Banks versus Venture Capital When the Venture Capitalist Values Private Benefits of Control*

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Abstract

If control of their firms allows entrepreneurs to derive private benefits, it also allows other controlling parties. Private benefits are especially relevant for venture capitalists, who typically get considerable control in their portfolio firms, but not for banks, which are passive loan providers. We incorporate this difference between banks and venture capital and analyze entrepreneurs' financing strategy between the two. We find that, in all strict Nash Equilibria, entrepreneurs who value private benefits more choose banks while the rest choose venture capital. Thus, bank-financed entrepreneurs allocate more resources to tasks that yield private benefits while VC-backed entrepreneurs have higher profitability.

Keywords: bank, control, entrepreneurship, private benefit, venture capital

JEL Classification: G21, G24, G32, L26, M13

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1 Introduction

In the standard incomplete financial contracting models or models of capital structure and control (such as Aghion and Bolton (1992), Grossman and Hart (1988), Harris and Raviv (1988), and Holmstrom and Tirole (1989)), entrepreneurs derive private benefits because of their control in their firm but *all* outside financiers are assumed to care only about contractible returns. This approach is a good approximation when entrepreneurs raise funds from one type of financier. However, when it comes to analyzing the entrepreneurs' financing strategy between active and passive sources of finance, the possibility that one type of financial intermediary has access to returns that are noncontractible to the other changes the nature of financing decisions.

Our contribution in this paper begins by noting that if control allows an entrepreneur to enjoy private benefits, it also allows other controlling parties in the firm to enjoy them, especially active financial intermediaries. This hypothesis is particularly relevant for VCs.[1] Because VCs take significant control in their portfolio firms, they may have access to private benefits to the extent of their control. Yet, private benefits are noncontractible to banks because as passive loan providers they do not have any control in the firm. We incorporate this difference between banks and VC to a model of start-up financing and analyze entrepreneurs financing strategy between the two. We find that, when banks and VC coexist in an economy, in all strict Nash Equilibria, entrepreneurs who value private benefits of control more choose banks while the rest choose VC. Thus, bank-financed entrepreneurs allocate more resources to tasks that yield private benefits while VC-backed entrepreneurs have higher profitability.

A VC's role in the portfolio firm clearly goes beyond the simple provision of finance. Typical contracts allocate considerable control of the firm to the VCs. As equity providers, they usually have seats in the board of directors. They have rights to use firm property and be actively involved in management. They participate in forming the organizational structure and establishing firm's strategies. They help finding customers, business consultants, lawyers, suppliers, and even further financing. The contracts also give them the right to be involved in employing or firing key managers and other personnel. Some contracts may even give them the rights to replace the founding entrepreneur with an outside manager.[2]

There are certain facts that imply VCs' concern about private benefits, which are not

[1] Hereafter, we use VC for both venture capital and venture capitalist.

[2] See Bottazzi, Da Rin, and Hellmann (2008), Gompers and Lerner (2000), Gorman and Sahlman (1989), Hellmann and Puri (2002), Kaplan and Stromberg (2003), Lerner (1995), and Sahlman (1990) for evidence on all of these.

necessarily monetary.[3] VCs usually care about not only the current deal with a portfolio firm but also the effect of this deal on their reputation in fund-raising and attracting promising projects (Gompers (1996)). They may prescribe investment strategies to hedge the risk in their own portfolio rather than to maximize returns from a firm. Many of them, especially corporate-VCs, have multiple goals. Profit is definitely the major goal but they may also have strategic goals. For example, Intel wants to promote technologies that use computing power; university-VCs care about academic prestige of technological advancements from their schools; government-VCs are concerned with innovation and employment (Brander, Egan, and Hellmann (2009)); bank-VCs care about future loan clients (Hellmann, Lindsey, and Puri (2009)). VCs may also use the information that they have about a portfolio firm to help it engage in strategic alliances with other firms in their portfolio (Lindsey (2008)). Some may care about sitting in the board of directors of many firms, which they may view as prestigious positions for their career or as a source of individual power that may yield private benefits. As well-connected individuals in specific industries and controlling board members in their portfolio firms, they may influence decisions so that firms purchase services and inputs, employ managers and other employees, from their network.

To understand the implications of the difference between "hands-on" contracting with VCs and "hands-off" contracting with banks, we consider entrepreneurs who are seeking finance for their start-up projects. Projects yield not only *contractible returns* that are observable and verifiable before a court but also *noncontractible returns* that are nontransferable and nonverifiable. For the ease of explication, we use *monetary returns* for contractible returns and *nonmonetary returns* for noncontractible returns, even though noncontractible returns can also be monetary such as resources secretly diverted from the firm (see, for example, Hart (1995, p. 101-106)). Nonmonetary returns accrue only to those who have control in the firm. Therefore, banks are not concerned with them. The VC attaches certain value to them, whose degree is common knowledge, but entrepreneurs differ in their privately-known concern about them.

Loan contracts with a bank take the simple debt form under asymmetric information. When an entrepreneur chooses bank-financing, he hires a manager as an agent and operates his project as the sole principal. Contracting with the manager involves moral hazard as his effort is not observable. Depending on his own valuation of nonmonetary returns, the

[3]Even though, private benefits are one of the building blocks of finance theory, the literature has been weak in defining and measuring them. This is mostly because they are not easy to observe, not because there is lack of interest in the topic. If they were observable, they would not be "private." Despite the difficulties, Dyck and Zingales (2004) managed to quantify them by using some indirect techniques. They find that the value of control is on average 14% of the equity value of a firm, and it can be as high as 65%.

entrepreneur offers an employment contract to the manager such that the manager optimally allocates his effort between two tasks: the task that yields the monetary returns and the task that yields the nonmonetary returns, both of which use up resources.

Contracting with the VC is more involved. If the entrepreneur chooses VC-financing, he first offers a fixed compensation along with an ownership share to the VC. If the VC accepts this offer, she effectively becomes a co-principal in the project with bargaining power (in the subsequent decisions) given by her ownership share. Thus, she becomes a controlling party in the firm who may have different preferences than the entrepreneur, which is captured in the model by her valuation of nonmonetary returns. To come to an agreement on how to have the firm managed by the manager, as co-principals, the VC and the entrepreneur bargain over how much weight to attach to nonmonetary returns in designing the optimal employment contract offer to the manager.

We first show that the VC contract may take three forms. Consider an entrepreneur who value nonmonetary returns more than the VC. If his project yields monetary returns that are sufficient to pay off the VC, the contract takes the simple *debt form* in which he surrender no ownership of the firm, but if not, the contract takes the *equity form* in which he provides some ownership share and fixed compensation to the VC in exchange for the start-up capital.[4] Thus, equity provision is in general attributable to *ex post* wealth constraints of entrepreneurs. When an entrepreneur gives an ownership share to the VC, he does so voluntarily, and this automatically gives the VC some control in the firm to the extent of her ownership share in the firm (or even higher in practice).[5] However, when the VC values nonmonetary returns more than the entrepreneur, it is optimal for the entrepreneur to sell the firm to the VC regardless of the level of monetary returns. In such cases, the contract is more like an existing company's *acquisition* of the start-up.

We then identify the two Nash Equilibria of the model when both banks and the VC are operative in the market, one of which is strict and the other is not. The strict Nash Equilibrium is always monotone, which means that entrepreneurs who value nonmonetary returns more always raise funds from banks while the rest choose the VC. Hence, in equilibrium, bank-financed entrepreneurs divert more resources to tasks that yield nonmonetary returns while VC-backed firms have higher internal rate of return.[6] The other equilibrium is not nec-

[4]The VC in our model does not have any managerial input to the firm. If there were this additional benefit for VC-financing, equity form would be even easier to obtain as an optimal contract.

[5]In many circumstances, VCs' control power is much higher than the size of their ownership share. This would make our results stronger.

[6]This result is in line with the conjecture that Hellmann (1998, p. 71) puts forward: "[O]nly those [entrepreneurs] willing to yield control rights choose venture capitalists, while the others seek financing with private investors or other more passive sources of funds."

essarily monotone. In this equilibrium, those who value nonmonetary returns more choose bank-financing, those who value them less choose VC-financing, but there is also a mass of entrepreneurs in between these two who are indifferent between bank- and VC-financing. This third group in principle can choose between bank- and VC-financing in anyway as long as the loan market clears. Nonetheless, this equilibrium is obviously not a strict Nash Equilibrium. Finally, there can also be another Nash Equilibrium in which there are only banks offering finance in the market. We show that all these three equilibria may coexist.

There are many papers focusing on the contracting between entrepreneurs and VCs and even more on the contracting between entrepreneurs and banks. However, we know of only four papers which get to the grips with modeling the entrepreneurs choice between raising funds from a bank or a VC: de Bettignies and Brander (2007), Landier (2003), Ueda (2004), and Winton and Yerramilli (2008), which we discuss in detail below. No paper we know of focuses on the importance of the value that a VC (or any other outside financiers in general) may put on private benefits.

In Ueda (2004), bank-financing takes place in the presence of incomplete information on behalf of the bank, which asks for collateral to screen. VCs have better ability to evaluate projects and thus VC contracting is not subject to asymmetric information. But, the VC is able to undertake the project by herself if the negotiation between the parties breaks apart. As a result of this expropriation possibility, a tighter intellectual property protection makes VC-financing attractive. Moreover, entrepreneurs with little collateral finance from VCs. Then, if there is perfect intellectual property protection or if entrepreneurs do not have sufficient collateral to provide, there will be no bank-financing. She also finds that entrepreneurs who raise funds from VCs have higher returns, in line with empirical observations.

Landier (2003) tries to explain the differences in forms of start-up financing across sectors, regions, or countries. In his model, failed entrepreneurs are stigmatized whose degree can be different in different sectors, regions, or countries. In a high stigma regime, entrepreneurs choose risky projects because their outside options are bad. Then, VCs finance start-ups since they can closely monitor entrepreneurs in this high risk environment. In a low stigma regime, however, the outside options of entrepreneurs are better which lead them to choose safe projects. Consequently, in this safer regime, banks finance start-ups with debt contracts which require little monitoring.

Winton and Yerramilli (2008) provide an explanation for why banks use debt contracts with little or no monitoring whereas VCs prefer convertibles with strong monitoring and exercise of control. They incorporate the differences in the risk and returns of firms' cash flows to explain the relative use of VC and bank loans. They find that entrepreneurs with higher chances of good outcomes use less informationally intensive methods of finance such as bank loans instead of more informationally intensive methods such as VC-financing. VC-financing is attractive only when the entrepreneur's returns are highly risky and skewed, with good outcomes being unlikely.

Finally, de Bettignies and Brander (2007) combined the entrepreneur's financing choice problem with the double moral hazard problem between the entrepreneur and the VC. Because they jointly provide costly effort in the firm but do not fully benefit from the return on effort as they only own a share of the firm, one important issue in VC contracting is the presence of double moral hazard problem.[7] In de Bettignies and Brander (2007), bank-financing involves debt financing which does not distort entrepreneur's incentives to provide effort in his firm that he wholly owns. However, if he raises funds from a VC, his incentives deteriorate because he surrenders an ownership share of his firm. In exchange, he gets VC's managerial input. They find that VC-financing is superior only when the entrepreneur highly regards the VC's managerial input or when his own effort is not too important in the firm.

The paper is organized as follows. Section 2 outlines the model. Section 3 derives the return expressions that are frequently used in the paper. Section 4 examines a bank-only financial system. Section 5 describes the details of contracting with the VC. Section 6 analyzes the entrepreneurs' choice between bank- and VC-financing and Section 7 concludes. An appendix contains the proofs.

2 The Model

We consider a unit mass of risk-neutral and penniless entrepreneurs (indexed by E). Each entrepreneur is endowed with a start-up project that requires K units of start-up capital and a manager. Start-up projects yield not only *contractible returns* that are observable and verifiable but also *noncontractible returns* that are nontransferable and nonverifiable. As explained in the introduction, for the ease of explication, we use *monetary returns* for contractible returns and *nonmonetary returns* for noncontractible returns, even though noncontractible returns can also be monetary. As usual, we assume that entrepreneurs are concerned with both monetary and nonmonetary returns from their start-up projects and

[7] Cassamatta (2003), for example, points to double moral hazard problem in explaining why VCs are sources of both managerial advice and finance rather than specializing only in financing while managerial advice is provided by consultants independently. Inderst and Muller (2004) explore the double moral hazard problem in a search model and explain short- and long-run dynamics of the VC industry.

that both types of returns use up start-up capital.

