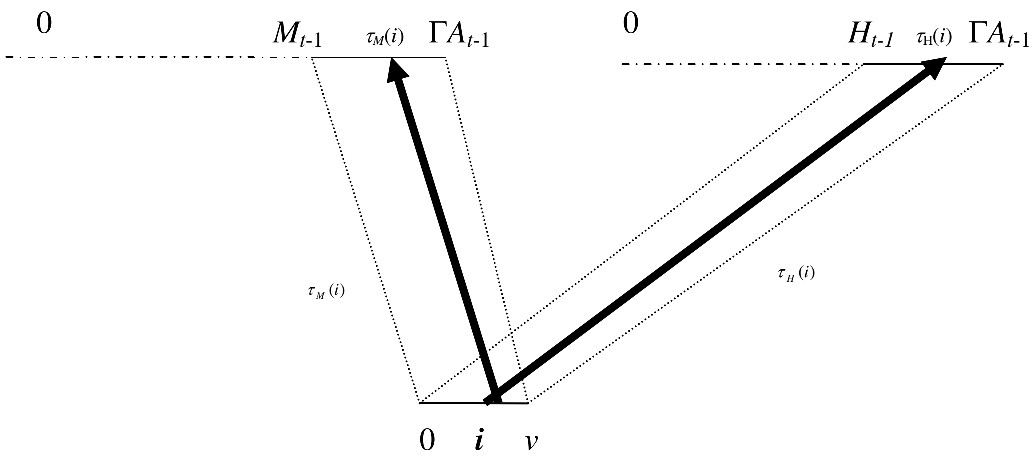
[6] The assumption that the numbers of innovators is fixed while the stock of knowledge is growing steadily was assumed by Romer (1990). Although we do not assume growth without scale effect (such as in Young (1998)), the model can be easily adjusted to such settings (this is left for future work).

[7] This additive function was chosen for simplicity only, and the results of the paper carry through with other functions as long as $B_{t-1} \geq \max\{M_{t-1}, H_{t-1}\}$.

Figure 1



If an innovator undertakes an x-project, and the project is not interrupted, then he eventually comes up with a new product of type x which is either highly productive ($\theta_{x,high}$) or poorly productive ($\theta_{x,low}$). Similarly, if an innovators embarks on a z-project, and the project is not interrupted, then he eventually comes up with a new product of type z which is either highly productive or less productive (*i.e.,* $\theta_{z,high}$ or $\theta_{z,low}$). It is assumed that ex-ante, innovators do not know ex-ante whether the project they undertake is productive or not but know the respective probabilities.

Innovators are born with no wealth and that gain utility from two related sources. First, they gain utility from perquisites they might possibly earn in their first period of life, by reporting extravagant investment. Second, in their second period of life, innovators gain utility from their share in the project's profits. Innovators can also have disutility from potential profits they do not earn when their project does not reach completion. Formally, the innovators utility function from a project is given by:

$$W = V(\varphi(\pi) \mid q) + T \tag{4}$$

where T denotes the resources that an innovator can extract from investors by reporting them incorrect investment expenditures, π denotes operating profits of a project when it is not liquidated, $\varphi(\pi)$ denote the innovator's share in the project's operating profits π, and $q \in \{p, l\}$ denote two possible actions that investors (namely banks) might possibly take subsequent to their "set-up" investment: (1) proceed with the project ($q=p$) or (2) liquidate the project ($q=l$). We assume that the innovators' utility function satisfies the following conditions.

(A-5) If $q=p$ then $V(\varphi(\pi) \mid q)$ is a monotonically increasing and concave function where $V(0 \mid q) = 0$ (i.e., $\frac{\partial V(\varphi(\pi) \mid q = p)}{\partial \varphi(\pi)} > 0$ and $\frac{\partial^2 V(\varphi(\pi) \mid q = p)}{\partial \varphi(\pi)^2} > 0$).[8]

(A-6) (references-dependence and loss-aversion) Given that investors' decision is to stop (liquidate) the project before the project reaches maturity, innovators' utility is lower, the higher are the losses of innovators' potential earning from the project's profits. Thus, $\frac{\partial V(\varphi(\pi) \mid q = l)}{\partial \varphi(\pi)} < 0$.

(A-7) For the sake of simplicity we assume that innovators attribute the same absolute value to losses and gains, such that:

$V(\varphi(\pi) \mid q = p) = -V(\varphi(\pi) \mid q = l)$.[9]

[8] This assumption implies that whenever $q=p$, innovators' utility is higher the higher are the earnings from the project's profits.

[9] The experimental literature about reference-dependence and loss aversion as well as about the endowment affect suggests that $u(\varphi(\pi) \mid q = p) \leq -u(\varphi(\pi) \mid q = l)$ which only reinforces the results of our model. (see, Kahneman, Knetsch and Thaler (1990)) and Tversky and Kahneman (1991) and Knetsch (1992)).

3. Equilibrium

Let the final good Y serve as a numeraire. Profit maximization by firms who produce the final good Y leads to the following first-order conditions:

$$
\begin{aligned}
P_{x(i)} &= \frac{\partial Y_t}{\partial x_i} = \alpha \cdot \theta_{x,i} \cdot L^{(1-\alpha)} \cdot x(i)^{\alpha-1} \\
P_{z(i)} &= \frac{\partial Y_t}{\partial z_i} = \alpha \cdot \theta_{z,i} \cdot L^{(1-\alpha)} \cdot z(i)^{\alpha-1}
\end{aligned}
\tag{5}
$$

which implies that the demand for intermediate goods is given by:

$$
\begin{aligned}
x^*(i) &= L \cdot \left[(\alpha \cdot \theta_{x,i}) / P_{x(i)}\right]^{\frac{1}{1-\alpha}} \\
z^*(i) &= L \cdot \left[(\alpha \cdot \theta_{z,i}) / P_{z(i)}\right]^{\frac{1}{1-\alpha}}
\end{aligned}
\tag{6}
$$

Suppose that, once invented, intermediate goods of type x and z cost one unit of the finial good Y to produce (i.e., each unit of the final good Y can be transformed into one unit of an intermediate good x or z). We assume that technologies cannot be adopted within less than one period and therefore innovators who just invented an intermediate good become monopolistic producers for one period only and at the end of this period are replaced by competitive firms. New products are therefore produced by monopolistic firms, while old vintage products are produced by competitive firms. Since old vintage products are purchased from competitive firms, their prices must be equal to their marginal cost which equals one (i.e., $p(x_i) = p(z_i) = 1$). By substituting these prices into equation (6) we get that the demands for old vintage products are:

$$
\begin{aligned}
x_c^*(i) &= L \cdot \left[(\alpha \cdot \theta_{x,i})\right]^{\frac{1}{1-\alpha}} \\
z_c^*(i) &= L \cdot \left[(\alpha \cdot \theta_{z,i})\right]^{\frac{1}{1-\alpha}}
\end{aligned}
\tag{7}
$$

