Expropriation Risk, Governance Control and Equilibrium Financial Contract

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Abstract

We present a model of financial contracting in the presence of asymmetric information between entrepreneur and investor. Either liquidation threat or governance control can be used to protect investor's interests against expropriation risk. The two parties first agree to a *financial arrangement* which assigns to the parties the "governance right" to choose the level of governance control and the "contracting right" to design the financing contract.

We show the trade-off between costs of liquidation and governance control determines the equilibrium. In Pareto-efficient equilibrium financial arrangements, a highly profitable project is financed by a contract which relies on liquidation threat so that liquidation occurs with a strictly positive probability. On the other hand, a less profitable project relies on governance control, thereby avoiding liquidation altogether. We relate different equilibrium financial arrangements to the ownership and financial structure of firm.

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1 Introduction

Different firms rely on different types of financial instruments to conduct their business, which differ in terms of how they are repaid to the investors, how secure the repayment is, who retains the control rights in the event of failure to repay, etc. The Modigliani-Miller theorem (1958) notwithstanding, some firms choose to finance their investment project by issuing debts to the financial market, whereas others have to give investors equity stakes and some control rights. This paper attempts to address this observation by studying a situation where nonverifiability of cash flow and contractual incompleteness result in different optimal financial arrangements depending on the characteristics of an investment project to be undertaken.

Suppose that an investment project lasts for two periods, yielding a strictly positive expected net cash flow in each period, but that the cash flows accrue to entrepreneur and are not verifiable. Since a potential investor for the project is at the risk of expropriation by the entrepreneur, the investor will be reluctant to provide financing unless an appropriate financial arrangement is made. There can be two mechanisms to deal with this expropriation risk: one is the threat of liquidation after first-period default, and the other is the governance control which converts a part of cash flow into verifiable income and thus reduces the need for liquidation threat. These mechanisms, however, are not costless. A better governance mechanism costs more to design and maintain, and an actual liquidation results in the loss of positive surplus of the second period. Therefore, the optimal financial arrangement will maximize the (expected) net surplus while ensuring that the investor be repaid.

In solving the problem, we follow the incomplete contracting/property right approach to the financial structure. The key insight from this approach is that contractual incompleteness requires the distribution of control rights to different contracting parties, and appropriate income streams have to be attached to each of the control rights to provide the controlling party with proper incentives. In the context of our model, the liquidation decision is contractible since it can be contingent upon repayment from entrepreneur, whereas the governance decision, or at least some elements of it, will not be contractible. Thus, unlike other models in the literature, e.g., Aghion and Bolton (1992) and Dewatripont and Tirole (1994), which concern ex post control rights, we will analyze the ex ante bargaining between entrepreneur and investor in which "governance right" to the governance control decision and "contracting right" to the verifiable income stream are assigned to the parties. We call the outcome of this bargaining process a *financial arrangement* denoted by *EI* for example, which is the entrepreneur-governance/investor-contract arrangement.[1] Subsequently to the bargaining, the "governance" party chooses a level of governance control and then the "contracting" party offers a *financing contract.* In efficient bargaining with side payment, an *equilibrium financial arrangement* will maximize the expected net surplus. Then the financial structure of firm is determined according to the financing contract of the equilibrium financial arrangement.

We show that different equilibrium financial arrangements obtain, depending upon the profitability of the investment project, the governance control cost , and the existence of opportunism.[2] In the absence of opportunism risk, the entrepreneur's governance control and contract *EE* is essentially the equilibrium financial arrangement and Pareto-efficient subject to the incentive compatibility constraint. A highly profitable investment project is financed with a positive probability of liquidation after default, while a moderately profitable project is always refinanced but requires sufficiently effective governance control.

On the other hand, when risk of opportunism is present, further protection against expropriation is necessary for the investor. This can be achieved by giving her the governance right for a highly profitable project, in which case *IE* is the equilibrium with a positive probability of liquidation, or by giving her the contracting right as well for a moderately profitable project, in which case *II* is the equilibrium with no liquidation. Regardless of opportunism risk, the equilibrium financial arrangement depends on the trade-off between the costs of liquidation threat and governance control: for a highly (moderately) profitable project, the former (the latter) is a less costly mechanism for investor protection.

Furthermore, since the ownership of a firm is usually associated with the residual income rights and the residual control rights, we can interpret the equilibrium financial arrangements in terms of financial structure as follows:

- *EE* or *IE* with liquidation: firm is owned by entrepreneur and financed by "debt,"
- *EE* with no liquidation: firm is owned by entrepreneur and is financed by "non-voting equity," or "preferred stock," and
- *EI* or *II* with no liquidation: firm is owned by investor as the sole "equity"

[1] The other possible outcomes are *EE*, *IE*, and *II*.

[2] Later, we will focus as opportunistic behavior on the parties' inability to precommit themselves *neither* to alter the level of governance control *nor* to renegotiate the financing contract.

holder, and entrepreneur is hired by the firm as manager with the financing contract being his compensation scheme.

Given these interpretations, the change in equilibrium financial arrangement from an entrepreneur-contract arrangement to an investor-contract one can be interpreted as an initial public offering (IPO). The change in the other direction can be viewed as a management buy-out (MBO).

One of the first papers to derive the optimal financial structure based upon the idea that different control rights are attached to different financial claims in an incomplete contract framework is Aghion and Bolton (1992). In their model, the firm's income is verifiable, but the private benefits entrepreneur gets create the conflict of interests between him and investor. They show that the optimal ex post contingent control can be implemented by an appropriate financial structure. Whereas both this and their papers do not need multiple investors, Berglöf and von Thadden (1994) and Dewatripont and Tirole (1994) derive the optimal financial structure with multiple types of investors.

Berglöf and von Thadden (1994) consider a situation where the firm's income is non-verifiable but its assets can be sold in the case of default, and show that it is optimal to issue a secured short-term claim (debt) and a contingent long-term claim (equity) to different investors. This separation of short-term and long-term interests among investors helps reduce the cost of ex post bargaining between the firm and short-term claim holder, thus increasing the firm's finance capacity. Dewatripont and Tirole (1994), on the other hand, study a model of managerial moral hazard in which a financial structure with multiple investors is used to discipline the manager by providing proper incentives for the outside controlling investor. With an appropriate assumption on the stochastic structure of income stream, the optimal financial structure can be interpreted in terms of debt and equity. Another related paper is Bolton and Scharfstein (1990) who derive a debt contract by using the liquidation threat.

The rest of the paper is organized as follows. Section 2 presents the basic elements of the model and the solution concept. In Section 3, we derive the equilibrium financial arrangements and their interpretations in terms of governance control and financial structure. We briefly conclude in Section 4.

2 The Model

Consider an entrepreneur with an investment project lasting for two periods which requires an initial expenditure of F and generates a cash flow of either 0 with probability $1-\theta$ or x with probability θ in each period, where

$$0 < F < x \quad \text{and} \quad \bar{x}\ (\equiv \theta x) > F.$$

The cash flow is assumed to be *nonverifiable* in court although it may be observable to investor. Therefore no investor would be willing to finance the project, even though it is ex ante profitable. We assume all the parties are risk-neutral, and the above description is common knowledge.

There are two ways to cope with the expropriation risk. One is *liquidation threat* (refusal to refinance after default on repayment) as in Bolton and Scharfstein (1990), which can mitigate the entrepreneur's incentive to *strategically* default when he has received a positive cash flow. The other is a *governance control* which converts a part of the cash flow into verifiable income.[3] In particular, a governance control with effectiveness $\gamma \in [0,1]$ will make γx of x verifiable, and cost $G(\gamma) = b\gamma$ with $b > 0$. Thus we can identify the governance control with γ.[4] To further contrast its role and that of liquidation threat, we assume that the governance control is effective only in the second period.[5] In general, a project, or a firm, can be represented by (x, F, θ, b), but since we fix both x and F throughout the paper, a firm will be simply identified with (θ, b), its profitability and control cost.