Because entrepreneurs are penniless, they have to raise funds from outside financiers. There are two different sources of finance in this economy. The first are risk-neutral banks which provide loans in a competitive market. They are concerned only with monetary returns from a project. If an entrepreneur gets bank-financing and if his firm generates enough monetary returns, he pays back $(1 + r)K$ at the end of the period, where r is the endogenously-determined lending interest rate. If his firm generates insufficient monetary returns to pay back the loan, then the bank seizes all monetary returns available in the firm. Therefore, there is limited liability in bank-financing.

The second source of finance is a risk-neutral VC (indexed by VC) who provides equity-like finance in exchange for a fixed compensation R, an ownership share $1 - \rho$ of the start-up (where $\rho \in [0, 1]$ is the share remaining to the entrepreneur), and certain control rights. Both R and ρ are also endogenously determined and there is limited liability in VC-financing, too.

The specification of the start-ups' production technology is based on the standard multiple-task moral hazard model of Holmstrom and Milgrom (1991). There are two tasks in our model, and if undertaken, the project yields two-dimensional, state-contingent, observable, and verifiable returns drawn from a normal distribution whose variance-covariance matrix is assumed to be fixed. The first dimension of returns is monetary and the second dimension nonmonetary. Nonmonetary returns accrue only to the principal(s) of a start-up project to the extent of control in the firm, which is assumed to be proportional to the principal's (or principals') ownership share in the firm.

In case of bank-financing, the entrepreneur is the sole principal and thus the sole beneficiary of the nonmonetary returns since contracting with a bank is just a lender-borrower relationship where one party gets the loan in the beginning of the period from the other party and pays it back at the end of the period along with the interest specified in the contract. However, in case of VC-financing, the VC becomes a co-principal in the project by acquiring an ownership share (and control) in the firm. Therefore, both the entrepreneur and the VC have access to the nonmonetary returns of the project in this case.

Our contribution begins by noting that, in addition to the entrepreneurs, the VC may also value nonmonetary returns because of her control in the firm. Let coefficient λ_i, where $i = \{E, VC\}$, be the weight that principal i assigns to nonmonetary returns. Entrepreneurs differ in terms of this privately-known coefficient. In particular, we assume that the coefficient of the entrepreneur, λ_E, is uniformly distributed over the interval $[0, \bar{\lambda}]$ with pdf $f(\lambda)$ and cdf $F(\lambda)$.[8] However, the coefficient of the VC, $\lambda_{VC} \in [0, \bar{\lambda}]$, is common knowledge.

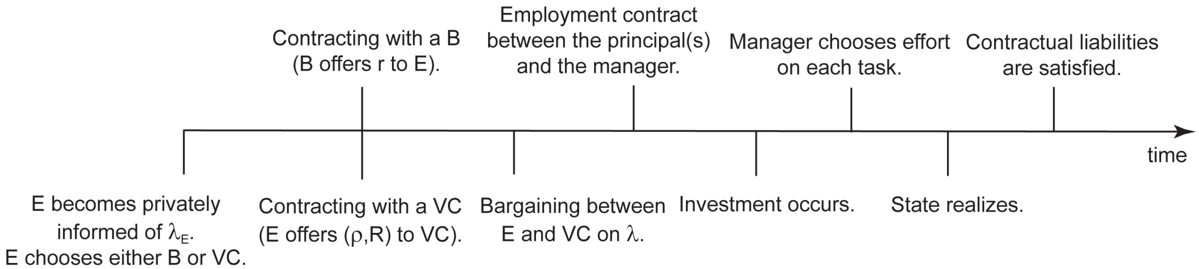

Figure 1: The sequence of events

Figure 1 shows the sequence of events. At the beginning of the period, entrepreneurs privately learn their types (λ-coefficients) and decide whether to raise funds from a bank (denoted by B in the figure) or the VC. If an entrepreneur chooses bank-financing, the bank offers him a standard debt contract. The game ends if he rejects this offer. If he chooses VC-financing, he offers the pair (ρ, R) to the VC along with certain control rights in exchange for VC's supply of start-up capital. If the VC rejects this offer, the game ends. Otherwise, it proceeds to the bargaining stage in which, as co-principals, the entrepreneur and the VC decide how to have the firm managed by the manager hired. Their bargaining powers are given by each co-principal's ownership share in the firm. Bargaining between them determines a coefficient $\lambda^\star$ that they agree on, or in words how much weight to put onto the task that yields the nonmonetary returns. If they do not get to an agreement, they get their disagreement payoffs: zero for the entrepreneur and $C > 0$ for the VC.[9] Following the bargaining stage, they offer an employment contract to the manager (entrepreneur does this alone in the case of bank-financing). The manager then decides whether to accept or reject the offer, and in the case he accepts, he decides his effort level on each task, which neither the entrepreneur nor the VC can observe or verify. Finally, the publicly observable and verifiable state realizes and all contractual liabilities are satisfied by each party.

3 Returns from Start-up Projects

This section derives four important expressions that are frequently used in the rest of the paper: an entrepreneur's net return from a VC-backed project (eq. (9)), the VC's net return

[8] Assuming uniform distribution of λ-coefficients is without loss of generality because we later show that the best responses of entrepreneurs are independent of shape of the distribution as long as it is continuous.

[9] Assuming a positive disagreement payoff for the VC is standard in the literature (among others see Hellmann (1998) and Ueda (2004)).

from that project (eq. (10)), a bank-financed entrepreneur's net return from his project (eq. (12)), and the monetary returns from that project (eq. (13)). Obtaining these expressions requires describing the production technology in detail and deriving the optimal employment contract with the manager under moral hazard.

Consider the manager's problem. He has two tasks to complete: *task 1* yields the monetary returns and *task 2* yields the nonmonetary returns. He is in a position to choose a vector of efforts $\mathbf{t} = (t_1, t_2)$ that specifies the effort he would like to provide on each task. The private cost of providing effort is given by T which is a continuous and strictly convex function of t_1 and t_2. We particularize this cost function by assuming the following quadratic form.

$$T(t_1, t_2) = \frac{k_1 t_1^2}{2} + \frac{k_2 t_2^2}{2}, \tag{1}$$

where k_1 and k_2 are strictly positive parameters.

Given the manager's effort choice on each task, the returns are distributed with a two-dimensional normal distribution with mean $\mu : \Re_+^2 \rightarrow \Re^2$. We assume that μ takes the following linear form.

$$\mu(\mathbf{t}) = \begin{pmatrix} \mu_1(t_1) \\ \mu_2(t_2) \end{pmatrix} = \begin{pmatrix} \gamma_1 t_1 \\ \gamma_2 t_2 \end{pmatrix}, \tag{2}$$

where $\mu_1(t_1)$ is the monetary return, $\mu_2(t_2)$ is the nonmonetary return, and γ_1 and γ_2 are strictly positive parameters. The manager's effort choice creates a two-dimensional signal of information, $\mathbf{x} \in \Re^2$, observable and verifiable by the principal(s): $\mathbf{x} = \mu(\mathbf{t}) + \varepsilon$, where ε is normally distributed with mean zero and variance-covariance matrix

$$\mathbf{\Sigma} = \begin{pmatrix} \sigma_1^2 & 0 \\ 0 & \sigma_2^2 \end{pmatrix}. \tag{3}$$

The manager has constant absolute risk aversion (CARA) and thus his preferences are represented by the utility function $u(w) = -\exp[-\eta w]$, where η is the coefficient of absolute risk aversion. Under a compensation scheme $w : \Re^2 \rightarrow \Re$, where $w(\mathbf{x})$ is often referred as the wage at information signal $\mathbf{x}$, the manager's expected utility is given by $u(CE) = -\int_{-\infty}^{+\infty} \exp[-\eta(w(\mathbf{x}) - T(\mathbf{t}))]\mathrm{d}\mathbf{x}$, where CE denotes the certainty equivalent money payoff of the manager under the compensation scheme w.

We normalize reservation utility of the manager to zero and restrict attention to linear incentive contracts of the form $w(\mathbf{x}) = \alpha^{\mathbf{T}}\mathbf{x} + \beta$, where $\alpha \in \Re_+^2$ and $\beta \in \Re$. Making use of the CARA preferences and the normal distribution assumption, it is easy to show that the certainty equivalent of such a compensation scheme is given by

$$CE = (\alpha_1 \gamma_1 t_1 + \alpha_2 \gamma_2 t_2) - \left(\frac{k_1 t_1^2}{2} + \frac{k_2 t_2^2}{2} \right) - \frac{1}{2} \eta \left(\alpha_1^2 \sigma_1^2 + \alpha_2^2 \sigma_2^2 \right) + \beta. \tag{4}$$

Consequently, the manager's optimal choice of the vector of efforts is

$$\mathbf{t}^* = (t_1^*, t_2^*) = \left(\frac{\gamma_1 \alpha_1}{k_1}, \frac{\gamma_2 \alpha_2}{k_2} \right). \tag{5}$$

Having derived the effort choice of the manager, we are now in a position to calculate the principal's (or principals') optimal offer to the manager. The expected gross return of principal i is given by

$$B_i(t) = \mu_1(t_1) + \lambda_i \mu_2(t_2) \quad \text{for } i = \{E, VC\}. \tag{6}$$

We first focus on the case of VC-financing. We know that the entrepreneur's coefficient on the nonmonetary returns is λ_E and the VC's is λ_{VC}. Therefore, if the entrepreneur chooses VC-financing, the entrepreneur and the VC have to bargain to determine a coefficient to be used in formulating the optimal employment contact offer to the manager. Let this bargained coefficient be $\lambda^\star$.[10] Once they agree on $\lambda^\star$, the preferences of the two principals are perfectly aligned and thus the optimal contract offer is obtained from the solution of the following (aggregated) maximization problem:

$$\max_{\alpha, \beta} \left\{ \mu_1(t_1) + \lambda^\star \mu_2(t_2) - T(\mathbf{t}) - \frac{1}{2} \eta \left(\alpha_1^2 \sigma_1^2 + \alpha_2^2 \sigma_2^2 \right) \right\}. \tag{7}$$

From Holmstrom and Milgrom (1991), we already know that the optimal contract would not render any surplus to the manager. Thus, the optimal constant intercept, β^*, (which does not affect incentives[11]) must be such that the certainty equivalent is equalized to reservation utility of the manager, which is zero. The first-order conditions of the principals' maximization problem yield that

$$\alpha_1^* = \frac{\frac{\gamma_1^2}{k_1}}{\frac{\gamma_1^2}{k_1} + \eta \sigma_1^2} \quad \text{and} \quad \alpha_2^* = \frac{\frac{\gamma_2^2}{k_2}}{\frac{\gamma_2^2}{k_2} + \eta \sigma_2^2} \lambda^\star. \tag{8}$$

[10] We provide the exact expression for $\lambda^\star$ when we analyze the details of the bargaining between an entrepreneur and the VC. Note that $\lambda^\star$ has to be in between λ_E and λ_{VC}.

[11] This is because we assume CARA preferences and thus there are no income effects.

Substituting (8) into (5) and using (2) show that the gross returns of the entrepreneur and the VC are

$$\Pi_E(\lambda^\star) = \Phi_1 + \lambda^\star\left(2\lambda_E - \lambda^\star\right)\Phi_2 \tag{9}$$

$$\Pi_{VC}(\lambda^\star) = \Phi_1 + \lambda^\star\left(2\lambda_{VC} - \lambda^\star\right)\Phi_2, \tag{10}$$

respectively, where

$$\Phi_1 = \frac{\left(\frac{\gamma_1^2}{k_1}\right)^2}{2\left(\frac{\gamma_1^2}{k_1} + \eta\sigma_1^2\right)} \quad \text{and} \quad \Phi_2 = \frac{\left(\frac{\gamma_2^2}{k_2}\right)^2}{2\left(\frac{\gamma_2^2}{k_2} + \eta\sigma_2^2\right)}. \tag{11}$$

The gross return of the entrepreneur in case of bank-financing can easily be obtained by setting $\lambda^\star = \lambda_E$ in (9):

$$\hat{\Pi}_E(\lambda_E) = \Phi_1 + \lambda_E^2\Phi_2. \tag{12}$$

Eqs. (9), (10), and (12) contain not only the monetary returns of the project but also the nonmonetary returns which accrue only to the principal(s) of a project. When deciding on its lending interest rate, a bank is concerned only with the monetary returns of a project, which we denote by $\hat{\Pi}_E^M(\lambda_E)$. It is calculated simply by deducting the nonmonetary returns of a project from the total returns from the project: $\hat{\Pi}_E^M(\lambda_E) = \hat{\Pi}_E(\lambda_E) - \lambda_E\mu_2(t_2^*)$. Plugging in the optimal levels of various terms gives

$$\hat{\Pi}_E^M(\lambda_E) = \Phi_1 - \lambda_E^2\Phi_2. \tag{13}$$

Note that the payment to the manager for him to supply the optimal level of effort in the task of the project that yields the nonmonetary returns are monetary and therefore they appear in $\hat{\Pi}_E^M(\lambda_E)$. Thus, the internal rate of return of projects owned by entrepreneurs with higher coefficients on nonmonetary returns are going to be lower since they allocate more resources to task 2, the task that yields the nonmonetary returns.