If, however, final good producers purchase new products, they must pay monopolistic prices:

$$P_{z(i)} = P_{x(i)} = \tfrac{1}{\alpha} \;\; > 1 \tag{8}$$

By substituting equation (8) into equation (6) we get that the quantities produced by monopolists of products of types *x* and *z* are:

$$\begin{aligned} x_m*(i) &= L\cdot(\alpha)^{\frac{2}{1-\alpha}}\cdot(\theta_{x,i})^{\frac{1}{1-\alpha}} \\ z_m*(i) &= L\cdot(\alpha)^{\frac{2}{1-\alpha}}\cdot(\theta_{z,i})^{\frac{1}{1-\alpha}} \end{aligned} \tag{9}$$

and that the monopolists operating profits are:

$$\begin{aligned} \pi_x &= (\tfrac{1-\alpha}{\alpha})\cdot\alpha^{(2/1-\alpha)}\cdot(\theta_{x,i})^{\frac{1}{1-\alpha}}\cdot L \\ \pi_z &= (\tfrac{1-\alpha}{\alpha})\cdot\alpha^{(2/1-\alpha)}\cdot(\theta_{z,i})^{\frac{1}{1-\alpha}}\cdot L \end{aligned} \tag{10}$$

By substituting (7) and (9) into (1) we get that

$$Y_t = L\times\left[\begin{array}{l} (\alpha)^{\frac{\alpha}{1-\alpha}}\left[\displaystyle\int_{[0,M_{t-1}]}(\theta_{x,i})^{\frac{1}{1-\alpha}}d\mu(i)+\int_{[0,H_{t-1}]}(\theta_{z,i})^{\frac{1}{1-\alpha}}d\mu(i)\right] \\ \qquad +(\alpha)^{\frac{2\alpha}{1-\alpha}}\left[\displaystyle\int_{[M_{t-1},M_t]}(\theta_{x,i})^{\frac{1}{1-\alpha}}d\mu(i)+\int_{[H_{t-1},H_t]}(\theta_{z,i})^{\frac{1}{1-\alpha}}d\mu(i)\right] \end{array}\right] \tag{11}$$

3.1 Investment

In order to launch a project j_x of type *x* (or a project j_z of type *z*), a certain investment is required. Each project has a unique investment threshold value which is identical to the innovator's ability *A*(*j*) (see assumption (A-3) above). If the investment is lower than this threshold value then the probability that the produced product will be highly productive is low. If, on the other hand, the amount of investment is higher or equal to this threshold value then the probability that the product will be highly productive is high. Formally, let a denote the amount of resources invested in a certain project. The probability that a project of type x (a project of type z) is highly productive is given by the following distribution function:

$$P(\theta_{x,i} = \theta_{x,high} \mid a) = \begin{cases} 0 & a < \underline{A}_x \\ \beta_x^1 & \underline{A} \le a < A_x(j)^* \\ \beta_x^2 & A_x(j)^* \le a \le \overline{A} \end{cases}$$

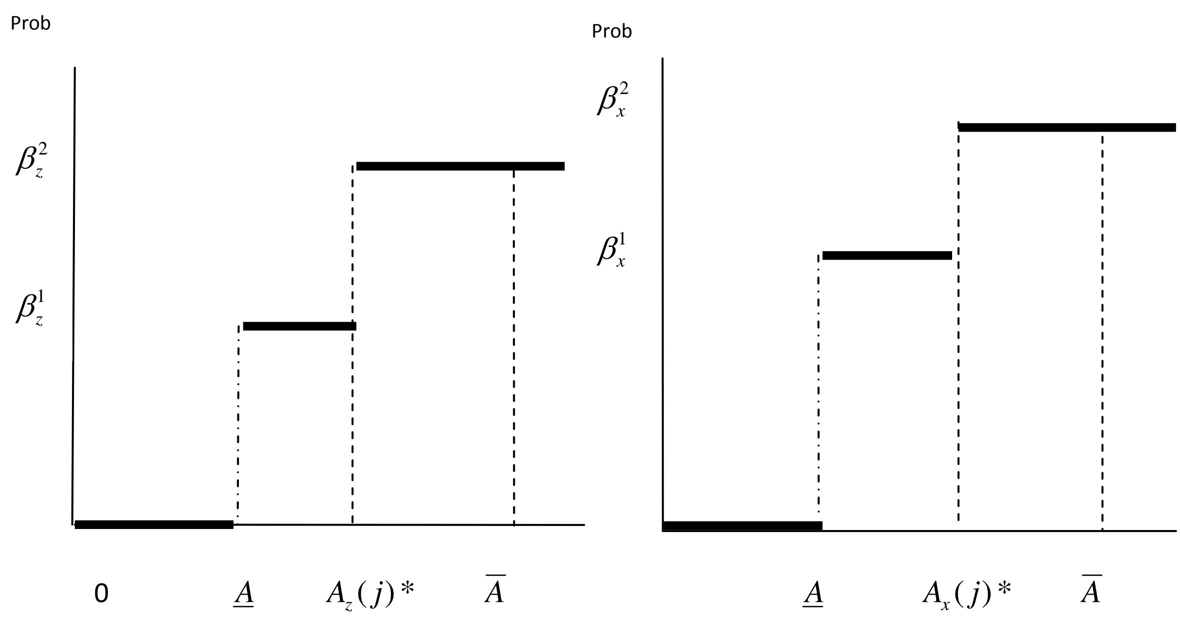
$$\left(P(\theta_{z,i} = \theta_{z,high} \mid a) = \begin{cases} 0 & a < \underline{A}_z \\ \beta_z^1 & \underline{A} \le a < A_z(j)^* \\ \beta_z^2 & A(j)^* \le a \le \overline{A} \end{cases} \right)$$

where $0 < \beta_x^1 < \beta_x^2 < \frac{1}{2}$ and $0 < \beta_z^1 < \beta_z^2 < \frac{1}{2}$ are the conditional probabilities of the project's success (which depends on the respective investment a), and $A_x(j)^*$and $A_z(j)^*$are the investment thresholds values of projects j_x and j_z which (as described in assumption (A-4) are idiosyncratic independently and identically distributed variables with a distribution function $F(a)$ on the interval $[\underline{A}, \overline{A}]$) (see Figure 2 below).