The contracting problem facing the entrepreneur and the investor is to decide whether to undertake the proposed project, with what level of governance control, and how to divide the surplus from the project. The liquidation decision can be a part of contract since it can be made contingent upon repayment, which is verifiable. On the other hand, the governance control decision in general will be difficult to fully describe ex ante, and is assumed to be noncontractible. To resolve this contractual incompleteness, the parties will first bargain over the assignment of *governance right* and *contracting right* to reach

[3] For example, net income on the financial statements generated by the internal accounting system and audited by a CPA is verifiable.

[4] For future reference, we will call b (marginal) control cost and $b\gamma$ (total) cost of governance control.

[5] One justification is that the governance mechanism can only be instituted and developed as designed during the first period after the project is undertaken.

a *financial arrangement*. Specifically, the governance right entitles a party to make the governance control decision γ and incur the cost $b\gamma$, and the contracting right entitles to the verifiable income and thus to design an actual *financing contract* which specifies the repayment schedule and the liquidation decision. Since the same party can retain both rights, there are four different financial arrangements: EE, EI, IE, and II, where IE is the one in which investor has the governance right, and entrepreneur has the contracting right, for example. Then an equilibrium financial arrangement is an outcome of efficient bargaining with side payment.

Equilibrium Financial Arrangement Since both entrepreneur and investor are risk-neutral, they will "buy" or "sell" these rights between themselves to reach a Pareto-efficient arrangement. In particular, a financial arrangement XY is an *equilibrium financial arrangement* for an investment project (θ, b) if (i) the project is actually undertaken, and (ii) there exists no other financial arrangement $X'Y'$ with side payment (t_E, t_I) such that

$$\begin{aligned} U^E_{X'Y'}(\theta, b) + t_E &\geq U^E_{XY}(\theta, b), \\ U^I_{X'Y'}(\theta, b) + t_I &\geq U^I_{XY}(\theta, b) \text{ with at least one strict inequality, and} \\ t_E + t_I &= 0, \end{aligned}$$

where $U^E_{XY}(\cdot)$ and $U^I_{XY}(\cdot)$ are the expected payoffs from the project in the financial arrangement (X, Y) for the entrepreneur and the investor, respectively.[6] The financial structure and the governance structure of firm are determined by the financing contract and the governance control decision, respectively, of the equilibrium financial arrangement.

Timing The sequence of events take place in three periods. In Period 0, the parties first bargain to reach a financial arrangement XY, party X with governance right makes a (governance) control decision γ_X, and then party Y with contracting right designs and proposes a financing contract C_Y in a take-it-or-leave-it fashion. If the contract is accepted, then Period 1 begins in which the project is undertaken with investment expenditure from investor, cash flow accrues to entrepreneur, and then he makes repayment or defaults. Then according to the contract, the project will be either terminated (firm is liquidated),

[6] We note that the initial financial arrangement for bargaining will be EE because the entrepreneur has the know-how to undertake the project and there are many investors willing to provide financing so that he will have all the bargaining power initially. Therefore, the subsequent bargaining process is consistent with our assumption that the entrepreneur has no initial wealth. For example, if another financial arrangement is to yield a higher surplus, they can agree that the entrepreneur "sell" the rights to the investor.

or refinanced. In the latter case, Period 2 follows, at the end of which repayment is made after cash flow accrues.

In this context, a financing contract C will take the following form: $\{r, \beta_0, \beta_1, R_0, R_1\}$, where r is the repayment at the end of Period 1; β_0 and β_1 are the probabilities of refinancing after default and repayment r, respectively; and R_0 and R_1 are the repayments in the event of positive cash flow in Period 2 after Period-1 default and repayment, respectively. Therefore, for a given project (x, F, θ, b), a financial arrangement XY yields the following expected net surplus:

$$V_{XY}(\theta, b) \equiv U^E_{XY}(\theta, b) + U^I_{XY}(\theta, b) = [1 + (1-\theta)\beta_0 + \theta\beta_1](\bar{x} - F) - b\gamma, \tag{1}$$

and is an equilibrium if $V_{XY}(\theta, b) \geq V_{X'Y'}(\theta, b)$ for any other arrangement $X'Y'$.

One-period Project Before we proceed, we illustrate the conflict of interests over the governance decision between entrepreneur and investor by considering a investment project which lasts for one period and whose governance control becomes effective immediately.

• **Financing Contract**: Working backwards, we first derive an optimal one-period financing contract $c(\gamma) = \{r(\gamma)\}$ given γ. The entrepreneur-contract c_E solves the following program:

$$\max_r \ \theta(x - r), \qquad \text{subject to} \quad r \leq \gamma x \quad \text{and} \quad \theta r - F \geq 0.$$

The first constraint is limited liability (LL) condition for entrepreneur and the second constraint is individual rationality (IR) condition for investor. By noting that the IR constraint should be binding at optimum, we can rewrite the program as follows:

$$\max_r \quad \bar{x} - F, \qquad \text{subject to} \quad \frac{F}{\theta} \leq \gamma x.$$

When we define $\bar{\gamma}_1 \equiv \dfrac{F}{\theta x}$, we conclude that $c_E = \left\{\dfrac{F}{\theta}\right\}$ if $\gamma \geq \bar{\gamma}_1$, and no entrepreneur-contract is feasible otherwise. From c_E, the entrepreneur's payoff is $\pi(\gamma) = \bar{x} - F$, and the investor's payoff is $R(\gamma) = 0$.

On the other hand, the investor-contract c_I solves the following program:

$$\max_r \ \theta r - F, \qquad \text{subject to} \quad r \leq \gamma x \quad \text{and} \quad \theta(x - r) \geq 0.$$

The second constraint is IR condition for entrepreneur and will be always satisfied because of LL constraint and $\gamma \leq 1$. When the investor sets $r = \gamma x$, she gets a payoff $R(\gamma) = \gamma\bar{x} - F$. Therefore, she will offer $c_I = \{\gamma x\}$ as long as her payoff is positive: $\gamma \geq \dfrac{F}{\theta x}$ $(\equiv \bar{\gamma}_1)$. The entrepreneur gets $\pi(\gamma) = \theta(1-\gamma)x$.

We make two observations: first, it is necessary that governance control be sufficiently effective ($\gamma \geq \bar{\gamma}_1$) for the project to be undertaken. In other words, more effective governance control increases "finance capacity." Second, beyond that minimal level of effectiveness, the interests of the parties over governance control diverge. Under c_E, entrepreneur gets all the surplus, whereas under c_I, entrepreneur's (investor's) payoff is decreasing (increasing) in γ. As a result, it matters which party possesses the governance right in determining the net surplus from a financial arrangement.

• **Governance Control Decision**: The party with governance right will make the control decision γ to maximize his/her own payoff, anticipating the optimal financing contract $c(\gamma)$. The entrepreneur's control decision is thus given as follows:

$$\gamma_E = \begin{cases} \bar{\gamma}_1 & \text{if } \bar{x} - F \geq G(\bar{\gamma}_1), \\ 0 & \text{otherwise,} \end{cases} \tag{2}$$

for both types of financing contract. The investor's control decision is given by

$$\gamma_I = \begin{cases} 1 & \text{if } \bar{x} - F \geq G(1), \text{ under investor-contract} \\ 0 & \text{otherwise.} \end{cases} \tag{3}$$

Note that the entrepreneur's control decision (2) is equivalent to the governance control which maximizes the net surplus subject to investor being fully repaid, whereas the investor either overdoes or underdoes the governance control. This implies only financial arrangements with entrepreneur-control will be equilibrium.