In order to establish the non-emptiness of the participation constraint of the entrepreneur (for both bank- and VC-financing), the technology should be such that it is worthwhile to operate the project regardless of the owner of the project. This requires making an assumption on the *face value* of the project.[12] The following assumption does the job.

[12] The face value of a project given by parameters $\{(\gamma_\ell, k_\ell, \sigma_\ell^2)_{\ell=1.2}, \eta, \lambda_E\}$ is the value of the project that does not depend on the identity of the owner of the project. Therefore, it must be a function of only $\{(\gamma_\ell, k_\ell, \sigma_\ell^2)_{\ell=1.2}, \eta\}$. Moreover, the face value of the project should contain only monetary returns.

Assumption 1 (Face Value) *The technology is such that the face value of the project satisfies* $\Phi_1 \geq K + C$*.*

This assumption says that the face value of the project is higher than the summation of the start-up cost of the project and the VC's disagreement payoff. When this is satisfied, it is worthwhile to undertake the project as a sole owner and thus markets for funding start-up projects can exist.[13] We can have two other interpretations of this assumption. One may say that it characterizes the payoff of the entrepreneur with coefficient $\lambda_E = 0$ or the monetary return of that project, both of which is equal to Φ_1, the face value of the project.

We close this section with the following lemma that records some technical results that will be useful in the subsequent proofs.

Lemma 1 (Properties of Return Functions) *Consider the case in which* $\lambda_{VC} \leq \lambda_E$*. Then, the following hold for* $\Pi_i : [\lambda_{VC}, \lambda_E] \to \Re$*,* $i = \{E, VC\}$*.*

1. *For all* $\lambda^\star \in [\lambda_{VC}, \lambda_E]$*,* $\Pi_E(\lambda^\star) - \Pi_{VC}(\lambda^\star) = \lambda^\star(\lambda_E - \lambda_{VC})\Phi_2 \geq 0$*.*
2. Π_i *is strictly increasing for any coefficient lower than* λ_i*, and strictly decreasing for any coefficient higher than* λ_i*.*
3. Π_i *is strictly concave on* $(0, 1)$ *and* $\partial\Pi_i(\lambda^\star)/\partial\lambda^\star$ *evaluated at* $\lambda^\star{=}\lambda_i$ *equals zero.*

The proof of the lemma is trivial. While the first conclusion follows from employing (9) and (10), the others are due to the derivative of $\Pi_i(\lambda^\star)$ being given by $\partial\Pi_i/\partial\lambda^\star = 2\Phi_2(\lambda_i{-}\lambda^\star)$.

4 Bank-only Financial System

Analyzing an economy in which there is only bank-financing sets a useful benchmark for the examination of entrepreneurs' choice between bank- and VC-financing. As indicated in Becker and Hellmann (2005), banks often play a dominant role in many countries. Even in the US, the VC industry is relatively small even if it is well established. According to Berger and Udell's (1998) estimations, commercial banks provide 18.75% whereas VCs provide 1.85% of

Therefore, it is as if the project is operated by someone who does not care about the nonmonetary returns (*e.g.,* by the bank), thus as if $\lambda_i = 0$. This means that the face value of a project given by parameters $\{(\gamma_\ell, k_\ell, \sigma_\ell^2)_{\ell=1.2}, \eta, \lambda_E\}$ is equal to Φ_1.

[13] For bank-financing, it is sufficient to assume that $\Phi_1 > K$, which is already satisfied when $\Phi_1 > K + C$.

all small business finance. We later make some back-of-the-envelope calculations to match these numbers and compare the results with those that derive in the case in which both bank- and VC-financing exist.

Consider now a bank-only financial system. Let the equilibrium lending interest rate chosen by banks be $r^\star$. The entrepreneur is the sole principal of the project if he is bank-financed, and his gross return in that case is given by (12). His net return is obtained by deducting the loan repayment to the bank from the gross return of the project: $\hat{\Pi}_E(\lambda_E) - (1 + r^\star)K$. Therefore, a bank loan is desirable for the entrepreneur if and only if

$$\Phi_1 + \lambda_E^2 \Phi_2 \geq (1 + r^\star)K. \tag{14}$$

This is the participation constraint of the entrepreneur in the bank-loan market.

The net monetary return of the project is obtained by deducting the loan repayment to the bank from the monetary return of the project given by (13): $\hat{\Pi}_E^M(\lambda_E) - (1 + r^\star)K$. Therefore, an entrepreneur is able to pay back his loan in full if and only if

$$\Phi_1 - \lambda_E^2 \Phi_2 \geq (1 + r^\star)K. \tag{15}$$

Limited liability is binding for all entrepreneurs who do not satisfy this inequality. Let coefficient $\lambda_{r^\star}$ be such that $\Phi_1 - \lambda_{r^\star}^2 \Phi_2 = (1 + r^\star)K$. We assume that there exist nonnegative lending interest rates solving $\Phi_1 = (1 + r)K$ and $\Phi_1 - \bar{\lambda}^2 \Phi_2 = (1 + r)K$ so that equilibria do not derive trivially from binding constraints. Consequently,

$$\lambda_{r^\star} = \sqrt{\frac{\Phi_1 - (1 + r^\star)K}{\Phi_2}}. \tag{16}$$

Suppose all entrepreneurs seek for funding (which will eventually be a maintained assumption). Then, the expected monetary return from a random loan applicant's project is calculated as follows:

$$\begin{aligned}
\mathbb{E}\left[\hat{\Pi}_E^M(\lambda_E)\right] &= \mathbb{E}\left[\Phi_1 - \lambda_E^2 \Phi_2\right] = \Phi_1 - \Phi_2 \mathbb{E}\left[\lambda_E^2\right] \\
&= \Phi_1 - \Phi_2 \left[(\mathbb{E}[\lambda_E])^2 + var(\lambda)\right] = \Phi_1 - \Phi_2 \left(\left(\frac{\bar{\lambda}}{2}\right)^2 + \frac{(\bar{\lambda})^2}{12}\right) \\
&= \Phi_1 - \frac{\bar{\lambda}^2}{3}\Phi_2.
\end{aligned}$$

Here $\mathbb{E}$ is the expected value operator and var the variance of the distribution of λ.

In this setting, banks finance projects if the expected monetary return of the project exceeds the cost of loanable funds. We normalize the risk-free interest rate to zero and thus the cost of a loan of K units of capital is K. Hence, banks finance projects if the following technological relation is satisfied.

$$\Phi_1 - \frac{\bar{\lambda}^2}{3}\Phi_2 \geq K. \tag{17}$$

Bank loan market shuts down when this technological constraint is not satisfied, which is nothing but a standard Akerlof (1970) or Rothschild and Stiglitz (1976) type of lemons problem in which the average loan applicant is not profitable and thus not creditworthy. For what follows, we assume that the technological constraint in (17) holds.

Since the banking sector is competitive, banks make zero profit in equilibrium. Their zero profit condition is given by

$$\int_0^{\lambda_{r^\star}} (1+r^\star)K \mathrm{d}F(\lambda) + \int_{\lambda_{r^\star}}^{\bar{\lambda}} \left(\Phi_1 - \lambda^2\Phi_2\right) \mathrm{d}F(\lambda) = K. \tag{18}$$

The first term here is for entrepreneurs whose projects yield sufficient monetary returns to pay back their loans. The second term is for those who are unable to pay back their loans in full. In this case, limited liability applies and the bank confiscates whatever left in the firm.

By manipulating (18) and using the fact that $\Phi_1 - \lambda_{r^\star}^2\Phi_2 = (1+r^\star)K$, we get

$$\lambda_{r^\star}^3(r) = \frac{3\bar{\lambda}\left[\Phi_1 - \frac{\bar{\lambda}^2}{3}\Phi_2 - K\right]}{2\Phi_2} \geq 0. \tag{19}$$

The right-hand side of this equation is nonnegative because $\Phi_1 - (\bar{\lambda}^2/3)\Phi_2 \geq K$. Plugging in the expression for $\lambda_{r^\star}$ from (16) and solving for $r^\star$ gives the equilibrium lending interest rate offered by banks:

$$r^* = \frac{\Phi_1 - \Psi}{K} - 1, \tag{20}$$

where

$$\Psi = \left(\frac{3\bar{\lambda}\left[\Phi_1 - \frac{\bar{\lambda}^2}{3}\Phi_2 - K\right]\sqrt{\Phi_2}}{2}\right)^{2/3}. \tag{21}$$

The zero profit condition assumes that there are entrepreneurs who cannot pay back their loans (those with $\lambda_E \in [\lambda_{r^\star}, \bar{\lambda}]$) along with those who can (those with $\lambda_E \in [0, \lambda_{r^\star}]$) so that banks can break even. One can easily show that the participation constraint given in (14) is satisfied for all entrepreneurs as long as $\Psi \geq 0$, which is always the case as long as (17) holds. The following proposition summarizes the findings of this section:

Proposition 1 (Bank-only Equilibrium) *Banks finance start-up projects if and only if* $\Phi_1 - (\bar{\lambda}^2/3)\Phi_2 \geq K$. *The equilibrium lending interest rate in a bank-only financial system is given by (20).*

5 The Venture Capital Contracting

This section works out the details of contracting between an entrepreneur and the VC. We start off by considering the symmetric information case in which both λ_E and λ_{VC} are common knowledge. This case is definitely too strong. In reality, the entrepreneur's information about how much the VC values nonmonetary returns should be better than the VC's information about how much each entrepreneur with whom she contracts values nonmonetary returns. However, we later show that our results extend to the one-sided asymmetric information case in which λ_E becomes private information, which is indeed what we plausibly assume throughout the paper.[14] The basic reason for why our results hold also in one-sided asymmetric information is dependent on the sequence of moves in the model which makes truthful revelation of λ_E a best response for the entrepreneur. We explain this in detail at the end of this section.

The VC contracting involves two stages. In the first stage, the entrepreneur offers a (ρ, R) pair to the VC. If the VC accept this offer, the game proceeds to the second stage in which the parties bargain over a $\lambda^\star$ that they will employ in running the firm. Their bargaining powers are given by each party's ownership share in the firm. This is nothing but a consensus on how to "control" the firm. As we have seen in Section 3, they offer an optimal employment contract to the manager based on the $\lambda^\star$-coefficient that they agree on. We now analyze these two stages starting from backwards.

[14] Similar assumptions are employed in the literature. For example, Admati and Pfleiderer (1994), and Ueda (2004) assume that the relationship between the entrepreneur and the VC does not involve asymmetric information; Chan, Siegel, and Thakor (1990) assume that the skills of the VC are publicly known. There is also a growing literature on VCs' reputation arguing that potential contractors learn a great deal of information about the VCs preferences from the entrepreneurs who have previously worked with her (see Gompers (1996)).

5.1 Bargaining

Consider the stage in which the entrepreneur and the VC bargain over implementable contracts. If the entrepreneur decides to raise funds from a VC, the entrepreneur offers an ownership share of $1-\rho$ and a fixed compensation of R to the VC along with some control rights in exchange for VC's supply of the start-up capital K.[15] Given the pair (ρ, R) offered by the entrepreneur in the previous stage, the two principals bargain over the choice of λ (*i.e.*, how much weight to put on nonmonetary returns in calculating the optimal employment contract offer to the manager) whose admissible values are in between λ_E and λ_{VC}. If the principals cannot agree on a $\lambda^\star$-coefficient, the project cannot go ahead and each principal gets a return equal to their disagreement payoffs, zero for the entrepreneur and $C > 0$ for the VC.[16] Thus, the pair of payoffs to disagreement is $\mathbf{d} = (0, C)$.

The bargaining set S, the set of pairs of payoffs to agreements, is defined by

$$S = \{(\pi_E, \pi_{VC}) : \pi_E \in [0, \Pi_E(\lambda)] \text{ and } \pi_{VC} \in [C, \Pi_{VC}(\lambda)] \\ \text{for some } \lambda \in [\min\{\lambda_E, \lambda_{VC}\}, \max\{\lambda_E, \lambda_{VC}\}]\}. \tag{22}$$

Then, the Pareto optimal frontier of S, denoted by $\mathcal{F}$, is

$$\mathcal{F} = \{(\pi_E, \pi_{VC}) : \pi_E = \Pi_E(\lambda) \text{ and } \pi_{VC} = \Pi_{VC}(\lambda) \\ \text{for some } \lambda \in [\min\{\lambda_E, \lambda_{VC}\}, \max\{\lambda_E, \lambda_{VC}\}]\}. \tag{23}$$

The following lemma establishes that the bargaining problem $(S, \mathbf{d})$ is well defined and well behaved.