Intermediate goods of type z are less likely to succeed than intermediate goods of type x (i.e., $0 < \beta_z^1 < \beta_x^1$, and $0 < \beta_z^2 < \beta_x^2$), however, intermediate goods of type z are much more productive, on average, than intermediate goods of type x, such that:

$$\begin{aligned} \theta_{z,low} &< \beta_x^1 \theta_{x,high} + (1-\beta_x^1)\theta_{x,low} < \beta_z^1 \cdot \theta_{z,high} + (1-\beta_z^1) \cdot \theta_{z,low} \\ \theta_{z,low} &< \beta_x^2 \theta_{x,high} + (1-\beta_x^2)\theta_{x,low} < \beta_z^2 \cdot \theta_{z,high} + (1-\beta_z^2) \cdot \theta_{z,low} \end{aligned}$$

Figure 2



The assumption that the variable $A(i) = A_x^*(i) = A_z^*(i)$ is the innovator's i private knowledge implies that information asymmetry exists between investors and innovators. This informational asymmetry might cause a moral hazard problem, whereby innovators have incentives to report extravagant investment threshold values while extracting investment resources to their own benefits. The corporate finance literature has extensively investigated the issue of how and under what conditions such a moral hazard problem can be mitigated by different investors such as private investors and financial intermediaries. It is widely recognized that different types of investors have different abilities to deal with such a moral hazard problem through monitoring. In the framework of our model the differences between private investors and financial intermediaries are characterized by assumptions (A-8)-(A-13):

(A-8) Private investors' access to monitoring technology is limited such that they cannot, ex ante, distinguish between innovators who truthfully report their projects' investment requirements and innovators who report false investment requirements (while at the same time extract investment resources).[10]

(A-9) In contrast to private investors, commercial banks have access to a costly monitoring technology that enables them to verify whether the reported amount of investment was actually invested in the project. Formally, if an innovator reports either a true or a false report about his investment threshold value $A_x^{report}(j_x)$ or $A_z^{report}(j_z)$ the bank can verify whether the amount $A_x^{report}(j_x)$ or $A_z^{report}(j_z)$ was invested in the project. We assume that monitoring cost per-project is proportional to the innovator's reported size of investment, which is given by $d \cdot A_x^{report}(j_x)$ and $d \cdot A_z^{report}(j_z)$) for projects j_x of type *x* and j_z of type *z*, respectively (where d>0 is a constant parameter).[11]

(A-10) After investment and before a project reaches maturity, each innovator can costlessly observe a noisy signal *s*(*j*) about his project type. The probability that the signal *s*(*j*) agrees with the correct type of project *j* is $\frac{1}{2} < \gamma_j < 1$.[12]

(A-11) The signal noise is positively correlated with the project risk such that signals for high-tech projects are noisier than signals for medium-tech projects. Thus,

[10] For instance, outside shareholders access to monitoring technology is very limited and extremely expansive due to free-rider problems among different investors (See Grossman and Hart (1980) and Shleifer and Vishny (1986)).
[11] The corporate finance literature often regards commercial banks as consortiums of investors who delegate the monitoring function to a single market participant (the bank), and thereby reduce the cost of monitoring for each investor (see Gale and Hellwig (1985)).
[12] Note that $1-\gamma_j$ reflects the degree to which the signal s(j) is noisy with respect to the correct type of the project *j*. Note also that the probabilities of signals' errors of type *I* and *II* (i.e., liquidating a good project and continuing a bad project) are identical. This is a simplifying assumption, and the results of the model carry through for a variety of errors' probabilities for of type *I* and *II*.

the signals $s_x(j_x)$ of projects of type x are less noisy than signals $s_z(j_z)$ of projects of type z. Formally, we assume that for all $0 < \delta \le 1$

$$\frac{\beta_z^2 \cdot V\left(\delta \cdot \pi_{z,high} \mid q = p\right)}{\beta_x^2 \cdot V\left(\delta \cdot \pi_{x,high} \mid q = p\right)} < \frac{(\gamma_x - \frac{1}{2})}{(\gamma_z - \frac{1}{2})}.^{13}$$

(A-12) Unlike private investors, commercial banks can acquire the noisy signals $s_x(j_x)$ and $s_z(j_z)$for projects j_x and j_z that they might finance, by paying an additional payment which is proportional to the reported size of investment ($A_x^{report}(j_x)$ and $A_z^{report}(j_z)$). This payment is given by $q \cdot A_x^{report}(j_x)$ and $q \cdot A_z^{report}(j_z)$, respectively (where $0<q<1$ is a constant parameter).[14]

(A-13) It is more costly for commercial banks to monitor and audit foreign projects than to monitor and audit domestic ones. In the context of our model this assumption implies that the aforementioned parameters d and q that express the banks monitoring and auditing costs for domestic projects are lower than the corresponding parameters for foreign projects d^f and q^f, respectively.

3.2 The Supply for Funds

Banks

To keep the analysis simple we describe the commercial banks' investment process in two sequential stages. In the first stage, each innovator either truthfully or falsely reports his project's investment threshold value $A_x^{report}(j_x)$ (or $A_z^{report}(j_z)$) and

[13] This condition holds for example when $V(\cdot) = \sqrt{\cdot}$ and γ_x is sufficiently higher than γ_z.

[14] The assumption that the signal's cost is proportional to the size of investment was made to simplify the proofs of Lemmas 1 and 2. The results of the model carry through with fixed costs as well.

then, after the bank receives all projects' reports, the bank selects a random sample of projects to monitor.[15] In the second stage, each innovator obtains a noisy signal $s(j)$. Banks acquire these noisy signals by paying an amount $q \cdot A_x^{report}(j_x)$ or $q \cdot A_z^{report}(j_z)$, for projects j_x of type x and j_z of type z, respectively. The structure of information for innovators, banks and outside shareholders is summarized in Table 1below.

Table 1

	Stage 1 **Information about the investment threshold value** $A_x(j_x)$ $A_z(j_z)$	Stage 2 **Information about the productivity of the project**
Innovators **(entrepreneurs)**	Know the actual investment costs $A_x(j_x)$ $A_z(j_z)$	Costlessly observe a signal $s \in \{high, low\}$ such that: P(s=high| t=high)=γ>1/2 P(s=low | t=high)=1-γ<1/2 P(s=low| t=low)= γ>1/2 P(s=low | t=low)= 1-γ<1/2
Outside shareholders	Do not know $A_x(j_x)$ $A_z(j_z)$ but know the prior distribution $F(a)$	Know only the prior probabilities β and $1-\beta$ but do not know the actual productivity of the project
Banks	Initially, do not know $A_x(j_x)$ $A_z(j_z)$ but know the prior distribution $F(a)$. However, they can costly verify innovators reports.	Can acquire a costly signal $s \in \{high, low\}$ such that: P(s=high| t=high)=γ>1/2 P(s=low | t=high)=1-γ<1/2 P(s=low| t=low)= γ>1/2 P(s=low | t=low)= 1-γ<1/2

[15] It is important to emphasize that at this stage both banks and innovators know only the ex-ante distribution of the project's productivity type, but do not know its precise realization.

After the bank's investment was made and a noisy signal about the project's type was observed, the bank can decide whether to continue the project or prematurely liquidate it. Assumptions (A-14)-(A-16) characterize the banks alternatives decisions and their consequences:

(A-14) If a project is liquidated, then the innovator is inevitably left with zero profits while the bank obtains a fraction $\xi > \frac{1}{2}$ of his initial investment. The liquidation value of projects of type $l \in \{x, z\}$ can therefore be given by $\xi \cdot A_l^{report}(j)$, where:

$$\xi \cdot \underline{A} > \beta_x^1 \cdot \pi_{x,low} + (1-\beta_x^1) \cdot \pi_{x,high}$$
$$\xi \cdot \underline{A} > \beta_z^1 \cdot \pi_{z,low} + (1-\beta_z^1) \cdot \pi_{z,high}$$

(A-15) If the bank continues the project but the project fails (i.e., the intermediate good turns out to be poorly productive (i.e., $\theta_l = \theta_{l,low}$) then the bank can claim the entire project's operating profits $\pi_{l,low}$ .These operating profits, however, are always lower than that the bank's initial investment, since the required investments in all projects are assumed to be higher than the operating profits of projects that eventually turn out to be unproductive. Specifically:

$$\pi_{x,low} < \underline{A}$$
$$\pi_{z,low} < \underline{A}$$

(A-16) If, on the other hand, the project proceeds and succeeds the banks can get a fraction $0 < \phi < 1$ of the projects' profit while innovators get the residual fraction $1-\phi$. It is assumed that $\phi(\cdot)$ is determined by the innovators bargaining power vis-à-vis banks which is an increasing function of the innovators reported investment value A_l^{report} — the higher A_l^{report} is, the lower is the innovator bargaining power vis-à-vis banks and the higher is ϕ.