• **Equilibrium Financial Arrangement**: From the above analysis, we conclude that the optimal governance control is $\gamma = \bar{\gamma}_1$, and the corresponding financing contract is $c_E = c_I = \left\{\frac{F}{\theta}\right\}$. Since both contracts yield the same surplus, we have an "irrelevance" result.

Proposition 1 *For a one-period project, both financial arrangements EE and EI are equilibrium financial arrangements.*

Governance control plays two roles: it increases finance capacity of the project so that it can be undertaken, and determines the division of surplus between entrepreneur and investor. For Pareto-efficiency, only the first role is relevant, and the entrepreneur-control is given proper incentives regardless of which party has the contracting right. It should be noted, however, that Proposition 1 is about the irrelevance of "ownership," but not about irrelevance of financial structure because the financing contract is identical in either equilibrium financial arrangement.

3 Equilibrium Financial Arrangement for Two-period Project

With two-period projects, there is another mechanism to cope with the expropriation risk, i.e., the liquidation threat. Since the entrepreneur expects to earn a positive surplus in Period 2, the threat of liquidation after Period 1 can prevent him from defaulting strategically. However, when this threat is actually carried out, a positive surplus of Period 2 will be lost. The equilibrium financial arrangements thus will be determined so as to optimize on the costs of governance control and liquidation.

We further note that the effectiveness of governance control and liquidation threat depends on whether the parties can behave opportunistically ex post. In particular, the governance control decision made and announced in Period 0 may be altered during Period 1, or the commitment not to renegotiate the financing contract in the face of impending liquidation may not be credible. These opportunistic behaviors tend to increase the expropriation risk of investor, and consequently will result in different equilibrium financial arrangements than when they are not present.

3.1 No Opportunism Risk

We first consider a situation where there is no risk of opportunistic behaviors. In this case, the original control decision and financing contract from Period 0 will remain in effect throughout the subsequent periods. We start by deriving the optimal financing contract $C = \{r, \beta_0, \beta_1, R_0, R_1\}$ when the governance control level is already fixed.

• **Financing Contract**: For a given project (θ, b) and a given γ, the *entrepreneur-contract* $C_E(\theta, \gamma)$ solves the following program to maximize his expected payoff:

$$\begin{array}{ll} \max\limits_{r,\beta_0,\beta_1,R_0,R_1} & (1-\theta)\beta_0\left[\theta(x-R_0)\right] + \theta\left\{x - r + \beta_1\left[\theta(x-R_1)\right]\right\} \\ \text{subject to} & r \leq x,\ R_0 \leq \gamma x,\ R_1 \leq \gamma x, \end{array} \tag{4}$$

$$x - r + \beta_1 \left[\theta(x - R_1)\right] \geq x + \beta_0 \left[\theta(x - R_0)\right], \tag{5}$$

$$-F + (1-\theta)\beta_0 \left[\theta R_0 - F\right] + \theta \left\{r + \beta_1 \left[\theta R_1 - F\right]\right\} \geq 0. \tag{6}$$

(4) is limited liability (LL) constraint for entrepreneur, (5) incentive compatibility (IC) constraint to prevent entrepreneur from *strategic default*, and (6) individual rationality (IR) constraint for investor.

Lemma 1 *Both IR and IC constraints are binding at optimum.*

Proof. First, if the IR constraint were not binding, the payments could be reduced without violating other constraints. Second, the IC constraint implies the first-period repayment is strictly less than x: $r < x$. This in turn implies that if the IC were not binding, then either β_0 or β_1 could be increased, or R_0 could be reduced, without violating other constraints. *Q.E.D.*

Now we can rewrite the program by substituting (6) into the objective function:

$$\max_{r,\beta_0,\beta_1,R_0,R_1} \quad \left[1 + (1-\theta)\beta_0 + \theta\beta_1\right](\bar{x} - F) \qquad \text{subject to} \quad (4), \text{ and}$$

$$r = \beta_1\theta(x - R_1) - \beta_0\theta(x - R_0), \tag{7}$$

$$-F + (1-\theta)\beta_0 \left[\theta R_0 - F\right] + \theta \left\{r + \beta_1 \left[\theta R_1 - F\right]\right\} = 0. \tag{8}$$

We observe that the entrepreneur contract can avoid liquidation and achieve the maximum surplus ($\beta_0 = \beta_1 = 1$) by setting $R_0 = R_1$ and $r = 0$, as long as the R_0 and R_1 are large enough to satisfy the IR constraint. This requires the governance control γ to be sufficiently high, according to LL constraint (4). If, however, that is not the case, then a positive repayment from Period 1 ($r > 0$) is also needed. This can be achieved by the use of liquidation threat after first-period default ($\beta_0 < 1$), as IC constraint (7) shows that the greater liquidation threat is (lower β_0), the larger repayment is induced (higher r).[7] On the other hand, liquidation after repayment ($\beta_1 < 1$) is *not* optimal since β_1 can be increased without violating any constraint.

Lemma 2 *An optimal entrepreneur-contract $C_E^*(\theta, \gamma)$ must satisfy:*

(i) $\beta_0 = \beta_1 = 1$ *for* $\gamma \geq \bar{\gamma}_2$ *and* $\frac{2F}{x} \leq \theta < 1$,

[7]The other way to induce a positive first-period repayment without using liquidation threat is to reduce the second-period repayment R_1. In this case, however, the investor's payoff remains the same, which implies that IR constraint is still violated.

(ii) $\beta_0 = \beta(\gamma)$, $\beta_1 = 1$ *for* $\gamma < \bar{\gamma}_2$ *and* $\hat{\theta} \leq \theta < 1$, *where* $\hat{\theta} \equiv \dfrac{F + \sqrt{F^2 + 4xF}}{2x}$, $\bar{\gamma}_2 \equiv \dfrac{2F}{\bar{x}}$, *and* $\beta(\gamma) = \dfrac{\theta(\bar{x} - F) - F}{\theta(\bar{x} - F) + F - \gamma\bar{x}}$,

(iii) *No entrepreneur-contract is feasible otherwise.*

Proof. See Appendix A.

The corresponding repayments in $C_E^*(\theta, \gamma)$ are as follows:[8]

$$\begin{cases} \beta_0 = 1: & r = 0,\ R_0 = R_1 = \dfrac{2F}{\theta}, \\ \beta_0 < 1: & r = [1 - \beta(\gamma)]\,(1 - \gamma)\bar{x},\ R_0 = R_1 = \gamma x. \end{cases} \tag{9}$$

The expected payoffs for investor and entrepreneur from the contract, $R(\theta, \gamma)$ and $\pi(\theta, \gamma)$ respectively, are given in Table 1. By convention, $R(\theta, \gamma) = \pi(\theta, \gamma) = 0$ if no financing contract is feasible.

The basic idea of the entrepreneur-contract is as follows. If the governance control can generate enough verifiable cash flows in Period 2, there is no need for liquidation threat, and the project is always refinanced—Case (i). Thus we will call $\bar{\gamma}_2$ the *requisite level* of governance control for C_E. If that is not the case, then liquidation is used so as to induce a positive repayment from Period 1, but it occurs only after default on repayment and just often enough to satisfy the investor's *IR* constraint—Case (ii). In this respect, governance control and liquidation threat are *substitutes* in protecting investor against expropriation risk. Note also that governance control has an additional benefit of allowing less profitable projects to get financed since $\hat{\theta} > 2F/x$.