[15] This offer scheme is similar to that of de Bettignies and Brander (2007). As they also mention, some other papers allow the VC to make the offer while keeping the entrepreneur relatively passive. Our approach is reasonably convenient in obtaining tractability and getting truthful revelation in the one-sided asymmetric information case.

[16] We have shown that when $C = 0$, bank-financing is optimal for the entrepreneur if and only if his project yields monetary returns less than its startup cost K, which means that these entrepreneurs will never be able to pay back their bank loans. As a result, banks never want to provide funds in the presence of VC-funding since they can never breakeven in the start-up market. This lemons problem is why banks may opt out from the financing of high-tech start-up market. From a technical point of view, C is nothing but a positive disagreement payoff which gives an extra power to the VC in the bargaining process. By following Ueda (2004), we interpret C as the possibility of expropriation of the project by the VC when the bargaining breaks up. Ueda (2004) finds that better intellectual property protection leads to less bank financing (and no bank-financing if protection is perfect) whereas Landier (2003) claims the opposite. Our results are consistent with Ueda's finding. One may alternatively employ the following interpretation. VCs usually specialize in certain industries and work with a portfolio of firms in that industry. They may well have portfolio firms that are working on different facets of a similar idea. As a result, the VC may obtain positive benefits from "seeing" the project even though the bargaining breaks apart for a particular firm simply because the information it acquires can be of use when working with other portfolio firms.

Lemma 2 (Properties of Bargain Problem) *Suppose that Assumption 1 holds. Then, S is non–empty, compact, and convex; and $\mathcal{F}$ is strictly concave.*

The proof of the lemma is in Appendix A.1. We employ the utilitarian bargaining solution (Thomson (1981)). According to this bargaining procedure, for $(S, \mathbf{d})$ and for any exogenously given coefficients θ, $(1-\theta) \in [0, 1]$, $\pi^\theta \in S$ is the *θ–utilitarian bargaining solution* of $(S, \mathbf{d})$ if and only if

$$(\pi_E^\theta, \pi_{VC}^\theta) = \mathcal{N}(S, \mathbf{d}; \theta) \equiv \arg \max_{(\pi_E, \pi_{VC}) \in S} \{\theta\pi_E + (1-\theta)\pi_{VC}\}. \tag{24}$$

Note that, by Lemma 2, there exists a unique solution to $(S, \mathbf{d})$ for all $\theta \in [0, 1]$ and thus $\mathcal{N}(S, \mathbf{d}; \theta)$ is a function. For notational purposes, let λ^θ be defined by $\Pi_i(\lambda^\theta) = \pi_i^\theta$ for $i = \{E, VC\}$. The following lemma characterizes the bargaining outcome.

Lemma 3 (Bargaining Outcome) *Suppose Assumption 1 holds and let without loss of generality that $\lambda_{VC} \leq \lambda_E$. Then, for every $\theta \in [0, 1]$, $\mathcal{N}(S, \mathbf{d}; \theta)$ is a function, and $\lambda^\theta \in [\lambda_{VC}, \lambda_E]$ is strictly increasing in θ and is uniquely defined by $\lambda^\theta = \theta\lambda_E + (1-\theta)\lambda_{VC}$.*

The proof of the lemma is in Appendix A.2. Given (ρ, R) offered to the VC, who accepted and supplied the start-up capital K, the net returns to the entrepreneur, $\tilde{\Pi}_E(\rho, R)$, and the VC, $\tilde{\Pi}_{VC}(\rho, R)$, are

$$\tilde{\Pi}_E(\rho, R) \equiv \rho\Pi_E(\lambda^\rho) - R \tag{25}$$

$$\tilde{\Pi}_{VC}(\rho, R) \equiv (1-\rho)\Pi_{VC}(\lambda^\rho) + R, \tag{26}$$

respectively, where $\lambda^\rho = \rho\lambda_E + (1-\rho)\lambda_{VC}$. That is, the entrepreneur gets a ρ percent of the firm but provides R to the VC as a fixed compensation while the VC gets $1-\rho$ percent of the firm in addition to getting a fixed compensation R.

Two comments on the actual determination of the joint λ^ρ-coefficient are in order. First, Kaplan and Stromberg (2003) find that VCs hold the majority of the board seats in 25.4% of the start-up firms whereas the entrepreneur's seats form the majority in the 13.9% of them. In the remaining 60.7%, neither the entrepreneur nor the VC have majority and in those cases the VC and the entrepreneur mutually appoint directors for the swing votes. Whom they should hire is a part of the bargaining process we employed.

Second, we implicitly rule out the use of covenants. Therefore, it is not possible to separate the allocation of cash-flow rights from the allocation of control rights. We assume one-share-one-vote norm and therefore the degree of control is proportional to the ownership share. As a result, when the entrepreneur (VC) gets a greater ownership share, his (her) share in the nonmonetary returns proportionally increases. The separation of the allocation of cash-flow rights from the allocation of control rights is clearly an important feature of VC contracts as mentioned in Hellmann (1998) and Kaplan and Stromberg (2003). However, our goal in this paper is to analyze the consequences of having control in the firm, not how the control is actually allocated. More importantly, it is well-known that VCs take proportionately more control rights than their cash-flow rights in the firm, and such a specification would clearly make our results stronger.

5.2 Entrepreneur's optimal offer

Having derived the bargaining outcome, we now consider the previous stage in which the entrepreneur chooses his optimal (ρ, R) offer to the VC. An optimal offer must maximize entrepreneur's payoff subject to the participation constraint of the VC (*i.e.*, $\tilde{\Pi}_{VC}(\rho, R) \geq K + C$). It should also guarantee his own participation (*i.e.*, $\tilde{\Pi}_E(\rho, R) \geq 0$). As a result, the maximization problem of the entrepreneur is given by

$$\max_{\rho, R} \{\rho \Pi_E(\lambda^\rho) - R\} \tag{27}$$

$$s.t.$$

$$\rho \Pi_E(\lambda^\rho) - R \geq 0 \tag{28}$$

$$(1-\rho)\Pi_{VC}(\lambda^\rho) + R \geq K + C. \tag{29}$$

Suppose that $(\rho^\star, R^\star)$ solves this maximization problem. Then, we know from Lemma 3 that $\lambda^{\rho^\star} = \rho^\star \lambda_E + (1-\rho^\star)\lambda_{VC}$. For brevity of notation, we define $\lambda^\star \equiv \lambda^{\rho^\star}$. The following proposition characterizes the solutions of this maximization problem followed by a verbal explanation. It turns out that, depending on the λ-coefficients of the entrepreneur and the VC, the optimal way of financing can take the debt-form, the equity form, or the form of an acquisition by the VC.

Proposition 2 (Optimal VC Contracts) *Suppose Assumption 1 holds. The optimal offers of the entrepreneur to the VC, $(\rho^\star, R^\star)$, are characterized as follows:*

1. *Entrepreneurs with $\lambda_E > \lambda_{VC}$:*

(a) *(Debt-financing) If* $\Phi_1 - \lambda_E^2 \Phi_2 \geq K + C$, *then*

$$\rho^\star = 1 \text{ and } R^\star = K + C, \tag{30}$$

and the entrepreneur's return is $\Phi_1 + \lambda_E^2 \Phi_2 - K - C > 0$.

(b) *(Equity-financing) If* $\Phi_1 - \lambda_E^2 \Phi_2 < K + C$, *then* $\rho^\star$ *is the maximum real number in* $[0,1]$ *solving*

$$\left((1-\rho^\star)^2 \lambda_{VC}^2 - (\rho^\star)^2 \lambda_E^2\right) \Phi_2 = K + C - \Phi_1 \text{ and } R^\star = \rho^\star \left(\Phi_1 - (\lambda^\star)^2 \Phi_2\right), \tag{31}$$

and the entrepreneur's return is $2\rho^\star \lambda_E \left(\rho^\star \lambda_E + (1-\rho^\star)\lambda_{VC}\right) \Phi_2 > 0$.

2. *Entrepreneurs with* $\lambda_E = \lambda_{VC} = \lambda$:

(a) *If* $\Phi_1 - \lambda^2 \Phi_2 \geq K + C$, *then*

$$\rho^\star \in [0,1] \text{ and } R^\star = K + C - (1-\rho^\star)(\Phi_1 + \lambda^2 \Phi_2). \tag{32}$$

In particular, both $\rho^\star = 1$ *and* $R^\star = K + C$ *(debt-financing); and* $\rho^\star = 0$ *and* $R^\star = K + C - (\Phi_1 + \lambda^2 \Phi_2) < 0$ *(acquisition) are among the solutions. The entrepreneur's return is* $\Phi_1 + \lambda^2 \Phi_2 - K - C > 0$.

(b) *If* $\Phi_1 - \lambda^2 \Phi_2 < K + C$, *then*

$$\rho^\star \in \{\rho \in [0,1] : (1-2\rho^\star)\lambda^2 \Phi_2 \geq K + C - \Phi_1\} \text{ and } R^\star = K + C - (1-\rho^\star)(\Phi_1 + \lambda^2 \Phi_2). \tag{33}$$

Note that, $\rho^\star = 0$ *and* $R^\star = K + C - (\Phi_1 + \lambda^2 \Phi_2) < 0$ *(acquisition) are among the solutions. The entrepreneur's return is* $\Phi_1 + \lambda^2 \Phi_2 - K - C > 0$.

3. *(Acquisition) Entrepreneurs with* $\lambda_E < \lambda_{VC}$: *The entrepreneur sells the project for a price of* $\Phi_1 + \lambda_{VC}^2 \Phi_2 - K - C$ *to the VC, i.e.*

$$\rho^\star = 0 \text{ and } R^\star = -(\Phi_1 + \lambda_{VC}^2 \Phi_2 - K - C) < 0. \tag{34}$$

The entrepreneur's return is $\Phi_1 + \lambda_{VC}^2 \Phi_2 - K - C$.

This important proposition, whose proof is given in Appendix A.3, requires a detailed treatment of its findings. Consider each case in turn. In Case 1, the entrepreneur values nonmonetary returns more than the VC. Thus, it is optimal for the entrepreneur to keep as much shares as possible without violating the participation constraint of the VC. When the project yields sufficient monetary returns to pay off the VC (*i.e.*, $\Phi_1 - \lambda_E^2\Phi_2 \geq K + C$) as in Case 1a, the entrepreneur is able to keep all shares (*i.e.*, $\rho^\star = 1$) and pays whatever he borrowed from the VC (*i.e.*, $R^\star = K + C$) at the end of the period.[17] The optimal contract here takes the simple *debt form*. In Case 1b, the project does not yield sufficient monetary returns to pay off the VC (*i.e.*, $\Phi_1 - \lambda_E^2\Phi_2 < K + C$). Thus, the entrepreneur cannot keep all shares to himself. To be able to raise the necessary funds, he has to relinquish control to the VC. What he does is then to provide some amount of shares just enough to guarantee the VC's participation. Consequently, the optimal contract takes an *equity form* in which both parties hold positive shares in the firm.[18] Hence, equity provision by a VC is attributable to *ex post* wealth constraints of entrepreneurs.

Skip Case 2 for the moment and consider Case 3. In this case, the VC values nonmonetary returns more than the entrepreneur. Thus, it is optimal for the entrepreneur to sell as much shares as possible to the VC. This is optimal because the value of the project is higher for the VC because $\lambda_{VC} > \lambda_E$. The entrepreneur can make use of this situation by selling the whole firm to the VC (*i.e.*, $\rho^\star = 0$) at a price higher than his own valuation of the firm. This case can be interpreted as a large firm's *acquisition* of a firm rather than a VC's investment in her portfolio company as a financial intermediary, since the "buyer" attaches greater valuation to the nonmonetary returns than the "seller". To conceptualize, it is much like, say, a large software company or a drug corporation acquiring a start-up firm that comes up with an innovation.

Now consider Case 2 in which the λ-coefficients of the two parties are the same (a measure zero event). Since now the preferences are perfectly aligned, there are many possible solutions (*i.e.*, $\rho^\star \in [0, 1]$). What is interesting is that both $\rho^\star = 1$ and $\rho^\star = 0$ are among those solutions in the case in which the project yields sufficient monetary returns to pay off the VC, which is stated in Case 2a. Additionally, $\rho^\star = 0$ is among the solutions when the entrepreneur is insolvent, as stated in Case 2b. These two points help us in comparing the payoffs of the entrepreneur in various situations in the proofs of the subsequent propositions.