The two following Lemmas provides the conditions under which a bank will be willing to supply funds to a project as well as the bank's optimal monitoring policy.

Lemma 1: If assumptions (A-8)-(A-16) are satisfied and a bank does not have information about the threshold investment value of the project *j* of type $l \in \{x,z\}$ it finances then given the reported threshold investment value A_l^{report} the bank will issue a debt contract:

$$\begin{cases} \text{If the bank observes that the innovator extracts investment resources (by doing tunneling)} \\ \text{or if the bank obtains a signal } s(j_l)=low \text{ then the project is liquidated, otherwise} \\ \\ P(\pi_l) = \begin{cases} 0 & if \;\; \pi_l = \pi_{l,low} \\ (1-\phi(A_l^{report}))\pi_{l,high} & f \;\; \pi_l = \pi_{l,low} \end{cases} \end{cases}$$

Under such conditions, the bank's income from the project is:

$$\begin{cases} R(\pi_l) = \begin{cases} \phi(A_l^{report}) \cdot \pi_{l,high} & if \;\; \theta_{l,i} = \theta_{l,high} \\ \pi_{l,low} & if \;\; \theta_{l,i} = \theta_{l,low} \end{cases} & \begin{array}{l} \text{if the bank does not detect tunneling} \\ \text{and if } \;\; s_l(j) = high \end{array} \\ \\ \xi \cdot A_l^{report} & \begin{array}{l} \text{otherwise (if the bank detects tunneling} \\ \text{or if } \;\; s_x(j) = low) \text{ then the bank liquidates the porject} \end{array} \end{cases}$$

Lemma 2: If assumptions (A-8)-(A-16) hold and a bank does not have information about the threshold investment value of the project *j* of type $l \in \{x,z\}$ it finances then given the reported threshold investment value A_l^{report} the bank's optimal monitoring policy that keeps innovators at least indifferent between reporting a true and false investment requirement is to inspect a fraction $0 < \delta(A_l^{report}) < 1$ of projects of type l such that:[16]

$$\delta(A_l^{report}) = 1 - \frac{\beta_l^2 \cdot (1-2\gamma_l) \cdot V((1-\phi(A_l^{report})) \cdot \pi_{l,high} \mid q = p)}{(1-2\gamma_l)\beta_l^1 V((1-\phi(A_l^{report})) \cdot \pi_{l,high} \mid q = p) + (A_l^{report} - \underline{A}_l)} \qquad (12)$$

Proof: See appendix

Obviously, a bank will not lend resources to a project j of type $l \in \{x, z\}$ unless it can charge payments with an expected rate of return that are, at the very least, equal to the world gross interest rate R^*. Specifically, the bank's individual-rationality condition is necessarily given by:

$$R^* \leq \beta_l^2 \cdot \left[\frac{\gamma_x(\phi(A_l)) \cdot \pi_{l,high} + (1-\gamma_l)\xi A_l}{A_l(1+q+c \cdot \delta(A_x))} \right] + (1-\beta_l^2) \cdot \left[\frac{\gamma_l \xi A_l + (1-\gamma_l) \cdot (\phi(A_l)) \cdot \pi_{l,low}}{A_l(1+q+c \cdot \delta(A_l))} \right] \qquad (13)$$

Without loss of generality, we assume henceforth that all innovators have a sufficient bargaining power (vis-à-vis banks) to secure for themselves the highest possible earnings from their projects' profits while banks can only cover their opportunity costs. This assumption implies that , if a bank finances a project j of type $l \in \{x, z\}$ and the project turns out to be productive then the bank gets a fraction $0 < \phi(\cdot) < 1$ of the projects' profit such that:[17]

[16] Note that equation (12) is equivalent to an incentive compatible condition for borrowers.

[17] This assumption may seem rather restrictive to some readers. However, the assumption that banks can only cover their opportunity costs does not limit the generality of our theory and even reinforces its results. As will become apparent the results of the model carry through even if the required rate of return on equities and banks' assets are equal to the world interest rate R^*.

$$R^{*}=\beta_l^2\cdot\left[\frac{\gamma_x(\phi(A_l))\cdot\pi_{l,high}+(1-\gamma_l)\xi A_l}{A_l(1+q+c\cdot\delta(A_x))}\right]+(1-\beta_l^2)\cdot\left[\frac{\gamma_l\xi A_l+(1-\gamma_l)\cdot(\phi(A_l))\cdot\pi_{l,low}}{A_l(1+q+c\cdot\delta(A_l))}\right] \quad (14)$$

Private Investors

Assumptions (A-8)-(A-16) imply that, unlike banks, private investors have very limited control over the investment process, which leads to conditions under which innovators might have incentives to report extravagant investment values and to extract perquisites to their own benefit. Take for instance an innovator with a project *j* of type $l\in\{x,z\}$ whose investment threshold value is given by $A_l^*(j)$. This innovator can extract resources from private investors by reporting an investment threshold value $A_l^{report}>\underline{A}_l$ and invest only $\underline{A}_l$ (where $\underline{A}_l$ is the lowest amount of investment that keeps the project *l* profits above zero (see Figure 2). The innovator therefore reduces his project's probability of success from β_l^2 to β_l^1, on the one hand, but, on the other hand, gains perquisites of the amount $(A_l^{report}-\underline{A}_l)$. It is easy to see that the innovator has an incentive to extract project's resources to his own benefit if and only if the marginal resource he extracts exceeds the utility loss from lowering the expected project's profits. Formally, the innovator has an incentive to extract an amount $(A_l^{report}-\underline{A}_l)$ if and only if:

$$\begin{aligned}&(1-\beta_l^1)u((1-\tilde{\phi}(A_l^{report}))\cdot\pi_{l,low}\mid q=p)\\&+\beta_l^1u((1-\tilde{\phi}(A_l^{report}))\cdot\pi_{l,high}\mid q=p)+(A_l^{report}-\underline{A}_l)\\&\geq[(1-\beta_l^2)u((1-\tilde{\phi}(A_l^{report}))\cdot\pi_{l,low}\mid q=p)+\beta_l^2u((1-\tilde{\phi}(A_l^{report}))\cdot\pi_{l,high}\mid q=p)]\end{aligned}\quad(15)$$

where $0 < \tilde{\phi}(A_l^{report}) < 1$ is the investors' share in the project's profit (as a function of the reported investment threshold value A_l^{report}) (see Figure (3) below). [18] Inequality (15) implies that when a project is financed through the market by private investors (outside shareholders) an innovator would report his true investment threshold value $A_l^{report} = A_l * (j)$ if and only if