On the other hand, the *investor-contract* $C_I(\theta, \gamma)$ solves the following program to maximize her expected payoff:

$$\begin{aligned} \max_{r, \beta_0, \beta_1, R_0, R_1} \quad & (1 - \theta)\beta_0\,[\theta R_0 - F] + \theta\,\{r + \beta_1\,[\theta R_1 - F]\} - F \\ \text{subject to} \quad & (4),\ (5),\ \text{and} \\ & (1 - \theta)\beta_0\,[\theta(x - R_0)] + \theta\,\{x - r + \beta_1\,[\theta(x - R_1)]\} \geq 0. \end{aligned} \tag{10}$$

Since *LL* and *IC* constraints together imply *IR* constraint (10) for entrepreneur will not be binding, it follows that *IC* constraint must be binding: $r = \beta_1(\bar{x} - \theta R_1) - \beta_0(\bar{x} - \theta R_0)$.

[8] In fact, the repayment schedule is not unique in this case. Any combination of r and R_1 will do such that $r = \bar{x} - \theta R_1 - \beta(\gamma)\theta(1 - \gamma)x$, $r \leq x$, and $R_1 \leq \gamma x$. The binding *IC* constraint (5) implies that the investor receives less in the second period if she wants to be paid more in the first period.

By substituting for r, we can rewrite the program:

$$\max_{r,\beta_0,\beta_1,R_0,R_1} \quad \beta_0\left[\theta R_0 - \theta\bar{x} - (1-\theta)F\right] + \beta_1\theta(\bar{x}-F) - F \qquad \text{subject to} \quad (4),(5).$$

It is clear that $\beta_1 = 1$ since $\bar{x} - F > 0$, but that $\beta_0 = 1$ if

$$\theta R_0 - \theta\bar{x} - (1-\theta)F = (1-\theta)(\theta R_0 - F) - \theta(\bar{x} - \theta R_0) \geq 0, \tag{11}$$

or $\beta_0 = 0$ otherwise. Unlike the entrepreneur-contract which tries to minimize the probability of liquidation, the investor-contract C_I liquidates the firm *with probability of* 1 after default on first-period repayment. To see why, note that, although the investor can expect to get $\theta R_0 - F$ (with probability $1-\theta$) by refinancing the project after default, she will have to reduce the first-period repayment by $\bar{x} - \theta R_0$ (with probability θ) to prevent the entrepreneur from strategic default. She will therefore agree to refinance only if the expected net gain from refinancing is positive.

Lemma 3 *An optimal investor-contract $C_I^*(\theta,\gamma)$ must satisfy:*

(i) $\beta_0 = \beta_1 = 1$ *for* $\gamma \geq \bar{\gamma}_2$ *and* $\frac{2F}{x} \leq \theta < \hat{\theta}$,

(ii) $\beta_0 = \beta_1 = 1$ *for* $\gamma \geq \bar{\gamma}_2'$ *and* $\hat{\theta} \leq \theta < 1$,

(iii) $\beta_0 = 0,\ \beta_1 = 1$ *for* $\gamma < \bar{\gamma}_2'$ *and* $\hat{\theta} \leq \theta < 1$, *where* $\bar{\gamma}_2' \equiv \dfrac{\theta(\bar{x}-F)+F}{\bar{x}}$,

(iv) *No investor-contract is feasible otherwise.*

Proof. See Appendix B.

The corresponding repayments in $C_I^*(\theta,\gamma)$ are as follows:

$$\begin{cases} \beta_0 = 1: & r = 0,\ R_0 = R_1 = \gamma x, \\ \beta_0 = 0: & r = (1-\gamma)\bar{x},\ R_0 = 0,\ R_1 = \gamma x. \end{cases} \tag{12}$$

The expected payoffs are given in Table 1.

C_E and C_I are similar in that they try to avoid liquidation by back-loading the repayment schedule, which is feasible only with a sufficiently high γ. Yet, they also highlight the conflicting interests over liquidation and governance control between investor and entrepreneur. First, C_I is not concerned about avoiding liquidation *per se* but rather about maximizing the investor's share of the surplus, as is shown in Condition (11), whereas C_E

	Entrepreneur-contract	Investor-contract
$R(\theta,\gamma) =$	0	$\begin{cases} \gamma\bar{x} - 2F & \text{if } \beta_0 = 1 \\ \theta(\bar{x}-F) - F & \text{if } \beta_0 = 0 \end{cases}$
$\pi(\theta,\gamma) =$	$\begin{cases} 2(\bar{x}-F) & \text{if } \beta_0 = 1 \\ [1+\theta+(1-\theta)\beta(\gamma)](\bar{x}-F) & \text{if } \beta_0 < 1 \end{cases}$	$\begin{cases} (2-\gamma)\bar{x} & \text{if } \beta_0 = 1 \\ \bar{x} & \text{if } \beta_0 = 0 \end{cases}$

Table 1: Payoffs from Equilibrium Financing Contract

is concerned about maximizing the total surplus by minimizing the probability of liquidation since the entrepreneur appropriates all the surplus. Second, the investor's payoff increases with γ under C_I, while the entrepreneur's payoff is constant under C_E once γ is above the requisite level. As a result of these conflicts, the requisite governance control for C_I can be higher than for C_E: $\bar{\gamma}_2' > \bar{\gamma}_2$ for $\hat{\theta} \leq \theta < 1$.

• **Governance Control Decision**: In any financial arrangement, the "governance" party will choose the level of governance control γ so as to maximize his/her expected net payoff, i.e., payoff from the ensuing financing contract $C(\theta,\gamma)$ minus cost of the governance control $b\gamma$.

Lemma 4 *Optimal governance control decisions are given as follows:*

	Entrepreneur-contract	Investor-contract
1. Investor-Governance		
(i) $\hat{\theta} \leq \theta < 1$:	$\gamma_{IE} = 0$	$\gamma_{II} = 1$ *if* $b \leq (1-\theta)(\bar{x}-F)$
(ii) $\frac{2F}{x} \leq \theta < \hat{\theta}$:	$\gamma_{IE} = 0$	$\gamma_{II} = 1$ *if* $b \leq \bar{x} - 2F$
2. Entrepreneur-Governance		
(iii) $\hat{\theta} \leq \theta < 1$:	$\gamma_{EE} = \bar{\gamma}_2$ *if* $b \leq b_1(\theta)$	$\gamma_{EI} = \bar{\gamma}_2'$ *if* $b \leq b_1(\theta)$
(iv) $\frac{2F}{x} \leq \theta < \hat{\theta}$:	$\gamma_{EE} = \bar{\gamma}_2$ *if* $b \leq b_2(\theta)$	$\gamma_{EI} = \bar{\gamma}_2$ *if* $b \leq b_2(\theta)$

where $b_1(\theta) = \dfrac{(1-\theta)\bar{x}(\bar{x}-F)}{\theta(\bar{x}-F)+F}$ *and* $b_2(\theta) = \dfrac{\bar{x}(\bar{x}-F)}{F}$. *Otherwise,* $\gamma_{..} = 0$.

Proof. See Appendix C.

The difference in control decisions made by entrepreneur and investor stems from their diverging interests over governance control, as mentioned above. The entrepreneur's payoff from a financing contract increases discreetly as γ reaches the requisite level, and then stays constant (under C_E) or decreases (under C_I) as γ becomes higher. Therefore, the control decision by entrepreneur will be either at the requisite level ($\bar{\gamma}_2$ or $\bar{\gamma}_2'$) or at 0, depending on the control cost b, which is "efficient" for the given financial arrangement in the sense that the governance control is never above the requisite level. On the other hand, the investor's payoff from a financing contract is either 0 under C_E or increasing in γ under C_I, which implies that the control decision by investor can be either "too low" at 0 or "too high" at 1. The following lemma makes this observation more precise, and will be useful for identifying equilibrium financial arrangements later.