We close this section by showing that Proposition 2 holds even under one-sided asym-

[17] The reason that $R^\star$ does not include any markup over $K + C$ is simply due to the fact that there is no asymmetric information in the financial contracting between the entrepreneur and the VC; otherwise the no-markup result is a superfluous detail which does not affect our findings.

[18] Of course, this abstracts from staging of investments (which occurs due to moral hazard problems between the entrepreneur and the VC as shown in Bergemann and Hege (1998)) and convertible securities as optimal contracts (which arises due to fine tuning of the incentives between the entrepreneur and the VC when there is double moral hazard as shown in Schmidt (2000) or Repullo and Suarez (2004)). We abstract from all these to highlight our results.

metric information in which λ_{VC} stays to be common knowledge but λ_E becomes private information.[19] The timing of the model is particularly important in extending the results to one-sided asymmetric information. First, the entrepreneur offers (ρ, R) to the VC, and they then get into bargaining. While the VC does not know the entrepreneur's type, the entrepreneur knows not only his own type but also the VC's type and he is the one who makes the offers. As a result, the entrepreneur leaves no surplus to the VC. That is, by a proper choice of a (ρ, R) pair in the stage before the bargaining, the entrepreneur always picks a point on the bargaining frontier where the VC obtains his disagreement payoff. Hence, truthful revelation of his type λ_E is optimal for him. We record this result in the following proposition.

Proposition 3 (Truthful Revelation) *Suppose Assumption 1 holds and λ_{VC} is common knowledge but λ_E is entrepreneur's private information. Then, the optimal choice of the entrepreneur's offer to the VC is as specified in Proposition 2.*

Because there is truthful revelation by the entrepreneur when λ_E becomes his private information, not only the optimal contract offers specified in Proposition 2 but also the bargaining outcome in the stage that follows the contract offer stage remain exactly the same.

6 Banks versus Venture Capital

We now turn to the analysis of entrepreneurs' choice between bank- and VC-financing. Existence of an equilibrium is never an issue in this economy. An equilibrium can easily be established by having banks offering a prohibitively high lending interest rate so that some (or possibly all) entrepreneurs get financed by the VC and the rest as well as banks remain inoperative. Such an equilibrium is clearly not interesting. We rather focus on equilibria in which both the VC and banks are operative in the market.[20] We define operativeness of a financial intermediary as follows.

Definition 1 (Operativeness) *A financial intermediary is **operative** if there exists a non-zero measure of entrepreneurs who in equilibrium choose it for financing their start-up projects. Otherwise, it is **inoperative**.*

[19] Even though a formulation with two-sided asymmetric information is very compelling, getting tangible results from such a model proves to be very difficult.

[20] We have already analyzed a bank-only financial system in Section 4.

The strategy of banks in this game is their lending interest rate, which is $r^\star$ in equilibrium. Let the entrepreneurs' equilibrium *financing strategy* (*i.e.*, their choice between bank- and VC-financing) be $s^\star(\lambda) : [0, \bar{\lambda}] \to \{B, VC\}$, where B denotes bank-financing and VC VC-financing. Remember that we define $\lambda_{r^\star}$ with (16), which implies a negative relationship between $r^\star$ and $\lambda_{r^\star}$. Under our assumptions, there is a one-to-one map between the two and therefore banks choosing a strategy $r^\star$ is equivalent to choosing a $\lambda_{r^\star}$-coefficient.

Given limited liability, there are three possibilities for a bank. If a bank-financed entrepreneur generates sufficient monetary returns to pay back his loan, the bank is able to get the principal and the interest, $(1+r^\star)K$, in full. However, bank-financed entrepreneurs with $\lambda_E > \lambda_{r^\star}$ will not be able to pay back their loans in full. In that case, the bank can confiscate only the monetary returns from the project, $\Phi_1 - \lambda^2\Phi_2$. Finally, if the entrepreneur chooses VC-financing, the bank obtains zero from him. Therefore, the payment of the entrepreneur (with coefficient λ) to the bank, $P(\lambda)$, is given by

$$P(\lambda) = \begin{cases} (1+r^\star)K & \text{if } s^\star(\lambda) = B \text{ and } \lambda \leq \lambda_{r^\star} \\ \Phi_1 - \lambda^2\Phi_2 & \text{if } s^\star(\lambda) = B \text{ and } \lambda > \lambda_{r^\star} \\ 0 & \text{otherwise.} \end{cases} \tag{35}$$

In an equilibrium, each entrepreneur's financing strategy is optimal given his λ-coefficient and the lending interest rate $r^\star$. The lending interest rate clears the bank loan market. The VC gets her reservation utility given the offer $(\rho^\star, R^\star)$ of entrepreneurs who chooses VC-financing. Thus, we formally define an equilibrium in this economy as follows.

Definition 2 (Equilibrium) *A financing strategy $s^\star(\lambda)$, a lending interest rate $r^\star$, and an entrepreneur's offer $(\rho^\star, R^\star)$ to the VC constitute an equilibrium if*

1. *$s^\star(\lambda)$ is an optimal choice for every $\lambda \in [0, \bar{\lambda}]$.*
2. *Banks break even:*
$$\int_{\lambda_E \in \{\lambda : s^\star(\lambda) = B\}} (P(\lambda) - K)\,\mathrm{d}F(\lambda) = 0. \tag{36}$$
3. *For every $\lambda_E \in \{\lambda \in [0, \bar{\lambda}] : s^\star(\lambda) = VC\}$, the VC gets her reservation utility C, given the offer $(\rho^\star, R^\star)$.*

We later show that, in all strict Nash equilibria,[21] all entrepreneurs under a λ-coefficient threshold choose VC-financing while all those above this threshold choose bank-financing. We call such an equilibrium monotone. We formally define monotonicity of an equilibrium as follows.

Definition 3 (Monotonicity) *An equilibrium $(s^\star, r^\star, \rho^\star, R^\star)$ is monotone if there exists a $\lambda^\nabla \in [0, \bar{\lambda}]$ such that all entrepreneurs with $\lambda < \lambda^\nabla$ choose VC-financing and all entrepreneurs with $\lambda > \lambda^\nabla$ choose bank-financing.*

In a monotone equilibrium, banks play threshold strategies so that they expect to have entrepreneurs with $\lambda > \lambda^\nabla$ in their loan applicant pool and set their lending interest rates accordingly. There are two implications of monotonicity that deserves mentioning at this point. First, $\lambda^\nabla < \lambda_{r^\star}$ must be satisfied in every monotone equilibrium, otherwise all bank loan applicants would have negative NPV projects and banks could not break even. Second, equilibria in which only one type of financial intermediary is operative are trivially monotone.

Having defined what an equilibrium is, we now turn to the calculation of equilibria in this economy. Remember that Assumption 1 guarantees that some projects yield high enough monetary returns to pay off the VC. We make two additional assumptions. The first assumption is about project returns and it guarantees that there are entrepreneurs whose projects do not yield sufficient monetary returns to pay off the VC.

Assumption 2 (Monetary Returns) *The technology is such that the monetary returns of the project satisfies $\Phi_1 - \bar{\lambda}^2 \Phi_2 < K + C$.*

Assumptions 1 and 2 together imply that there must be a $\lambda_C \in (0, \bar{\lambda})$ such that

$$\Phi_1 - \lambda_C^2 \Phi_2 = K + C. \tag{37}$$

This means that some projects are creditworthy in the eyes of the VC while the rest are not. The other assumption is that the VC's λ-coefficient is (weakly) less than λ_C since otherwise the monetary returns generated when the VC is operating the project on his own is strictly negative, which conflicts with the fact that VC being a financial intermediary.

Assumption 3 (VC's λ-coefficient) $\lambda_{VC} \leq \lambda_C$.

[21] A Nash Equilibrium is *strict* if a player becomes *strictly* worse off by deviating from his equilibrium strategy.

Our motivation for this assumption is straightforward. Even though VC-financing is an active source of financing, a VC is still a financial intermediary, which means that there is a pecking order in her goals. Her major goal is to obtain monetary returns from financing start-up projects. Provided that she can earn positive monetary returns from a project, she then tries to enjoy non-contractible returns by having control in the firm. Thus, nonnegative monetary returns are necessary before enjoying nonmonetary returns.

The following lemma characterizes the best responses of entrepreneurs against a given $r^\star$ in each case. Because the payoff functions are continuous in all possibilities, we ignore without loss of generality the equality cases. Since there is one-to-one map between $r^\star$ and $\lambda_{r^\star}$, we focus on $\lambda_{r^\star}$, which implicitly defines an $r^\star$ value. There are three general cases to consider: In case A, $r^\star$ is such that $\lambda_{r^\star}$ is less than both λ_{VC} and λ_C. In case B, $r^\star$ is such that $\lambda_{r^\star}$ is in between λ_{VC} and λ_C. Finally in case C, $r^\star$ is such that $\lambda_{r^\star}$ is higher than both λ_{VC} and λ_C.

Lemma 4 (Best responses) *Suppose that Assumptions 1-3 hold. The best responses of an entrepreneur against a given lending interest rate, $\mathcal{BR}_E(r^\star)$, are given as follows.*

Case A *($\lambda_{r^\star} < \lambda_{VC} < \lambda_C$):*

- $\mathbf{A-1}$: *For entrepreneurs with $\lambda_E < \lambda_{r^\star} < \lambda_{VC} < \lambda_C$, $\mathcal{BR}_E(r^\star) = VC$.*
- $\mathbf{A-2}$: *For entrepreneurs with $\lambda_{r^\star} < \lambda_E < \lambda_{VC} < \lambda_C$, $\mathcal{BR}_E(r^\star) = VC$.*
- $\mathbf{A-3}$: *For entrepreneurs with $\lambda_{r^\star} < \lambda_{VC} < \lambda_E < \lambda_C$, $\mathcal{BR}_E(r^\star) = VC$.*
- $\mathbf{A-4}$: *For entrepreneurs with $\lambda_{r^\star} < \lambda_{VC} < \lambda_C < \lambda_E$, $\mathcal{BR}_E(r^\star) = B$.*

Case B *($\lambda_{VC} < \lambda_{r^\star} < \lambda_C$):*

- $\mathbf{B-1}$: *For entrepreneurs with $\lambda_E < \lambda_{VC} < \lambda_{r^\star} < \lambda_C$,*

$$\mathcal{BR}_E(r^\star) = \begin{cases} VC & \text{if } (\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + r^\star K - C > 0 \\ \{B, VC\} & \text{if } (\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + r^\star K - C = 0 \\ B & \text{otherwise.} \end{cases}$$

- $\mathbf{B-2}$: *For entrepreneurs with $\lambda_{VC} < \lambda_E < \lambda_{r^\star} < \lambda_C$,*

$$\mathcal{BR}_E(r^\star) = \begin{cases} VC & \text{if } r^\star K - C > 0 \\ \{B, VC\} & \text{if } r^\star K - C = 0 \\ B & \text{otherwise.} \end{cases}$$

- **B − 3** : *For entrepreneurs with* $\lambda_{VC} < \lambda_{r^\star} < \lambda_E < \lambda_C$, $\mathcal{BR}_E(r^\star) = VC$.

- **B − 4** : *For entrepreneurs with* $\lambda_{VC} < \lambda_{r^\star} < \lambda_C < \lambda_E$, $\mathcal{BR}_E(r^\star) = B$.

Case C *(*$\lambda_{VC} < \lambda_C < \lambda_{r^\star}$*):*

- **C − 1** : *For entrepreneurs with* $\lambda_E < \lambda_{VC} < \lambda_C < \lambda_{r^\star}$,

$$\mathcal{BR}_E(r^\star) = \begin{cases} VC & \textit{if } (\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + r^\star K - C > 0 \\ \{B, VC\} & \textit{if } (\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + r^\star K - C = 0 \\ B & \textit{otherwise.} \end{cases}$$

- **C − 2** : *For entrepreneurs with* $\lambda_{VC} < \lambda_E < \lambda_C < \lambda_{r^\star}$,

$$\mathcal{BR}_E(r^\star) = \begin{cases} VC & \textit{if } r^\star K - C > 0 \\ \{B, VC\} & \textit{if } r^\star K - C = 0 \\ B & \textit{otherwise.} \end{cases}$$

- **C − 3** : *For entrepreneurs with* $\lambda_{VC} < \lambda_C < \lambda_E < \lambda_{r^\star}$, $\mathcal{BR}_E(r^\star) = B$.

- **C − 4** : *For entrepreneurs with* $\lambda_{VC} < \lambda_C < \lambda_{r^\star} < \lambda_E$, $\mathcal{BR}_E(r^\star) = B$.