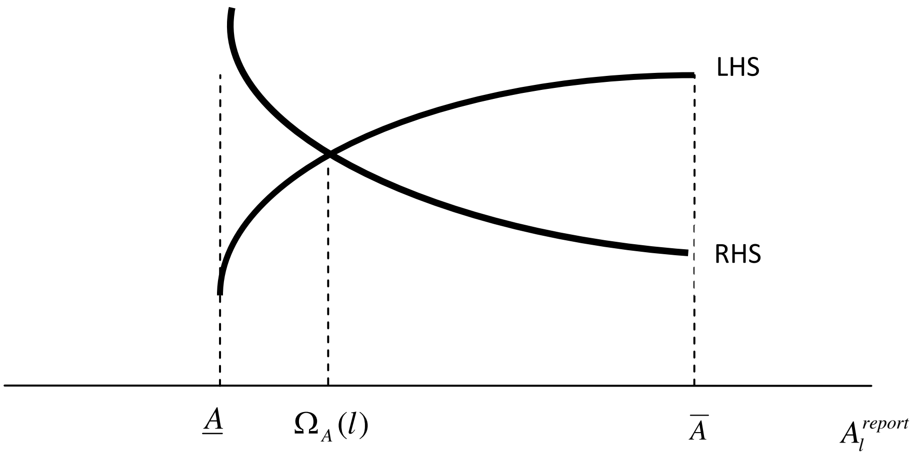
$$A_l^*(j) \leq \Omega(l) \qquad (16)$$

where $\Omega(l) = \underline{A} + (\beta_l^2 - \beta_l^1)\left[V((1-\tilde{\phi}(\Omega(l)))\pi_{l,high}) - V((1-\tilde{\phi}(\Omega(l)))\pi_{l,low})\right]$.

The rationale of this condition is straightforward. Innovators with projects such that $A_l^*(j) \leq \Omega(l)$ would not have an incentive to extract perquisites from investment resources, since their expected earnings are already high and they do not want to damage their projects' probability of success. Since private investors can derive inequalities (15) and (16) they would be ready to supply funds only to all projects of types $l \in \{x, z\}$ whose reported investment values are at most $\Omega(l)$ and will be reluctant to supply funds to projects whose reported investment values exceeds $\Omega(l)$. Thus, the range of projects of type $l \in \{x, z\}$ that can be financed by private investors is necessarily limited by the threshold investment value $\tilde{\Omega}(l)$, while banks who are equipped with monitoring technology will be ready to finance projects with $A_l^{report}(j) > \Omega(l)$.

[18]As will become apparent, equilibrium stock price implies that the investors' share in their projects' profit $\tilde{\phi}(A_l^{report})$ is an increasing function of the reported investment value A_l^{report}.

Figure 3



Shareholders Protection

We now describe how legal protection for shareholders rights affects private investors supply for funds. We borrow from Becker (1968) "crime and punishment" and from Jensen and Meckling (1976) and Shleifer and Wolfenzon (2002) and assume that the quality of investors protection is given by the likelihood that the innovator is caught and fined for expropriating from shareholders. Specifically, if an innovator is caught, he is fined and forced to return the diverted amount to the project. In addition, the entire project's profits are distributed as dividends to shareholders. Thus, according to assumptions (A-4) and (A-5), the innovator not only reduces his project's probability of success from β_l^2 to β_l^1, but also risks utility losses (see assumptions (A-6) and (A-7). Let $0<\chi<1$ denote the probability that an innovator who diverts investment resources is caught and let c denote the innovator's cost from being sued and fined. By applying the same logic as in inequality (16) we find that an innovator, whose offers share to the public would report his true investment threshold value (i.e., $A_l^{report} = A_l * (j)$) if and only if:

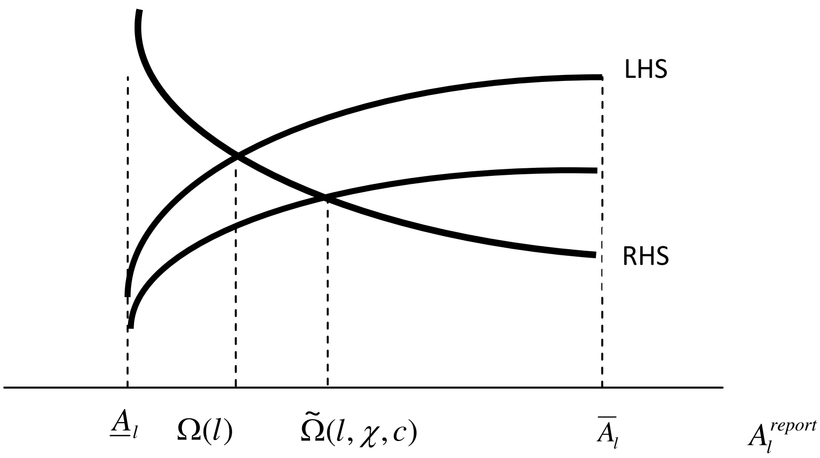
$$A_l^*(j) \le \tilde{\Omega}(l,\chi,c) \qquad (17)$$

where

$$\tilde{\Omega}(l,\chi,c) =$$
$$\underline{A} + \frac{1}{(1-\chi)}\left[\begin{array}{l}[(1-\beta_l^2)V((1-\tilde{\phi}(\tilde{\Omega}(l,\chi,c)))\pi_{l,low} \mid q=p) + \beta_l^2 V((1-\tilde{\phi}(\tilde{\Omega}(l,\chi,c)))\pi_{l,high} \mid q=p)] \\ -(1-2\chi)[(1-\beta_l^1)V((1-\tilde{\phi}(\tilde{\Omega}(l,\chi,c)))\pi_{l,low} \mid q=p) + \beta_l^1 V((1-\tilde{\phi}(\tilde{\Omega}(l,\chi,c)))\pi_{l,high} \mid q=p)]\end{array}\right]$$
$$+c\left[\frac{\chi}{(1-\chi)}\right]$$

since the breakeven point $\tilde{\Omega}(l,\chi,c)$ is an increasing function of χ and c, we conclude that the better investors' protection is, the wider is the range of projects that private investors are willing to finance (see Figure (4) below).

Figure 4



The Required Return on Equity

Before we turn to analyze the innovators' decision problem and to describe the demand for funds we must first determine the required rate of return on equity.

Lemma 3: The required rate of return on equity for all projects j of type $l \in \{x, z\}$ such that $A_l^*(j) \leq \Omega(l)$), is necessarily equal to the world gross interest rate R^*.