Lemma 5 *For any project (θ, b), a financial arrangement with entrepreneur-control yields a (weakly) higher net surplus than one with investor-control: $V_{EE}(\theta, b) \geq V_{IE}(\theta, b)$ and $V_{EI}(\theta, b) \geq V_{II}(\theta, b)$.*

Proof. See Appendix D.

• **Equilibrium Financial Arrangement**: Now that we have characterized the optimal governance control decision and the optimal financing contract for each financial arrangement, we are set to derive the equilibrium. A financial arrangement is an equilibrium if there is no other arrangement that yields a strictly higher net surplus.

Proposition 2 Equilibrium financial arrangements *for a project (θ, b) are*

(i) *EE and IE with* $0 \leq \beta_0 < 1$ *if* $\hat{\theta} \leq \theta < 1$ *and* $b > b_1(\theta)$.

(ii) *EE with* $\beta_0 = 1$ *if* $\hat{\theta} \leq \theta < 1$ *and* $b \leq b_1(\theta)$.

(iii) *EE and EI with* $\beta_0 = 1$ *if* $\frac{2F}{x} \leq \theta < \hat{\theta}$ *and* $b \leq b_2(\theta)$.

Proof. Thanks to Lemma 5, we can first restrict our attention to the comparison of *EE* and *EI* to find equilibrium. For a project (θ, b) such that $\hat{\theta} \leq \theta < 1$, both arrangements will have $\beta_0 = 1$ if $b \leq b_1(\theta)$, or $\beta_0 < 1$ otherwise. However, in the first case of no liquidation, *EE* incurs a lower control cost since $\bar{\gamma}_2 < \bar{\gamma}_2'$, and in the second case of liquidation, *EE* has a strictly lower probability of liquidation since $\beta(0) > 0$ for $\hat{\theta} < \theta < 1$ (Lemma 4 (iii)). Therefore, *EE* is an equilibrium financial arrangement in Cases (i) and (ii). Note that *IE* is also an equilibrium in Case (i) with $\gamma_{IE} = 0$ since it achieves the same expected net surplus as *EE*.

For a project with $\frac{2F}{x} \leq \theta < \hat{\theta}$, both *EE* and *EI* yield the same net surplus since they induce the same level of governance control and probability of liquidation (Lemma 4 (iv)). *Q.E.D.*

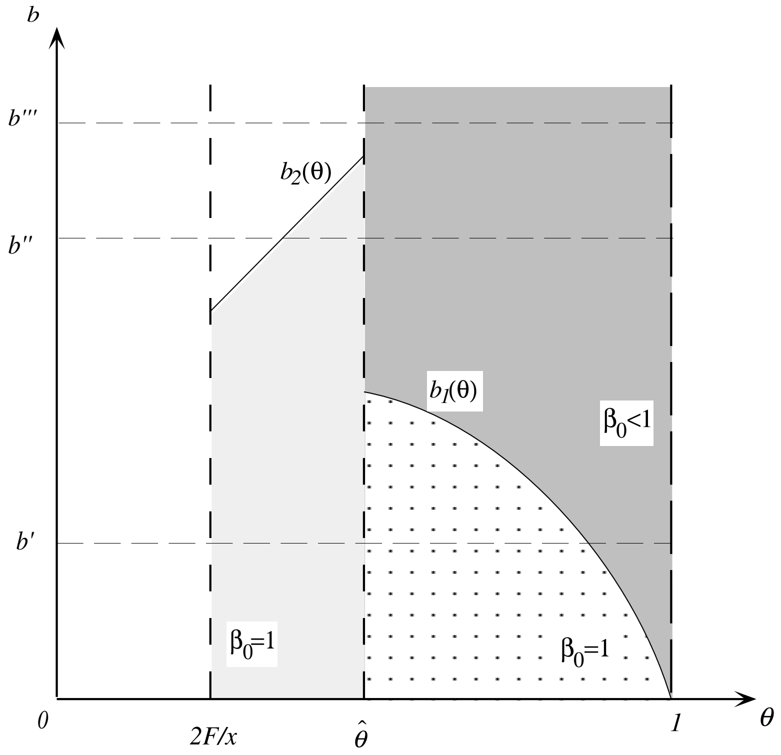

Figure 1: Equilibrium Financial Arrangements under no Opportunism Risk

Although there are other equilibrium arrangements which can finance *some* projects, *EE* is the only arrangement that can finance *any* project with $\frac{2F}{x} \leq \theta < 1$ in equilibrium. In this sense, the entrepreneur-governance/entrepreneur-contract arrangement alone is sufficient to provide investor with the necessary protection against expropriation risk, and we will subsequently call *EE the equilibrium financial arrangement* in the absence of opportunism risk. This is not surprising because the decision problem for the entrepreneur in *EE* is exactly the same as maximizing the expected net surplus, $[1 + \theta\beta_1 + (1 - \theta)\beta_0] (\bar{x} - F) - b\gamma$, subject to the *IR* and *IC* constraints.

Financial Structure of Firm Given the properties of the equilibrium financial arrangement *EE*, we now show that it can correspond to either debt or preferred stock, among the actual financial instruments observed in the market. The ownership of firm is usually associated with the residual income right and the residual control right. In the context of our model, the income right is equivalent to the "contracting right" which entitles the contracting party to verifiable income, while there is no ex post control right to be exercised. Therefore, we can interpret the equilibrium *EE* as firm being owned by entrepreneur and financed by outside investor. In particular, *EE* with $\beta_0 < 1$ corresponds to *debt* financing since liquidation occurs, but only after default on repayment —Case (i), and *EE* with $\beta_0 = 1$ to *non-voting equity* or *preferred stock* since the firm is not required to pay out in each period to avoid liquidation—Cases (ii) and (iii).

Note that debt financing is associated with no governance control ($\gamma = 0$), while preferred stock with the requisite level of governance control ($\gamma = \bar{\gamma}_2$). This bears out our earlier observation that liquidation threat and governance control are substitutes in protecting the investor's interests and that the less costly of the two will be chosen in equilibrium. Generally speaking, the more profitable a firm is (higher θ), the less costly is the liquidation threat because its probability of actually occurring $(1-\theta)(1-\beta_0)$ is lower. More specifically, we make the following observations about firms' financial structure:[9]

- When the control cost b is low enough, high-profit firms ($\theta_d < \theta < 1$), are financed by debt, while medium-profit firms ($\frac{2F}{x} \leq \theta \leq \theta_d$) by preferred stock. ($b'$ in Figure 1)
- When b is high, all firms with $\hat{\theta} < \theta < 1$ is financed by debt, while those with $\theta_p \leq \theta \leq \hat{\theta}$. ($b''$ in Figure 1)
- When b is very high, only firms with $\hat{\theta} \leq \theta < 1$ get financed, and by debt, (b''' in Figure 1)

where $\theta_d = b_1^{-1}(b)$ and $\theta_p = b_2^{-1}(b)$.

3.2 Equilibrium with Opportunism Risk

In the previous subsection, we have obtained a "unique" equilibrium financial arrangement that does not require any involvement of investor. Now we introduce an additional source of expropriation risk, i.e., that of opportunistic behaviors, and obtain equilibrium arrangements with investor-governance or investor-contract, which are commonly observed in the financial market. In particular, we consider two kinds of opportunistic behavior which are relevant to our model. First, the party with governance right may change the level of governance control during the first period, and second, the parties may not precommit

[9] They are based on the fact that b_2 is increasing in θ, b_1 is decreasing for θ close to 1, and $b_2(\frac{2F}{x}) > \max_{\hat{\theta} \leq \theta < 1} b_{1}(\theta)$. To be more precise, we need an additional assumption that $2F < x \leq 4F$, which is a sufficient condition for $b_1(\theta)$ decreasing in θ for $\hat{\theta} \leq \theta < 1$. ($b_1$ can be increasing near $\hat{\theta}$ in general.) Then the proof goes along the same line as in Corollary 1.

themselves not to renegotiate in the face of impending liquidation according to the original contract.