The proof of this lemma consists of a tedious check of all possible cases and is provided in Appendix A.4. A very important point to mention here is that because this lemma has no statement that stems from the distributional assumptions, our results are qualitatively independent of our uniform distribution assumption. Another important point is that, regardless of with whom she partners, the VC obtains an expected surplus of C and thus we may dispense with optimization concerns for her.

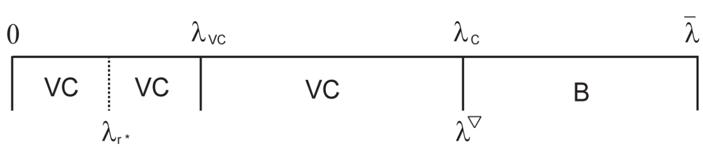

Figure 2: Best responses – Case A ($\lambda_{r^\star} < \lambda_{VC} < \lambda_C$)

We use figures, which are quite useful in visualizing the best responses, to derive the equilibria. Figure 2 shows the best responses in case A. In this case, by Lemma 4, all entrepreneurs with $\lambda > \lambda_C$ choose bank-financing while those with $\lambda < \lambda_C$ choose VC-financing. According to Definition 3, such an equilibrium is monotone with $\lambda^\nabla = \lambda_C$, if it exists. However, in this case, all those with $\lambda > \lambda_{r^\star}$ have negative NPV projects in the eyes of banks, which means that banks cannot break even. Therefore, case A cannot happen in general equilibrium.

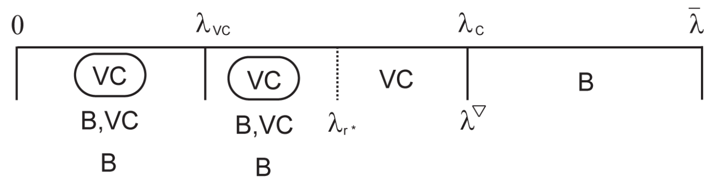

Figure 3: Best responses – Case B ($\lambda_{VC} < \lambda_{r^\star} < \lambda_C$)

Consider now case B, which is depicted in Figure 3. Notice that $\lambda_C > \lambda_{r^\star}$ in this case, which implies $r^\star K - C > 0$. Therefore, it is immediate to see that the best response for entrepreneurs with $\lambda_E \in [\lambda_{VC}, \lambda_{r^\star}]$ is VC-financing. Moreover, since $\lambda_{VC} > \lambda_E$ for entrepreneurs with $\lambda_E \in [0, \lambda_{VC}]$, we can conclude that $\lambda_{VC}^2 - \lambda_E^2 > 0$, which in turn implies $(\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + r^\star K - C > 0$. Thus, the best response for entrepreneurs with $\lambda_E \in [0, \lambda_{VC}]$ is also VC-financing. According to Definition 3, such an equilibrium is monotone with $\lambda^\nabla = \lambda_C$, if it exists. However, as in case A, all bank-financed entrepreneurs in this proposed equilibrium have negative NPV projects from the perspective of banks, which means that banks cannot break even. Hence, case B cannot happen in general equilibrium, either.

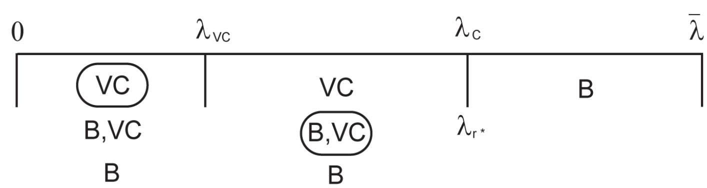

Figure 4: Best responses – Case C(i) ($\lambda_{VC} < \lambda_C = \lambda_{r^\star}$)

Finally, consider case C. Because the best responses of entrepreneurs change from VC-financing to bank-financing exactly at λ_C, we should check two possibilities, both of which are shown to constitute an equilibrium. The first possibility is a knife-edge situation in which $\lambda_C = \lambda_{r^\star}$. The best responses of this situation are shown in Figure 4. One can easily see that $r^\star K = C$ when $\lambda_C = \lambda_{r^\star}$. Therefore, as in case B, for all entrepreneurs with $\lambda_E < \lambda_{VC}$, the best response is VC-financing since $(\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + r^\star K - C > 0$. However, this time, all entrepreneurs with $\lambda_E \in [\lambda_{VC}, \lambda_C]$ are indifferent between bank- and VC-financing because $r^\star K - C = 0$, and that is why this is a knife-edge situation. The only requirement that is left to be satisfied for a general equilibrium is the zero-profit condition for banks, which can be satisfied if entrepreneurs who are indifferent between the two strategies properly sort themselves between bank and VC-financing. We call such an equilibrium a *type I equilibrium.* This equilibrium is not a strict Nash Equilibrium because entrepreneurs who are indifferent between bank- and VC-financing do not become strictly worse off if they deviate from their equilibrium strategy. We record these results in the following proposition.

Proposition 4 (Type I Equilibrium) *Suppose that Assumptions 1-3 hold. Then, there can be an equilibrium such that $r^\star = C/K$ and entrepreneurs with $\lambda_E \in [0, \lambda_{VC})$ choose VC-financing, entrepreneurs with $\lambda_E \in [\lambda_C, \bar{\lambda}]$ choose bank-financing, and entrepreneurs with $\lambda_E \in [\lambda_{VC}, \lambda_C]$ choose between bank- and VC-financing in any way until the markets clear. This equilibrium is not a strict Nash Equilibrium.*

Type I equilibrium is not *necessarily* monotone. Entrepreneurs with low λ-coefficients (*i.e.,* $\lambda_E \in [0, \lambda_{VC}]$) prefer VC-financing, entrepreneurs with high λ-coefficients (*i.e.,* $\lambda_E \in [\lambda_C, \bar{\lambda}]$) prefer bank-financing but entrepreneurs in the middle-range can sort themselves in any way as long as the zero profit condition for banks is satisfied.

Consider the monotone version of a type I equilibrium. Suppose that there exists a $\lambda^\nabla \in [\lambda_{VC}, \lambda_C]$ such that entrepreneurs with $\lambda_E \in [\lambda_{VC}, \lambda^\nabla]$ choose VC-financing while those with $\lambda_E \in [\lambda^\nabla, \lambda_C]$ choose bank-financing. Then, the zero profit condition is given by

$$\int_{\lambda^\nabla}^{\lambda_C} (1 + r^\star) K \mathrm{d}F(\lambda) + \int_{\lambda_C}^{\bar{\lambda}} \left(\Phi_1 - \lambda^2 \Phi_2\right) \mathrm{d}F(\lambda) - K \int_{\lambda^\nabla}^{\bar{\lambda}} \mathrm{d}F(\lambda) = 0. \tag{38}$$

Substituting in $r^\star = C/K$, incorporating the uniform distribution assumption, and solving λ^∇ for yields

$$\lambda^\nabla = \frac{\lambda_C (K + C) + \left(\bar{\lambda} - \lambda_C\right) \Phi_1 - \left(\frac{\bar{\lambda}^3 - \lambda_C^3}{3}\right) \Phi_2 - \bar{\lambda} K}{C} \in [\lambda_{VC}, \lambda_C). \tag{39}$$

We have already shown that in every equilibrium in which banks are operative $\lambda_{r^\star} \geq \lambda_C \geq \lambda_{VC}$ since cases A and B proved to be nonexistent in general equilibrium. Moreover, remember that $\lambda_{r^\star}$ and $r^\star$ are negatively related and there are no other equilibria in which banks are operative when $\lambda_{r^\star} < \lambda_C$. Thus, $r^\star = C/K$ is indeed the highest equilibrium lending interest rate in any economy in which both banks and the VC are operative. Then, we have the following corollary.

Corollary 1 (Properties of Type I Equilibrium) *Type I equilibrium is not necessarily monotone. A monotone type I equilibrium is characterized by $r^\star = C/K$ and (39). Moreover,*

$r^\star = C/K$ is the highest equilibrium lending interest rate with minimum number of bank-financed entrepreneurs in any economy in which both banks and the VC are operative.

A special case of monotone type I equilibrium occurs when $\lambda^\nabla = \lambda_C$ in which all entrepreneurs who are indifferent between bank- and VC-financing choose VC-financing. However, as in cases A and B, banks cannot break even in this case, which means that this special case cannot happen in general equilibrium. That is why $\lambda^\nabla \in [\lambda_{VC}, \lambda_C)$. Another special case occurs when $\lambda^\nabla = \lambda_{VC}$ in which all entrepreneurs who are indifferent between bank- and VC-financing choose bank-financing. This case is indeed a bank-only equilibrium which we work out in Section 4.

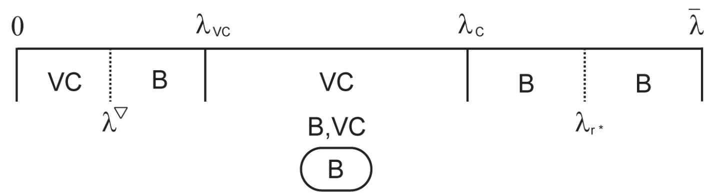

Figure 5: Best responses – Case C(ii) ($\lambda_{VC} < \lambda_C < \lambda_{r^\star}$)

The second possibility in case C is the situation in which $\lambda_C < \lambda_{r^\star}$. The best responses in this situation are shown in Figure 5. One can easily see that $r^\star K < C$ when $\lambda_C < \lambda_{r^\star}$. Because $r^\star K - C < 0$, all entrepreneurs with $\lambda_E \in [\lambda_{VC}, \lambda_C]$ prefer bank-financing. However, the best responses of entrepreneurs with $\lambda_E < \lambda_{VC}$ depends on whether $(\lambda_{VC}^2 - \lambda_E^2)\Phi_2 > 0$ is greater or smaller than $r^\star K - C < 0$ in absolute value. The best response of entrepreneurs who satisfy $(\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + r^\star K - C > 0$ is VC-financing while the best response of entrepreneurs who satisfy $(\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + (r^\star K - C) < 0$ is bank-financing. Therefore, there is a $\lambda^\nabla \in [0, \lambda_{VC}]$ in case C such that all entrepreneurs above λ^∇ prefer bank-financing while the rest prefer VC-financing. Moreover, banks can make zero expected profits, which means that we obtain another equilibrium. We call such an equilibrium a *type II equilibrium.*

The equilibrium lending interest rate in a type II equilibrium is found from the zero-profit condition given in (36):

$$\int_{\lambda^\nabla}^{\lambda_{r^\star}} (1 + r^\star) K \mathrm{d}F(\lambda) + \int_{\lambda_{r^\star}}^{\bar{\lambda}} \left(\Phi_1 - \lambda^2 \Phi_2\right) \mathrm{d}F(\lambda) = \int_{\lambda^\nabla}^{\bar{\lambda}} K \mathrm{d}F(\lambda), \tag{40}$$

where $\lambda_{r^\star} \in (\lambda_C, \bar{\lambda})$. Incorporating the uniform distribution assumption and solving for λ^∇ yields

$$\lambda^\nabla = \frac{\lambda_{r^\star}(1+r^\star)K + \left(\bar{\lambda} - \lambda_{r^\star}\right)\Phi_1 - \left(\frac{\bar{\lambda}^3 - \lambda_{r^\star}^3}{3}\right)\Phi_2 - \bar{\lambda}K}{r^\star K} \in [0, \lambda_{VC}). \tag{41}$$

Moreover, the entrepreneur with coefficient λ^∇ must be indifferent between bank- and VC-financing, which means $\Phi_1 + \lambda_{VC}^2\Phi_2 - K - C = \Phi_1 + (\lambda^\nabla)^2\Phi_2 - (1+r^\star)K$. Then, the equilibrium lending interest rate is given by

$$r^\star = \frac{\left(\left(\lambda^\nabla\right)^2 - \lambda_{VC}^2\right)\Phi_2 + C}{K}. \tag{42}$$

A special case of type II equilibrium occurs when $\lambda^\nabla = 0$, in which case a bank-only equilibrium is obtained. Our conclusions above lead to the following proposition.

Proposition 5 (Type II Equilibrium) *Suppose that Assumptions 1-3 hold. Then, there can be an equilibrium solving (16), (41), and (42) simultaneously. This equilibrium is a strict Nash Equilibrium and it is always monotone.*

There is an important corollary of this proposition.

Corollary 2 (Monotonicity of Strict Nash Equilibrium) *All strict Nash Equilibria in which both banks and the VC are operative must be monotone.*

We have already mentioned that all Nash Equilibria in which only one type of financial intermediary is operative are trivially monotone. In addition, the above corollary finds that, in all strict Nash equilibria in which both banks and the VC are operative, entrepreneurs who value nonmonetary returns more choose bank-financing while the rest choose VC-financing. Thus, it is always the case that bank-financed entrepreneurs allocate more resources to task 2, the task that yields the nonmonetary returns, than their VC-financed counterparts. This also means that projects of the VC-financed entrepreneurs have higher internal rate of return, or they are more profitable in other words.