Proof: According to the CCAPM model, the expected rate of return of any risky asset j must satisfy the following equilibrium condition: [19]

$$\mathscr{E}(R_j) = R^* - \frac{\operatorname{cov}\left[U'(c_{t+1}^t), R_j\right]}{\mathscr{E}\left[U'(c_{t+1}^t)\right]}.$$

However, since in our model, all projects' expected rate of return are independently distributed, their risks can be fully diversified as long as outside shareholders can truthfully reveal their projects' investment values $A(j)^*$. Thus, stocks' gross expected rate of return must be equal to the risk free alternative investment opportunity (i.e., the world's gross interest rate R^*).□

Lemma 3 implies that whenever private investors can truthfully reveal projects' investment values $A_l^*(j)$, the innovators have a sufficient bargaining power (vis-à-vis private investors) to keep investors indifferent between purchasing projects' equity

[19] For any risky asset j, and for any risk free asset B*, the Euler conditions for consumers' must satisfy: 1) $U'(c_t^t) = \Theta^{-1}\mathscr{E}\left[U'(c_{t+1}^t)R_j\right]$ and 2) $U'(c_t^t) = \Theta^{-1}\mathscr{E}\left[U'(c_{t+1}^t)R^*\right]$. These two conditions lead to the CCAPM expected return condition: $\mathscr{E}(R_j) = R^* - \operatorname{cov}\left[U'(c_{t+1}^t), R_j\right] / \mathscr{E}\left[U'(c_{t+1}^t)\right]$.

and purchasing assets that yield the world interest rate.[20] According to Lemma 3 and condition (14) the required rate of return on equities as well as on banks assets are equal to the world interest rate R* and therefore savers will be willing to finance all types of projects whether by purchasing equity (if $A_l^{report}(j) \le \Omega(l)$) or through banks.

3.3 The Demand for Funds

Until now we have described the supply for funds by showing how informational asymmetries affect banks and private investors' decisions. We now turn to describe the demand for funds. In our model, each innovator j must make two related decisions. First, he must decide whether to undertake a project of type x or z and then he must decide whether to raise funds by borrowing from a bank or by offering shares to the public. These two decision problems are closely related to two issues that were previously pointed out. The first issue is whether an innovator can or cannot raise finance by offering equity to the public. We have seen that due to moral hazard problem an innovator cannot raise finance from private investors if his project's threshold investment value is higher than $\tilde{\Omega}(l,\chi,c)$ (see condition (17) above). This condition implies that the poorer investors' protection is the smaller is the range of projects that can be financed by selling equity and the larger is the range of projects that can be financed solely by banks. The second issue is the risk of

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[20] Specifically, Lemma 3 implies that the share of outside investors in the projects' profit as a function of its investment value is given by: $\tilde{\phi}(A_x^*(j)) = \frac{R^*}{R(A_x^*(j))}$ and $\tilde{\phi}(A_z^*(j)) = \frac{R^*}{R(A_z^*(j))}$ where R* is the world gross investment rate and $R_x(A_x(j)^*)$ and $R_z(A_z(j)^*)$ are the gross expected rate of return for projects of type x and z, with investment values $A_x(j)^*$ and $A_z(j)^*$, respectively, where $R_x(A_x^*(j)) = \frac{\beta_x^2\pi_{x,high} + (1-\beta_x^2)\pi_{x,low}}{A_x^*(j)}$ and $R_z(A_z^*(j)) = \frac{\beta_z^2\pi_{z,high} + (1-\beta_z^2)\pi_{z,low}}{A_z^*(j)}$.

unjustified liquidation that an innovator must take when he raises funds by borrowing from banks (see assumptions (A-12)-(A-14) and Lemma 1). Such a liquidation risk might leads innovators to undertake less profitable projects only because the probability of auditing errors (and thereby unjustified liquidation) is lower. We now show how investors' moral hazard problems, on the one hand, and liquidation risk (due to auditing errors) on the other hand impinge on innovators decisions. Specifically we demonstrate that better investors' protection rules (which lessen the investors' moral hazard problem) lead innovators to undertake a higher numbers of high-tech projects. This leads to the main result of the paper that investors' protection intensifies investment in high-tech projects and increases economic growth.

Lemma 4: If projects' signal errors $1-\gamma_l$ are sufficiently high (i.e., $1-\gamma_l$ lies in some interval $[z_l, \frac{1}{2}]$ where $0 \le z_l \le \frac{1}{2}$ is sufficiently high), then innovators will always prefer to raise funds for their projects by offering equities to private investors rather than by borrowing from banks.

Proof: See Appendix.

Lemma 4 simply states that if a project's signal error is sufficiently high, then due to the high probability of bank's auditing error and thereby high risk of unjustified liquidation by the bank, the innovator would prefer to raise funds by offering equity to the public rather than from borrowing from banks.

We henceforth assume that:

(A-17) All projects' signal errors $1-\gamma_l$ are sufficiently high such that Lemma 4 holds.

(A-18) Whenever a product of type z turns out to be productive its contribution to the production of the final good Y is remarkably higher than that of products of type x. Formally, $\theta_{z,high}$ is sufficiently higher than $\theta_{x,high}$ such that for all $0 < \delta \leq 1$ the following condition holds:[21]

$$\frac{V(\delta \cdot \pi_{x,high}) - V(\delta \cdot \pi_{x,low})}{V(\delta \cdot \pi_{z,high}) - V(\delta \cdot \pi_{z,low})} < \min\left\{\frac{\beta_z^2 - \beta_z^1}{\beta_x^2 - \beta_x^1}, \frac{\beta_z^2}{\beta_x^2}\right\}$$

Proposition 1: Suppose that assumptions (A-17) and (A-18) are satisfied. Consider an innovator j with ability $A(j) \in [\underline{A}, \overline{A}]$.

(i) If $A(j) \leq \Omega(z, \chi, c)$ (where $\Omega(z, \chi, x)$ is as in inequality (18)), then the innovator would embark on his z project and would raise funds by offering equity to private investors.

(ii) Otherwise the innovator would embark on his x project and would raise funds by borrowing from a bank.

Proof: see Appendix

[21] This condition implies that whenever a product of type z turns out to be productive then its contribution to the production of the final good Y is remarkably higher than that of product of type x. This condition holds for example when $V(\cdot) = \sqrt{\cdot}$ and $\theta_{z,high}$ is sufficiently high.

4. Economic Growth

From Proposition 1 and assumption (A-3) we can deduce that the number of innovators who undertake a project of type z is $\nu \cdot F(\Omega(z,\chi,c))$, while the number of innovators who embark on projects of type x is $\nu \cdot (1 - F(\Omega(z,\chi,c)))$.[22] Proposition 1 and assumption (A-3) and (A-4) allow us to calculate the number of new intermediate goods that are produced at each period t (see Table 2 below).