In this modified timing, the control party can modify his/her control decision during the first period *after* the financing has been signed and the project has been launched. At the end of the first period, the new level of governance control becomes observable and will determine the actual cost. Then the first-period repayment is made, and the parties can renegotiate over whether to refinance, based upon the payment and the governance control level. If they renegotiate, the new contract will be effective from then on; otherwise, the original contract will stay in effect.

Therefore, we will look for an *opportunism-proof (equilibrium) financial arrangement* in which

(i) the equilibrium financing contract is renegotiation-proof, and

(ii) the governance party has no incentive to alter his/her original control decision.

We start with *EE* which was the equilibrium arrangement in the absence of opportunism risk. First, *EE* with $\beta_0 = 1$ (non-voting equity) is not opportunism-proof. Recall from the previous section that a control level $\bar{\gamma}_1$ is sufficient to satisfy the investor's *IR* constraint in the second period alone. This implies the entrepreneur will have an incentive to *downgrade* the governance control to $\bar{\gamma}_1$ (from $\bar{\gamma}_2$) and still manage to renegotiate for refinancing even after a first-period default. Since the investor knows she will not be fully repaid with the lower level of governance control, she is not willing to invest in the project in the first place. Note that *EI* also suffers from the same kind of opportunistic behavior. Therefore, only financial arrangements with investor-governance can be an equilibrium in which no liquidation is required, $\beta_0 = 1$.

On the other hand, in the equilibrium *EE* with $\beta_0 < 1$ (debt), the entrepreneur may have an incentive to *upgrade* the governance control from 0 to $\bar{\gamma}_1$ if

$$[\bar{x} + (\bar{x} - F)] - b\bar{\gamma}_1 \geq [1 + \theta + (1 - \theta)\beta_0(0)]\,(\bar{x} - F).$$

The RHS is the payoff to the entrepreneur in equilibrium when he stays with $\gamma = 0$, while the LHS is the payoff from upgrading γ to $\bar{\gamma}_1$, defaulting on the repayment, and then being refinanced through renegotiation. In the latter case, the investor won't recover all of her investment expenditures. A simple safeguard against this kind of opportunistic behavior is to give the governance right to investor since she has no incentive to incur cost of governance control under the entrepreneur contract. Therefore, in the presence of opportunism risk, the *IE* is the equilibrium financial arrangement in which liquidation is required, $\beta_0 < 1$. The following proposition characterizes the equilibrium financial arrangement.

Proposition 3 Equilibrium financial arrangements *for a project* (θ, b) *under opportunism risk are*

(i) *IE with* $0 \leq \beta_0 < 1$ *if* $\hat{\theta} \leq \theta < 1$ *and* $b > \tilde{b}_1(\theta)$*.*

(ii) *II with* $\beta_0 = 1$ *if* $\hat{\theta} \leq \theta < 1$ *and* $b \leq \tilde{b}_1(\theta)$*.*

(iii) *II with* $\beta_0 = 1$ *if* $\frac{2F}{x} \leq \theta < \hat{\theta}$ *and* $b \leq \tilde{b}_2(\theta)$*,*

where $\tilde{b}_1(\theta) = \dfrac{2(1-\theta)F(\bar{x}-F)}{\theta(\bar{x}-F)+F}$ *and* $\tilde{b}_2(\theta) = \bar{x} - 2F$*.*

Proof. Since, in financial arrangements with entrepreneur-governance, the opportunistic behaviors render financing contracts infeasible, we can restrict our attention to those with investor-governance. For $\hat{\theta} \leq \theta < 1$, $\gamma_{IE} = 0$ and $\beta_0 = \beta(0)$ for any b in *IE*, whereas $\gamma_{II} = \beta_0 = 1$ if $b \leq (1-\theta)(\bar{x}-F)$, or $\gamma_{II} = \beta_0 = 0$ otherwise, in *II* (Lemma 4 (i)). Therefore, *II* will be an equilibrium if $b \leq (1-\theta)(\bar{x}-F)$ *and*

$$V_{II}^{O}(\theta, b) = 2(\bar{x}-F) - b \geq [1 + \theta + (1-\theta)\beta(0)]\,(\bar{x}-F) = V_{IE}^{O}(\theta, b),$$

or equivalently, if $b \leq (1-\theta)(1-\beta(0))(\bar{x}-F) = \tilde{b}_1(\theta)$. Otherwise, *IE* is an equilibrium

For $\frac{2F}{x} \leq \theta < \hat{\theta}$, no contract is feasible with $\gamma < \bar{\gamma}_2$, and therefore only *II* can be equilibrium if the investor chooses $\gamma_{II} = 1$, i.e., $\bar{x} - 2F - b \geq 0$. *Q.E.D.*

Essentially, in response to increased expropriation risk due to opportunistic behaviors, investor is provided with further protection through governance right and even contracting right. For "debt" financing where no governance control is optimal, investor with the governance right makes the correct control decision $\gamma = 0$ and can expect to be repaid. For financial arrangements in which no liquidation occurs, however, the governance control has to be at the requisite level or above. The entrepreneur's opportunism implies that it is only the investor who can credibly commit to that level of governance control. Since she must be given the proper incentive to do so through a positive surplus from the financing contract, the investor retains *both* governance and contracting rights. Therefore, we can interpret the equilibrium financial arrangement *II* as firm being owned by investor and financed by *(voting) equity*. Note that the equity-financed firm is associated with the requisite governance control higher than that of a firm financed by preferred stock, $\gamma_{II} = 1 > \bar{\gamma}_2$.

Given the above characterization of equilibrium, it is straightforward to describe the financial structure of firm.

Corollary 1 *The more profitable (higher θ) a firm is, the more likely it is to be financed by debt, instead of equity. The higher control cost b is, the more firms are financed by debt.*

Proof. See Appendix E.

As in the previous subsection of no opportunism risk, it is the trade-off between costs of liquidation and governance control that determines the equilibrium. A highly profitable firm is more willing to incur the cost of liquidation, thereby saving the cost of governance control because the liquidation will occur with a very low probability, whereas a moderately profitable firm is more willing to incur the cost of governance control to avoid liquidation as long as b is not too high.

It is interesting to note the analogy between the way how the three different equilibrium financial arrangements obtain in our model, and the *pecking-order* theory of governance structures and the corresponding financial contracts in Aghion and Bolton (1992). As in their model, the entrepreneur-governance/entrepreneur-contract *EE* is the most efficient if it is feasible. If, however, *EE* cannot provide sufficient protection for the investor's interests due to opportunism risk, then the governance right should be given to her when the firm is sufficiently profitable. When the firm is only moderately profitable, even the contracting right should be given to the investor. But the difference should be also noted. In their model, it is the conflicting interests over the ex post choice of a non-contractible action which determines the monetary return of the project that induces the pecking order over allocation of control rights. In our model, it is the pure expropriation risk due to opportunistic behaviors that induces a different allocation of control and contracting rights.

IPO and MBO Our model can also provide an explanation for two important market transactions involving a change in ownership and financial structure: *initial public offering* (IPO) and *management buy-out* (MBO). Since the equilibrium financial arrangement depends on the firm's profitability, the control cost, and the existence of opportunism risk, a change in these factors can induce both entrepreneur and investor to bargain for a new financial arrangement. A change in equilibrium from the entrepreneur-contract, *EE* or *IE* to the investor-contract *II* can be interpreted as an *IPO*, that is, entrepreneur-cum-owner selling the firm to outside investors. This can happen when the governance control cost falls, the firm becomes less profitable, or the risk of opportunism becomes more severe. A change in the other direction, from *II* to *IE* for example, can be implemented by an *MBO*, i.e., entrepreneur-cum-manager buying out the inside investors. In our model, the wealth-constrained entrepreneur may have to borrow from another source to buy out the investor, which is often the case as with *leveraged MBO*.