We close this section with some start-up financing arithmetic. Our purpose in these back-of-the-envelope calculations is not to come up with the most realistic calibrated example but rather to show the possibility of coexistence of type I, type II, and bank-only equilibria under the same parameter specifications.

Consider a unit investment; thus, set $K = 1$. We assume $C = 0.687$, which implies a lending interest rate of $r^\star = C/K = 6.870\%$ in a type I equilibrium. This interest rate is in line with lending interest rates published in Federal Reserve's statistical releases in 1990s. We assume that the coefficient terms is distributed between zero and 4.2; that is, $\bar{\lambda} = 4.2$. Dyck and Zingales (2004) estimate the average value of private benefits as 14% of the equity value of a firm. We employ this as a rough measure of nonmonetary returns. So, if $\Phi_2 = 1$, then Φ_1 can be found from

$$\frac{E[\lambda_E \Phi_2]}{E[\Phi_1 + \lambda_E \Phi_2]} = \frac{(\bar{\lambda}/2)\Phi_2}{\Phi_1 + (\bar{\lambda}/2)\Phi_2} = \frac{14}{100}, \tag{43}$$

which yields $\Phi_1 = 12.9$.

Consider monotone type I equilibrium. From (39), we find that $\lambda^\nabla = 0.3672$. This means that the VC industry is active only in the 8.7418% of the economy. Is this a reasonable number? By using the National Survey of Small Business Finances (NSSBF), Berger and Udell (1998) find the estimated distributions of equity and debt in the small business finance. In their estimations, VC's share is 1.85% while the commercial banks' share is 18.75%. This means that the relative size of the VC industry is 8.98%, which is pretty close to our back-of-the-envelope calculation here.

Table 1: Numerical Example

	Type I eq. (monotone)	Type II eq.	Bank-only eq.
λ_C	3.3486	3.3486	3.3486
$\lambda_{r^\star}$	3.3486	3.3505	3.3598
λ^∇	0.3672	0.3097	0
$r^\star$	6,8700%	6.7402%	6.1180%
$\lambda^\nabla/\bar{\lambda}$	8.7418%	7.3739%	0%

Parameters: $\Phi_1 = 12.9$, $\Phi_2 = 1$, $K = 1$, $C = 0,687$
$\bar{\lambda} = 4.2$, $\lambda_{VC} = 0.33$.

Table 1 reports the equilibrium outcomes for different equilibrium types. It turns out that, under the same parameters, we have a type II equilibrium in which the size of the VC industry is 7.3739% and the bank lending interest rate is 6.7402%. There is also a bank-only equilibrium with a lending interest rate of 6.1180%. We thus have the following proposition.

Proposition 6 (Coexistence of Equilibria) *Type I, type II, and bank-only equilibria may coexist.*

7 Conclusion

The existence of private benefits on behalf of the entrepreneur is now a standard feature of entrepreneurial finance models. Unlike banks, VCs are not passive investors. They are specialized financial intermediaries who take considerable control in their portfolio firms. Protective provision terms in contracts allow them to veto transactions that are unfavorable to them and board control gives them the ability to initiate new transactions.

The basic insight we underline in this paper is that if control allows the entrepreneur to enjoy private benefits, it also allow the VC to enjoy them. This paper is the first to incorporate this difference between active and passive sources of finance. Under this conjecture, we focus on entrepreneurs' financing strategy between banks and the VC. We find that, in all strict Nash Equilibria, entrepreneurs who value private benefits more finance from banks while the rest go to VCs. Therefore, VC-financed entrepreneurs have higher internal rate of return whereas bank-financed entrepreneurs divert more resources in their firms to the task that yield the private benefits.

There are couple of important features of VC industry, which are already well studied in the literature, that we do not focus in this paper: intensive monitoring by the VC (Gompers (1996)); staging of funding (Bergemann and Hege (1998), Cornelli and Yosha (2003)); usage of special financial instruments such as convertible securities (Marx (1998), Repullo and Suarez (2004), Schmidt (2003)); syndication of VC investments (Admati and Pfleiderer (1994), Brander, Amit, and Antweiler (2002), Lerner (1994)); and the exit route of VCs (Black and Gilson (1998), Cumming (2008), Cumming, Fleming, and Schwienbacher (2006), Cumming and Johan (2008), Schwienbacher (2008, 2009)). A nice venue of future research is to interact all of these features with the entrepreneur's choice between bank- and VC-financing to better understand the market split between the two.

A Appendix

A.1 Proof of Lemma 2

Under Assumption 1, the non-emptiness is trivial, because $(\Pi_E(\lambda_{VC}), \Pi_{VC}(\lambda_{VC}))$ is in S. Moreover, since all variables are continuous and $[\min\{\lambda_E, \lambda_{VC}\}, \max\{\lambda_E, \lambda_{VC}\}]$ is compact, compactness of S follows. Since showing convexity of S is a standard exercise, it suffices to prove that $\digamma$ is strictly concave. To that regard, let $\alpha \in (0,1)$ and $\pi, \pi' \in \digamma$ with

$\lambda \neq \lambda'$ such that $\pi_i = \Pi_i(\lambda)$ and $\pi_i' = \Pi_i(\lambda')$, for all i. For a contradiction, suppose that $\tilde{\pi} = \alpha\pi + (1-\alpha)\pi'$ is in $\mathcal{F}$. Then, there exists a $\tilde{\lambda}$ such that $\tilde{\pi}_i = \Pi_i(\tilde{\lambda})$. Hence, due to the strict concavity of Π_i, established in Lemma 1, we have

$$\Pi_i(\tilde{\lambda}) = \alpha\Pi_i(\lambda) + (1-\alpha)\Pi_i(\lambda') < \Pi_i(\alpha\lambda + (1-\alpha)\lambda'), \quad i = \{E, VC\}. \tag{A-1}$$

Finally, without loss of generality, assume that $\lambda_E > \lambda_{VC}$. Due to the Lemma 1, we know that Π_E is strictly increasing and therefore (A-1) implies $\tilde{\lambda} < \alpha\lambda + (1-\alpha)\lambda'$. This completes the proof since (A-1) and Π_{VC} being strictly decreasing imply $\tilde{\lambda} > \alpha\lambda + (1-\alpha)\lambda'$, which delivers the necessary contradiction.

A.2 Proof of Lemma 3

The required conditions for the existence of the utilitarian bargaining solution have been shown to be satisfied. Namely, S is compact and convex, $\mathbf{d} \in S$, and by Assumption 1, there exists some $s \in S$ with $s_j > 0$ for $j = 1, 2$. Therefore, for any $\theta \in [0, 1]$ we have $\mathcal{N}(S, \mathbf{d}; \theta) \neq \emptyset$. Moreover, since $\mathcal{F}$ is strictly concave, $\mathcal{N}(S, \mathbf{d}; \theta)$ is a function. By the Pareto Efficiency axiom of the utilitarian bargaining solutions, $\mathcal{N}(S, \mathbf{d}; \theta) \in \mathcal{F}$ for all $\theta \in [0, 1]$. Recall that the definition of $\mathcal{F}$ implies that there is some $\lambda^\theta \in [\lambda_{VC}, \lambda_E]$ such that $\mathcal{N}(S, \mathbf{d}; \theta) = (\pi_1^\theta, \pi_2^\theta) = (\Pi_E(\lambda^\theta), \Pi_{VC}(\lambda^\theta))$. This λ^θ is unique because Π_is are one-to-one (strictly monotone) functions of λ on $[\min\{\lambda_E, \lambda_{VC}\}, \max\{\lambda_E, \lambda_{VC}\}]$ by Lemma 1. Trivially, when $\lambda_E = \lambda_{VC}$, $\lambda^\theta = \lambda_E = \lambda_{VC}$. Without loss of generality, let $\lambda_E > \lambda_{VC}$. Therefore, solving the following maximization problem with first-order conditions

$$\max_{\lambda \in [\lambda_{VC}, \lambda_E]} \{\theta\left[\Phi_1 + \lambda\left(2\lambda_E - \lambda\right)\Phi_2\right] + (1-\theta)\left[\Phi_1 + \lambda\left(2\lambda_{VC} - \lambda\right)\Phi_2\right]\} \tag{A-2}$$

delivers the conclusion upon observing that the objective function is linear, the boundary of the constraint set is strictly concave by Lemma 2, and $\lambda_E - \lambda_{VC} > 0$.

A.3 Proof of Proposition 2

When Assumption 1 holds, the constraint set is non-empty and compact. Thus, there exists a solution due to the continuity of the objective function given in (27). We should consider three different cases $\lambda_E > \lambda_{VC}$, $\lambda_E = \lambda_{VC}$, and $\lambda_E < \lambda_{VC}$. Under each case, there are two subcases, one in which the entrepreneur is able to pay off the VC (*i.e.*, $\Phi_1 - \lambda^2\Phi_2 \geq K + C$) and the other in which he is not (*i.e.*, $\Phi_1 - \lambda^2\Phi_2 < K + C$). Consider each case in turn.

Case 1: Suppose $\lambda_E > \lambda_{VC}$. When $\lambda_E > \lambda_{VC}$, $\tilde{\Pi}_E(\rho, R)$ is strictly increasing and $\tilde{\Pi}_{VC}(\rho, R)$ is strictly decreasing in ρ. This implies that the participation constraint of the VC holds with equality at the solution $(\rho^\star, R^\star)$. Thus, ignoring the participation constraint of the entrepreneur for now, we can write down (27) as

$$\max_{(\rho,R)} \left\{\rho\Pi_E\left(\rho\lambda_E + (1-\rho)\lambda_{VC}\right) + (1-\rho)\Pi_{VC}\left(\rho\lambda_E + (1-\rho)\lambda_{VC}\right) - (K+C)\right\}. \tag{A-3}$$

By Lemma 1, this objective function is continuous in ρ. Moreover, the entrepreneur is solving a non-trivial utilitarian planner's problem where the weights assigned to the principals must be interpreted as their shares of the project.

Let $\Phi_1 - \lambda_E^2\Phi_2 \geq K + C$ (*i.e.,* the monetary returns of the project when the entrepreneur operates it is greater than or equal to the start-up cost plus the VC's disagreement payoff). Because that the entrepreneur is solving a planner's problem given in (A-3) and $\Pi_E(\lambda_E) - \Pi_{VC}(\lambda_{VC}) = \Phi_2(\lambda_E^2 - \lambda_{VC}^2) > 0$ by $\lambda_E > \lambda_{VC}$, the optimal solution is such that the entrepreneur is the sole owner of the project. In expected terms, he pays off the start-up cost of the firm borrowed from the VC, K, and his disagreement payoff, C, in full out of the monetary returns of the project given by $\Phi_1 - \lambda_E^2\Phi_2$. This is the unique solution of this case. Note that the participation constraint of the entrepreneur is satisfied in equilibrium:

$$\Phi_1 + \lambda_E^2\Phi_2 - R^\star = \Phi_1 + \lambda_E^2\Phi_2 - (K+C) \geq \Phi_1 + \lambda_E^2\Phi_2 - (\Phi_1 - \lambda_E^2\Phi_2) = 2\lambda_E^2\Phi_2 > 0. \tag{A-4}$$

If $\Phi_1 - \lambda_E^2\Phi_2 < K + C$, then setting $\rho = 1$ violates the participation constraint of the VC. As a result, the entrepreneur tries to compensate the VC with monetary payments as much as possible in order not to distort the returns from the project (because considering the planner's problem given in (A-3) reveals that the social optimum requires that the entrepreneur is allocated as much shares as possible). The remaining part is covered by ownership shares to the VC, which the entrepreneur tries to keep as minimal. Consequently, the entrepreneur gives all monetary returns he collects with his share ρ to the VC. Thus, for any ρ, $R = \rho(\Phi_1 - (\lambda^\rho)^2\Phi_2)$. Consequently, the VC's payoff at ρ should satisfy

$$\rho\left(\Phi_1 - (\lambda^\rho)^2\Phi_2\right) + (1-\rho)\left(\Phi_1 + \lambda^\rho(2\lambda_{VC} - \lambda^\rho)\Phi_2\right) \geq K + C. \tag{A-5}$$

Here, the first term on the left-hand side is the monetary returns that the entrepreneur earns from the project and the second term is the VC's monetary and nonmonetary returns.