Table 2

The product type	The number of intermediate goods that are produced at period t from each product type
Product x with productivity $\theta_{x,low}$	$(\Gamma - 1)\cdot \beta_x^2 \cdot \gamma_x (1 - F(\Omega(z,,\chi,c)))\cdot B_{t-1}$
Product x with productivity $\theta_{x,high}$	$(\Gamma - 1)\cdot (1-\beta_x^2)(1-\gamma_x)\cdot (1 - F(\Omega(z,,\chi,c)))\cdot B_{t-1}$
Product z with productivity $\theta_{z,low}$	$(\Gamma - 1)\cdot (1-\beta_z^2)\cdot F(\Omega(z,\chi,c))\cdot B_{t-1}$
Product z with productivity $\theta_{z,high}$	$(\Gamma - 1)\cdot \beta_z^2 \cdot F(\Omega(z,\chi,c))\cdot B_{t-1}$

The most important implication of Proposition 1 is that better investors' protection rules (as manifested by the parameters χ and c) increase the variety of high-tech products while decreasing the variety of medium tech products. that is, the higher $\Omega(z,\chi,c)$ is (see inequality (17)) the larger is the number of innovators who would

[22] Assumption (A-18) is a simplifying assumption. The results of the paper carry through even if $\theta_{z,high}$ is higher than $\theta_{x,high}$ but not sufficiently higher such that $\tilde{\Omega}(x,\chi,c) > \tilde{\Omega}(z,\chi,c)$. Due to assumption (A-18) Proposition 1 implies that all projects of type x are financed by banks while projects of type z are financed by non-bank investors. Assumption (A-18), however, does not limit the generality of the model since even if we relax this assumption we still obtain the result that better investors' protection rules increase the number of projects that are financed by non-bank investors, and that the number of z projects rise.

undertake a project of type z and the lower is the number of innovators who would undertake a project of type x.

We now examine how investors' protection rules affect output, wages and growth. From Table 2 and equation (11) we get that the level of output at each period t is given by:

$$Y_t = L \times \left(\begin{array}{l} \left[M_{t-1} \left(\frac{(\alpha)^{\frac{\alpha}{1-\alpha}}}{\beta_x^2 \cdot \gamma_x + (1-\beta_x^2)(1-\gamma_x)} \right) + (\Gamma - 1)(\alpha)^{\frac{2\alpha}{1-\alpha}} \left(1 - F(\Omega(z,\chi,c))\right) \cdot B_{t-1} \right] \cdot s_x \\ \qquad + \left[H_{t-1}(\alpha)^{\frac{\alpha}{1-\alpha}} + (\Gamma - 1)(\alpha)^{\frac{2\alpha}{1-\alpha}} F(\Omega(z,\chi,c)) \cdot B_{t-1} \right] \cdot s_z \end{array} \right) \tag{18}$$

where

$$s_x = \beta_x^2 \cdot \gamma_x \cdot (\theta_{x,high})^{\frac{1}{1-\alpha}} + (1-\beta_x^2)(1-\gamma_x) \cdot (\theta_{x,low})^{\frac{1}{1-\alpha}}$$

and

$$s_z = \beta_z^2 \cdot (\theta_{z,high})^{\frac{1}{1-\alpha}} + (1-\beta_z^2) \cdot (\theta_{z,low})^{\frac{1}{1-\alpha}}$$

From equation (18) we can immediately deduce that (*i*) the level of output Y_t ; (*ii*) the wage rate w_t and (*iii*) the output growth rates must be positively related with the quality of investors protection rules (as manifested by the parameters χ and c). First, it is easy to see that if Y_t is an increasing function of χ and c, then the wage rate w_t must also be positively related with χ and c since profit maximization by firms who produce the final good Y leads to the first order condition: $w_t = (1-\alpha)\frac{Y}{L}$.

The level of output Y_t is an increasing function of χ and c since $s_z > s_x$ and since $\Omega(z,\chi,c)$ is positively related with χ and c. By applying the same arithmetic on

$\frac{\partial}{\partial \Omega}\left(\frac{Y_{t+1}-Y_t}{Y_t}\right)$ we get that investors' protection rules increase the rates of economic growth.

Proposition 2 summarizes the results of the paper.

Proposition 2: *An enhancement in the quality of investors' protection rules*

(i) Increases the number of innovators who undertake a project of type z and (weakly) decrease the number of innovators who undertake projects of type x;

(ii) Increases the number of projects that are financed by non-bank investors and decreases the number of projects that are financed by banks;

(iii) Increases output;

(iv) Increases wage rates; and last

(v) Increases growth rates.

5. Concluding Remarks

New empirical studies that have recently emerged showed that legal protection for private investors is not only important for the structure of the financial market but also for economic structure and performance both at the industry and the macroeconomic level. The chief contribution of this paper is that it demonstrates a new economic mechanism through which these empirical findings can be derived. We show that investors' protection affects both the supply and the demand side for funds. On one hand it increases the range of risky projects that private investors are willing to finance (projects that otherwise would not have been financed at all), and, on the other hand, it increases the number of innovators who are able to change their financial structure from bank loans to market funds. Legal protection for investors therefore:1) expands the range of the most advanced, risky and productive sector (high-tech) while reducing the relative size of less advanced, less risky and less productive sector; 2) shifts resources from the medium to the high-tech sector; and 3) raises aggregate output, wages and growth.

Appendix

Proof of Lemma 2:

The bank monitoring policy (i.e., the lowest inspection probabilities $\delta(A_x^{report})$ and $\delta(A_x^{report})$ that satisfy the innovators incentive compatible condition). Consider an innovator j who embarked on a project x and seeks to extract perquisites by reporting a certain investment value $A_x^{report}(j)$ and then extracting $A_x^{report}(j)-\underline{A}$ to his own private benefits (note that by doing so the innovator reduces the project's probability of success from β_x^2 to β_x^1).

- If the innovator's project (j) is scrutinized by the bank, then the bank finds out that the innovator did not invest an amount $A_x^{report}(j)-\underline{A}$, and therefore the bank liquidates the project (while leaves the innovator with zero utility).

- If, however, project j is left unscrutinized by the bank, then the innovator extract an amount $A_x^{report}(j)-\underline{A}$ to his own benefit in addition to his share in the project's expected profits. Note, however, that the bank who still observes a noisy signal (see assumption (A-10)) might liquidate the project if the signal indicates that the project is bad.

Hence, whenever an innovator extracts resources to his own benefits his expected utility is necessarily:

$$\mathscr{E}(V_1)= \\ \left(1-\delta(A_x^{report})\right)\times\left\{\gamma_x\beta_x^1\cdot u((1-\phi(A))\cdot\pi_{x,high}\mid q=p)+(1-\gamma_x)\beta_x^1\cdot u((1-\phi(A))\cdot\pi_{x,high}\mid q=l)+(A_x^{report}-\underline{A})\right\} \quad (*)$$

If, on the other hand, the innovator j reports his true investment value and allocate all the funds to the project. Under such condition, the innovator's expected utility is given by:

$$\mathscr{E}(V_2)=\gamma_x\beta_x^2\cdot u((1-\phi(A))\cdot\pi_{x,high}\mid q=p)+(1-\gamma_x)\beta_x^2\cdot u((1-\phi(A))\cdot\pi_{x,high}\mid q=l) \qquad (**)$$

Equations (*), (**) as well as assumption (A-5)-(A-7) imply that, the incentive compatible condition for innovators to truthfully reveal their investment value and to allocate all the funds to their project (i.e., $\mathscr{E}(V_1)\le\mathscr{E}(V_2)$) holds as long as the innovator's inspection probability $\delta(A_x^{report})$ is sufficiently high such that:[23]

$$\delta(A_x^{report})\ge 1-\frac{\beta_x^2\cdot(1-2\gamma_x)\cdot V(\phi(A)\cdot\pi_{x,high}\mid q=p)}{(1-2\gamma_x)\beta_x^1 V(\phi(A)\cdot\pi_{x,high}\mid q=p)+(A_x^{report}-\underline{A})} \qquad (***)$$

[23] Note that (***) ensures that the innovators will not be better-off by extracting resources to their own benefit (i.e., $\mathscr{E}(V_1)\le\mathscr{E}(V_2)$).