Finally, we note that the opportunism risk not only changes the equilibrium financial arrangement, but also results in an additional loss of social surplus. Although this result is not surprising, it is useful to see how the additional cost comes about.

Proposition 4 *For a given project, the equilibrium net surplus with opportunism risk (OR) can never be higher than that without opportunism risk (NO). In particular, it is strictly lower, except for the case where the project would be financed by debt, EE with* $\beta_0 = \beta(0)$*, regardless of opportunism risk.*

Proof. Since $b_1(\theta) > \tilde{b}_1(\theta)$ and $b_2(\theta) > \tilde{b}_2(\theta)$, we must consider four distinct cases of equilibrium for a given project (θ, b):

(i) *IE* under *OR* and *EE* under *NO*, both with $\beta_0 = \beta(0)$: $V_{IE}^{O} = V_{EE}$ since the governance control and the financing contract are identical.

(ii) *IE* with $\beta_0 = \beta(0)$ under *OR* but *EE* with $\beta_0 = 1$ under *NO*: $V_{IE}^{O} < V_{EE}$ since the cost of liquidation under *OR* is larger than the governance control cost under *NO* (Lemma 5).

(iii) *II* under *OR* and *EE* under *NO*, both with $\beta_0 = 1$: $V_{IE}^{O} < V_{EE}$ since the governance control cost is higher under *OR*, $\bar{\gamma}_2 < 1$.

(iv) No contract under *OR* but *EE* with $\beta_0 = 1$ under *NO*: $V_{IE}^{O} = 0 < V_{EE}$, obviously. *Q.E.D.*

Intuitively, "more rights to investor" in response to opportunism risk implies more extensive use of the two safeguard mechanisms against expropriation, in terms of actual financial arrangement. As a result, more firms are financed by debt, incurring higher liquidation cost, or firms financed by equity employ a higher level of governance control.

4 Conclusion

In this paper, we have presented a model of financial contracting based upon the ex ante bargaining between entrepreneur and investor over governance control and verifiable income. The financial structure and governance control of firm are determined in the equilibrium financial arrangement by the trade-off between the costs of liquidation and governance control, which are the two mechanisms to protect the investor's interest against expropriation risk due to nonverifiability of cash flow and opportunistic behaviors.

In the absence of risk of opportunistic behaviors, the financial arrangement with entrepreneur's governance control and contract is sufficient to protect the investor's interests. In other words, he can credibly set the level of governance control and design the financial structure so as to maximize the net surplus and ensure that the investor is properly compensated. In this case, the firm will be financed either by debt or by non-voting equity, depending on its profitability and control cost.

When there is the risk of opportunism, however, it becomes necessary that investor be given more control over the financial arrangement. The firm will be financed either by debt with the investor retaining governance right, or by equity with her retaining both governance and contracting rights. That an increase in expropriation risk leads to a financial arrangement with "more investor rights" is consistent with the "pecking order" of governance and financial structure in Aghion and Bolton (1992). Also, in equilibrium, a highly (moderately) profitable firm is associated with a minimal (high) level of governance control. Diamond (1991b) shows a similar result that a highly rated firm will choose a directly placed debt, e.g. commercial paper, with little monitoring from investors, while a moderately rated firm will choose a bank loan with an extensive monitoring.

In our model, the entrepreneur is not engaged in any activities which can change the project's profitability such as exerting efforts to increase the productivity of the assets employed or pursuing a different business strategy. An interesting extension would be to endogenize θ by having the entrepreneur compete against another entrepreneur in the product market so that the equilibrium financial arrangement and the equilibrium in the product market will be determined simultaneously. This would be a different approach to the interaction between product market and financial market from Fershtman and Judd (1987), Brander and Lewis (1986), and Bolton and Scharfstein (1990) where the financial contract or the compensation contract are signed first so that they can serve strategic purposes.

APPENDIX

A Proof of Lemma 2

We rewrite the equivalent program for reference:

$$\begin{aligned}
\max_{r,\beta_0,\beta_1,R_0,R_1} \quad & [1+(1-\theta)\beta_0+\theta\beta_1](\bar{x}-F) \\
\text{subject to} \quad & r \le x,\ R_0 \le \gamma x,\ R_1 \le \gamma x, && \text{(A1)}\\
& r = \beta_1\theta(x-R_1) - \beta_0\theta(x-R_0) && \text{(A2)}\\
& -F+(1-\theta)\beta_0[\theta R_0 - F] + \theta\{r+\beta_1[\theta R_1 - F]\} = 0 && \text{(A3)}
\end{aligned}$$

First, we consider a solution with $\beta_0 = \beta_1 = 1$. In this case, (A2) and (A3) can be rewritten, respectively, as follows:

$$r - \theta R_0 + \theta R_1 = 0,$$
$$\theta R_0 + \theta(r - \theta R_0 + \theta R_1) - 2F = 0,$$

which together imply that $\theta R_0 = 2F$. Then, from the LL constraint, we get $\theta\gamma x \ge 2F$, or equivalently,

$$\gamma \ge \frac{2F}{\theta x}\ (\equiv \bar{\gamma}_2),$$

and since γ must be less than 1 for this solution to be feasible, we get $\theta \ge \dfrac{2F}{x}$. This proves case (i).

Next, suppose $\gamma < \bar{\gamma}_2$. In this case, there will be liquidation after first-period default, $\beta_0 < 0$. Setting $\beta_1 = 1$ and solving (A2) and (A3) for β_0, we get

$$\beta_0 = \frac{\theta(\bar{x}-F)-F}{\theta(\bar{x}-F)+F-\theta R_1}.$$

Since the entrepreneur prefers a higher β_0, R_1 will be set as large as possible: $R_1 = \gamma x$, which yields

$$\beta(\gamma) = \frac{\theta(\bar{x}-F)-F}{\theta(\bar{x}-F)+F-\gamma\bar{x}}.$$

It is easy to check that $\beta(\gamma) \le 1$ for $\gamma < \bar{\gamma}_2$, while $\beta(\gamma) \ge 0$ if

$$\theta \ge \frac{F+\sqrt{F^2+4xF}}{2x}\ (\equiv \hat{\theta}).$$

For any other values of θ and γ, no contract will be accepted by the investor since she will not be fully repaid.

Q.E.D.

B Proof of Lemma 3

First, since $R_0 \leq \gamma x$, the condition (11) will be satisfied if and only if $\theta\gamma x \geq \theta\bar{x} + (1-\theta)F \;\Leftrightarrow\; \gamma \geq \bar{\gamma}_2'$. Furthermore, in the case of $\beta_0 = \beta_1 = 1$, the investor's expected payoff is $R(\theta,\gamma) = \gamma\bar{x} - 2F$, which is positive if $\gamma \geq \bar{\gamma}_2$. By noting that $\bar{\gamma}_2 > (<)\, \bar{\gamma}_2'$ if $\theta < (>)\, \hat{\theta}$, and $\bar{\gamma}_2 = \bar{\gamma}_2'$ at $\theta = \hat{\theta}$, we get Cases (i) and (ii). Finally, if $\gamma < \bar{\gamma}_2'$, then $\beta_0 = 0$ and the investor's payoff if $R(\theta,\gamma) = \theta(\bar{x} - F) - F$, which is positive if $\theta \geq \hat{\theta}$.

Q.E.D.

C Proof of Lemma 4

(i) & (ii) investor-governance: Since the investor earns no surplus under entrepreneur contract, she has no incentive to incur the cost of governance control. Under investor contract, her payoff is linear in γ for $\gamma \geq \bar{\gamma}_2'$ ($\beta_0 = 1$). Therefore, she will choose $\gamma = 1$ if doing so gives her higher payoff than what she would have got without any governance control ($\beta_0 = 0$): $\bar{x} - 2F - b \geq \theta(\bar{x} - F) - F$ for $\hat{\theta} \leq \theta < 1$, or $\bar{x} - 2F - b \geq 0$ for $\frac{2F}{x} \leq \theta < \hat{\theta}$.

(iii) entrepreneur-governance ($\hat{\theta} \leq \theta < 1$): Under entrepreneur contract, entrepreneur's payoff is given by

$$\pi(\gamma) - b\gamma = \begin{cases} 2(\bar{x} - F) - b\gamma & \text{for } \gamma \geq \bar{\gamma}_2, \\ [1+\theta+(1-\theta)\beta(\gamma)]\,(\bar{x}-F) - b\gamma & \text{for } \gamma < \bar{\gamma}_2. \end{cases}$$

Note that $\beta(\gamma)$ is convex in γ and $\beta(\bar{\gamma}_2) = 1$. Therefore, he will choose $\gamma = \bar{\gamma}_2$ if $2(\bar{x} - F) - b\bar{\gamma}_2 \geq [1+\theta+(1-\theta)\beta(0)]\,(\bar{x}-F)$, i.e.,

$$b \leq \frac{(1-\theta)\bar{x}(\bar{x} - F)}{\theta(\bar{x} - F) + F} \; (\equiv b_1(\theta)),$$

or 0 otherwise.

On the other hand, his payoff under investor contract is given by

$$\pi(\gamma) - b\gamma = \begin{cases} (2-\gamma)\bar{x} - b\gamma & \text{for } \gamma \geq \bar{\gamma}_2', \\ \bar{x} - b\gamma & \text{for } \gamma < \bar{\gamma}_2'. \end{cases}$$

He will choose $\gamma = \bar{\gamma}_2'$ if $(2-\bar{\gamma}_2')\bar{x} - b\bar{\gamma}_2' \geq \bar{x}$, i.e., $b \leq b_1(\theta)$, or 0 otherwise.

(iv) entrepreneur-governance ($\frac{2F}{x} \leq \theta < \hat{\theta}$): Under entrepreneur contract, his payoff is given by

$$\pi(\gamma) - b\gamma = \begin{cases} 2(\bar{x}-F) - b\gamma & \text{for } \gamma \geq \bar{\gamma}_2, \\ 0 & \text{for } \gamma < \bar{\gamma}_2. \end{cases}$$

Therefore, he will choose $\gamma = \bar{\gamma}_2$ if $2(\bar{x}-F) - b\bar{\gamma}_2 \geq 0$, i.e.,

$$b \leq \frac{\bar{x}(\bar{x}-F)}{F} \ (\equiv b_2(\theta)),$$

or 0 otherwise.

Under investor contract, the entrepreneur's payoff is given by

$$\pi(\gamma) - b\gamma = \begin{cases} (2-\gamma)\bar{x} - b\gamma & \text{for } \gamma \geq \bar{\gamma}_2, \\ 0 & \text{for } \gamma < \bar{\gamma}_2. \end{cases}$$

He will choose $\gamma = \bar{\gamma}_2$ if $(2-\bar{\gamma}_2)\bar{x} - b\bar{\gamma}_2 > 0$, i.e., $b \leq b_2(\theta)$, or 0 otherwise.

Q.E.D.

D Proof of Lemma 5

First, note from the previous lemmas that, under entrepreneur-contract, the investor gets no surplus, and the entrepreneur all the surplus, from the financing contract. Therefore, the investor-governance always sets $\gamma_{IE} = 0$ while the entrepreneur-governance sets $\gamma_{EE} = \bar{\gamma}_2$ and avoids liquidation *if and only if* it increases the net surplus:

$$V_{EE}(\theta, b) = \max_{\gamma} \ \pi(\theta,\gamma) - b\gamma \geq \pi(\theta, 0) = V_{IE}(\theta, b).$$

Next, consider financial arrangements with investor-contract, under which β_0 is either 1 or 0. Note from Lemma 4 that $b_1(\theta) > (1-\theta)(\bar{x}-F)$ for $\hat{\theta} \leq \theta < 1$ and $b_2(\theta) > \bar{x} - 2F$ for $\frac{2F}{x} \leq \theta < \hat{\theta}$, and therefore that *EI* has $\beta_0 = 1$ whenever *II* does, but at a lower control cost (since $\bar{\gamma}_2, \bar{\gamma}_2' < 1$). Furthermore, when the entrepreneur-governance sets $\gamma_{EI} > 0$, it indeed increases the net surplus. Formally, for $\hat{\theta} \leq \theta < 1$

$$\begin{aligned} V_{EI} &= 2(\bar{x}-F) - b\bar{\gamma}_2' > 2(\bar{x}-F) - b = V_{II} && \text{if } b \leq (1-\theta)(\bar{x}-F), \\ V_{EI} &= 2(\bar{x}-F) - b\bar{\gamma}_2' \geq (1+\theta)(\bar{x}-F) = V_{II} && \text{if } (1-\theta)(\bar{x}-F) < b \leq b_1(\theta), \\ V_{EI} &= (1+\theta)(\bar{x}-F) = V_{II} && \text{if } b > b_1(\theta), \end{aligned}$$

and for $\frac{2F}{x} \leq \theta < \hat{\theta}$

$$\begin{array}{ll} V_{eis} = 2(\bar{x}-F) - b\bar{\gamma}_2 > 2(\bar{x}-F) - b = V_{II} & \text{if } b \leq \bar{x} - 2F, \\ V_{EI} = 2(\bar{x}-F) - b\bar{\gamma}_2 \geq 0 = V_{II} & \text{if } \bar{x} - 2F < b \leq b_2(\theta), \\ V_{EI} = 0 = V_{II} & \text{if } b > b_2(\theta). \end{array}$$

Q.E.D.

E Proof of Corollary 1

We first note that $\tilde{b}_2(\theta)$ is increasing in θ for $\frac{2F}{x} \leq \theta < \hat{\theta}$, $\tilde{b}_1(\theta)$ is decreasing for $\hat{\theta} \leq \theta < 1$, and $\tilde{b}_1(\hat{\theta}) = \tilde{b}_2(\hat{\theta}) = \frac{1-\hat{\theta}}{\hat{\theta}}F$ since, by definition, $\hat{\theta}(\hat{\theta}x - F) - F = 0$. Let $\theta_e = \tilde{b}_2^{-1}$ for $\frac{2F}{x} \leq \theta < \hat{\theta}$ and $\theta_d = \tilde{b}_1^{-1}$ for $\hat{\theta} \leq \theta < 1$.

Then, for $b \leq \frac{1-\hat{\theta}}{\hat{\theta}}F$, we can define $\Theta_e(b)$ and $\Theta_d(b)$ such that

$$\Theta_e(b) = [\theta_e(b), \theta_d(b)] \text{ and } \Theta_d(b) = (\theta_d(b), 1),$$

and Proposition 3 implies that a project (θ, b) is financed by equity if $\theta \in \Theta_e(b)$, or by debt if $\theta \in \Theta_d(b)$. Furthermore, $\Theta_e(b) \supset \Theta_e(b')$ and $\Theta_d(b) \subset \Theta_d(b')$ for $b < b'$, since θ_e is increasing in θ and θ_d is decreasing.

For $b > \frac{1-\hat{\theta}}{\hat{\theta}}F$, $\Theta_e(b)$ is empty and $\Theta_d(b) = \left[\hat{\theta}, 1\right)$, i.e., a project can be financed only by debt when the cost of governance control is sufficiently high.

Q.E.D.

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