Proof of Lemma 4: For a project *j* of type $l \in \{x, z\}$, an innovator will prefer to raise funds from the public (rather than borrowing from a bank) if and only if

$$\beta_l^2 \cdot V\Big((1-\tilde{\phi}(A_l^*(j)))\pi_{l,high} \mid q = p\Big) + (1-\beta_l^2)\cdot V\Big((1-\tilde{\phi}(j)))\pi_{l,low} \mid q = p\Big)$$
$$>$$
$$\beta_l^2 \cdot \Big[\gamma_l \cdot V\Big((1-\phi(A_l^*(j)))\pi_{l,high} \mid q = p\Big) + (1-\gamma_l)\cdot V\Big((1-\phi(A_l^*(j)))\pi_{l,high} \mid q = l\Big)\Big]$$

This inequality holds if the condition (*) below holds for all $0 \le \delta \le 1$:

$$\frac{1}{2} + \frac{(1-\beta_l^2)\cdot V\big(\delta\cdot\pi_{l,low} \mid q = p\big)}{2\beta_l^2 \cdot V\big((\delta\cdot\pi_{l,high} \mid q = p\big)} > \frac{V\big((1-\phi(A_l^*(j)))\pi_{l,high} \mid q = p\big)}{V\big((1-\tilde{\phi}(A_l^*(j)))\pi_{l,high} \mid q = p\big)}\cdot\left(\gamma_l - \frac{1}{2}\right) \qquad (*)$$

where

$$(1-\tilde{\phi}(A_l^*)) = \left(\frac{\left[\beta_l^2\cdot\left[\frac{\gamma_x\cdot\pi_{l,high}}{A_l(1+q)}\right] + (1-\beta_l^2)\cdot\left[\frac{(1-\gamma_l)\cdot\pi_{l,low}}{A_l(1+q)}\right]\right] + \beta_l^2\cdot\left[\frac{(1-\gamma_l)\xi A_l}{A_l(1+q)}\right] + (1-\beta_l^2)\cdot\left[\frac{\gamma_l\xi A_l}{A_l(1+q)}\right] - R^*}{\left[\beta_l^2\cdot\left[\frac{\gamma_x\cdot\pi_{l,high}}{A_l(1+q)}\right] + (1-\beta_l^2)\cdot\left[\frac{(1-\gamma_l)\cdot\pi_{l,low}}{A_l(1+q)}\right]\right]}\right)$$

and $$(1-\phi(A_l^*)) = \frac{\beta_l^2\frac{\pi_{l,high}}{A_l^*(j)} + (1-\beta_l^2)\frac{\pi_{l,low}}{A_l^*(j)} - R^*}{\beta_l^2\frac{\pi_{l,high}}{A_l^*(j)} + (1-\beta_l^2)\frac{\pi_{l,low}}{A_l^*(j)}}.$$

If $\gamma_l = \frac{1}{2}$ then obviously (*) holds.

Now since $\beta_l^2 < \frac{1}{2}$ it must be that $(1-\tilde{\phi}(A_l^*))>0$ is an increasing function of γ_l and therefore there exists an interval $[\frac{1}{2}, z_l]$ such that that condition (*) holds for all $\gamma_l \in [\frac{1}{2}, z_l]$. □

Proof of Proposition 1: If $A(j) \le \min\{\Omega(x,\chi,c), \Omega(z,\chi,c)\}$, then according to lemma 4 the innovator would raise funds for his project (either *x* or *z*) by offering equity to private investors. The condition under which an innovator would prefer to embark on his *z* project rather than his *x* project is given by:

$$\beta_z^2 \cdot V\left((1-\tilde{\phi}(A(j))\pi_{z,high} \mid q=p\right)+(1-\beta_z^2)\cdot V\left((1-\tilde{\phi}(A(j)))\pi_{z,low} \mid q=p\right)$$
$$\geq$$
$$\beta_x^2 \cdot V\left((1-\tilde{\phi}(A(j))\pi_{x,high} \mid q=p\right)+(1-\beta_x^2)\cdot V\left((1-\tilde{\phi}(A(j)))\pi_{x,low} \mid q=p\right)$$

This inequality holds if $\frac{\beta_z^2}{\beta_x^2} > \frac{V(\delta \cdot \pi_{x,high} \mid q=p) - V(\delta \cdot \pi_{x,low} \mid q=p)}{V((\delta \cdot \pi_{z,high} \mid q=p) - V(\delta \cdot \pi_{z,low} \mid q=p)}$ for all $\delta > 0$ (which according to assumption (A-19) holds). Thus, if an innovator j has an ability parameter $A(j) \in [\underline{A}, \overline{A}]$ such that $A(j) \leq \min\{\Omega(x,\chi,c), \Omega(z,\chi,c)\}$ then the innovator would prefer to undertake his z project (rather than his x project) and will raise funds by offering equities to private investors.

Now since assumption (A-18) also implies that $\tilde{\Omega}(x,\chi,c) < \tilde{\Omega}(z,\chi,c)$ then either statement (*i*) holds (i.e., $A(j) \leq \Omega(z,\chi,c)$) and the innovator embarks on his z project, or $A(j) > \Omega(z,\chi,c) > \Omega(x,\chi,c)$ and then the innovator can raise funds (for both projects) only by borrowing form a bank.

Under such conditions, the innovator would prefer to embark on his x project rather that his z project if and only if

$$\beta_z^2 \cdot \left[\gamma_z \cdot V\left((1-\phi(A_z^*(j)))\pi_{z,high} \mid q=p\right)+(1-\gamma_z)\cdot V\left((1-\phi(A_z^*(j)))\pi_{z,high} \mid q=l\right)\right]$$
$$<$$
$$\beta_x^2 \cdot \left[\gamma_x \cdot V\left((1-\phi(A_x^*(j)))\pi_{x,high} \mid q=p\right)+(1-\gamma_x)\cdot V\left((1-\phi(A_x^*(j)))\pi_{x,high} \mid q=l\right)\right]$$

If and only if $\frac{\beta_z^2 \cdot V(\delta \cdot \pi_{z,high} \mid q=p)}{\beta_x^2 \cdot V(\delta \cdot \pi_{x,high} \mid q=p)} < \frac{(\gamma_x - \frac{1}{2})}{(\gamma_z - \frac{1}{2})}$ for every $0 < \delta \leq 1$, which holds due to assumption (A-).□

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