Manipulating this yields

$$
\begin{aligned}
&\rho\left(\Phi_1-\left(\lambda^{\rho}\right)^2\Phi_2\right)+(1-\rho)\left(\Phi_1+\lambda^{\rho}(2\lambda_{VC}-\lambda^{\rho})\Phi_2\right)\geq K+C\\
&=\rho\left(\Phi_1-\left(\lambda^{\rho}\right)^2\Phi_2\right)+(1-\rho)\left[\left(\Phi_1-\left(\lambda^{\rho}\right)^2\Phi_2\right)+\left(\lambda^{\rho}\left(2\lambda_{VC}-\lambda^{\rho}\right)+\left(\lambda^{\rho}\right)^2\right)\Phi_2\right]\geq K+C\\
&=\left(\Phi_1-\left(\lambda^{\rho}\right)^2\Phi_2\right)+2\left(1-\rho\right)\lambda^{\rho}\lambda_{VC}\Phi_2\geq K+C. \qquad \text{(A-6)}
\end{aligned}
$$

At the optimum, it must be that the VC does not obtain any surplus. As a result, $\rho^\star\in[0,1]$ must be the maximal real number (because recall that $\Pi_E(\cdot,R)$ is strictly increasing in ρ) such that

$$2\left(1-\rho^\star\right)\lambda^\star\lambda_{VC}\Phi_2=K+C-\left(\Phi_1-\left(\lambda^\star\right)^2\Phi_2\right). \qquad \text{(A-7)}$$

Note that the right-hand side of this equation gives the amount of monetary returns that the entrepreneur is short on and the left-hand side gives the nonmonetary returns of the VC. Manipulating this expression yields

$$
\begin{aligned}
&\Phi_1-\left(\lambda^\star\right)^2\Phi_2+2\left(1-\rho^\star\right)\lambda^\star\lambda_{VC}\Phi_2-(K+C)=0\\
&\lambda^\star\left(2(1-\rho^\star)\lambda_{VC}-\lambda^\star\right)\Phi_2=K+C-\Phi_1. \qquad \text{(A-8)}
\end{aligned}
$$

Finally, substituting $\lambda^\star=\rho^\star\lambda_E+(1-\rho^\star)\lambda_{VC}$ gives the following conclusion: $\rho^\star\in[0,1]$ is the maximal real number such that

$$\left(\left(1-\rho^\star\right)^2\lambda_{VC}^2-\left(\rho^\star\right)^2\lambda_E^2\right)\Phi_2=K+C-\Phi_1. \qquad \text{(A-9)}$$

Case 2: Suppose $\lambda_E=\lambda_{VC}=\lambda$. Because that the two principals' interests are perfectly aligned, this case features many solutions.

When $\Phi_1-\lambda^2\Phi_2\geq K+C$, the monetary returns from the project are sufficient to pay off K and C. Given $\rho\in[0,1]$, the monetary payment that should be made to the VC (for whom the participation constraint holds with equality) is $R=K+C-(1-\rho)(\Phi_1+\lambda^2\Phi_2)$. If $R>0$, the monetary payments need to be made by the entrepreneur to cover R calls for $\rho(\Phi_1-\lambda^2\Phi_2)\geq K+C-(1-\rho)(\Phi_1+\lambda^2\Phi_2)$, the left-hand side giving us the monetary returns allocated to the entrepreneur at ρ and the right-hand side the monetary payment needed to be made to the VC. This implies $(1-2\rho)\lambda^2\Phi_2\geq K+C-\Phi_1$. Hence, every $\rho\in[0,1]$ is a solution, because then in all of them the entrepreneur obtains the highest returns which is due to $\rho(\Phi_1+\lambda^2\Phi_2)-R=\rho(\Phi_1+\lambda^2\Phi_2)-(K+C)+(1-\rho)(\Phi_1+\lambda^2\Phi_2)=\Phi_1+\lambda^2\Phi_2-(K+C)\geq 0$, where the final inequality is due to Assumption 1. Furthermore, the situation in which the monetary payments to the entrepreneur from the project are not sufficient to pay off the VC is not possible. This is because we need to have $(1-2\rho)\lambda^2\Phi_2 < K - \Phi_1$, which contradicts to the hypothesis that $\Phi_1 - \lambda^2\Phi_2 \geq K + C$ for any value of $\rho \in [0,1]$.

When $\Phi_1 - \lambda^2\Phi_2 < K + C$, the monetary returns from the project if the entrepreneur were the sole owner are not sufficient to pay off $K+C$. The payment needed to be made for a given level of ρ is $R = K+C-(1-\rho)(\Phi_1+\lambda^2\Phi_2)$. Therefore, we have a solution if ρ is such that $\rho(\Phi_1-\lambda^2\Phi_2) \geq K+C-(1-\rho)(\Phi_1+\lambda^2\Phi_2)$ (which implies $(1-2\rho)\lambda^2\Phi_2 \geq K+C-\Phi_1$). Note that $\rho^\star = 0$ and $R^\star = K+C-(\Phi_1+\lambda^2\Phi_2) < 0$ is such a solution (yet $\rho^\star = 1$ and $R^\star = K+C$ is not a solution in this case, because the monetary payments from the project to the liquidity-constrained entrepreneur is not sufficient to cover $K+C$). The participation constraint of the entrepreneur is clearly satisfied and he obtains the highest payoff possible: $\rho(\Phi_1+\lambda^2\Phi_2)-R = \rho(\Phi_1+\lambda^2\Phi_2)-(K+C)+(1-\rho)(\Phi_1+\lambda^2\Phi_2) = \Phi_1+\lambda^2\Phi_2-(K+C) \geq 0$.

Case 3: Suppose $\lambda_E < \lambda_{VC}$. In this case, the entrepreneur's problem shown in (A-3) calls for choosing ρ as low as possible, because, when $\lambda_E < \lambda_{VC}$, $\tilde{\Pi}_E(\rho,R)$ is strictly decreasing and $\tilde{\Pi}_{VC}(\rho,R)$ strictly increasing in ρ. Moreover, the VC is not liquidity constrained. Finally, because the entrepreneur makes a monetary return of $-R = \Phi_1 + \lambda_{VC}^2\Phi_2 - (K+C)$, which strictly exceeds $\Phi_1 + \lambda_E^2\Phi_2 - (K+C) \geq 0$ due to Assumption 1, his participation constraint is also satisfied. This is the unique solution of this case.

A.4 Proof of Lemma 4

There are three general cases to consider: case A: $\lambda_{r^\star} < \lambda_{VC} < \lambda_C$, case B: $\lambda_{VC} < \lambda_{r^\star} < \lambda_C$, case C: $\lambda_{VC} < \lambda_C < \lambda_{r^\star}$. Due to the continuity of the payoff functions in every possible case, it suffices to check for strict inequalities.

Case A ($\lambda_{r^\star} < \lambda_{VC} < \lambda_C$): The inequality $\lambda_{r^\star} \leq \lambda_C$ implies $r^\star K - C \geq 0$.

Case A-1 ($\lambda_E < \lambda_{r^\star} < \lambda_{VC} < \lambda_C$): An entrepreneur's return by choosing bank-financing is $\Phi_1 + \lambda_E^2\Phi_2 - (1+r^\star)K$, which is positive because $\lambda_E < \lambda_{r^\star}$. On the other hand, his return by choosing VC-financing is $\Phi_1 + \lambda_{VC}^2\Phi_2 - (K+C)$, which is positive because $\lambda_E < \lambda_{VC} < \lambda_C$. Hence, choosing VC-financing instead of bank-financing delivers the entrepreneur a net payoff of $(\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + (r^\star K - C)$. Because that $\lambda_{VC} > \lambda_E$ and $r^\star K - C > 0$, $(\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + (r^\star K - C) > 0$. Thus, the entrepreneur's best response is

$$\mathcal{BR}_E^{\mathbf{A-1}} = VC. \tag{A-10}$$

Case A-2 ($\lambda_{r^\star} < \lambda_E < \lambda_{VC} < \lambda_C$): An entrepreneur's return by choosing bank-financing is $2\lambda_E^2\Phi_2$, which is positive because $\lambda_E > \lambda_{r^\star}$. On the other hand, his return by choosing VC-financing is $\Phi_1 + \lambda_{VC}^2\Phi_2 - (K+C) > 0$, which is positive because $\lambda_{VC} > \lambda_E$. Moreover, because that $\lambda_{r^\star} < \lambda_C$, we have $r^\star K - C > 0$. Consequently, $\Phi_1 + \lambda_{VC}^2\Phi_2 - (K+C) > 2\lambda_E^2\Phi_2$, because otherwise

$$\begin{aligned} 0 &\geq \Phi_1 + \lambda_{VC}^2\Phi_2 - (K+C) - 2\lambda_E^2\Phi_2 \\ &= \Phi_1 + \left(\lambda_{VC}^2 - 2\lambda_E^2\right)\Phi_2 - (K+C) > \Phi_1 - \lambda_E^2\Phi_2 - (K+C), \end{aligned} \tag{A-11}$$

contradicting to $\lambda_E \leq \lambda_C$. Thus, the entrepreneur's best response is

$$\mathcal{BR}_E^{\mathbf{A-2}} = VC. \tag{A-12}$$

Case A-3 ($\lambda_{r^\star} < \lambda_{VC} < \lambda_E < \lambda_C$): An entrepreneur's return by choosing bank-financing is $2\lambda_E^2\Phi_2$, which is positive because $\lambda_{r^\star} < \lambda_E$. On the other hand, his return by choosing VC-financing is $\Phi_1 + \lambda_E^2\Phi_2 - (K+C) > 0$, which is positive because $\lambda_{VC} < \lambda_E < \lambda_C$. Thus, bank-financing cannot be a best response, because if it were $2\lambda_E^2\Phi_2 \geq \Phi_1 + \lambda_E^2\Phi_2 - (K+C)$ would result in $\Phi_1 - \lambda_E^2\Phi_2 - (K+C) \leq 0$, a contradiction to $\lambda_E < \lambda_C$. Thus, the entrepreneur's best response is

$$\mathcal{BR}_E^{\mathbf{A-3}} = VC. \tag{A-13}$$

Case A-4 ($\lambda_{r^\star} < \lambda_{VC} < \lambda_C < \lambda_E$): An entrepreneur's return by choosing bank-financing is $2\lambda_E^2\Phi_2 > 0$, which is positive because $\lambda_E > \lambda_{r^\star}$. On the other hand, his return by choosing VC-financing is $2\rho^\star\lambda_E(\rho^\star\lambda_E + (1-\rho^\star)\lambda_{VC})\Phi_2 > 0$ where $\rho^\star$ is the maximal real number in $[0,1]$ that satisfies the equation $((1-\rho^\star)^2\lambda_{VC}^2 - \rho^{\star 2}\lambda_E^2)\Phi_2 = K + C - \Phi_1$. Because that

$$2\rho^\star\lambda_E(\rho^\star\lambda_E + (1-\rho^\star)\lambda_{VC})\Phi_2 < 2\rho^\star\lambda_E^2\Phi_2 \leq 2\lambda_E^2\Phi_2, \tag{A-14}$$

as a result of $\lambda_E > \lambda_C > \lambda_{VC}$ and $\rho^\star \leq 1$, the entrepreneur's best response is

$$\mathcal{BR}_E^{\mathbf{A-4}} = B. \tag{A-15}$$

Case B ($\lambda_{VC} < \lambda_{r^\star} < \lambda_C$):

Case B-1 ($\lambda_E < \lambda_{VC} < \lambda_{r^\star} < \lambda_C$): An entrepreneur's return by choosing bank-financing is $\Phi_1 + \lambda_E^2\Phi_2 - (1+r^\star)K$, which is positive because $\lambda_E < \lambda_{r^\star}$. On the other hand, his return by choosing VC-financing is $\Phi_1 + \lambda_{VC}^2\Phi_2 - (K+C)$, which is positive because $\lambda_E < \lambda_{VC} < \lambda_C$. Hence, choosing VC-financing instead of bank-financing delivers the entrepreneur a net payoff of $(\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + (r^\star K - C)$. Thus, the entrepreneur's best response is

$$\mathcal{BR}_E^{\mathbf{B-1}} = \begin{cases} VC & \text{if } (\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + r^\star K - C > 0 \\ \{B, VC\} & \text{if } (\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + r^\star K - C = 0 \\ B & \text{otherwise.} \end{cases} \tag{A-16}$$

Case B-2 ($\lambda_{VC} < \lambda_E < \lambda_{r^\star} < \lambda_C$): An entrepreneurs return by choosing bank-financing is $\Phi_1 + \lambda_E^2\Phi_2 - (1 + r^\star)K > 0$, which is positive because $\lambda_E < \lambda_{r^\star}$. On the other hand, his return by choosing VC-financing is $\Phi_1 + \lambda_E^2\Phi_2 - (K + C)$, which is positive because $\lambda_{VC} < \lambda_E$. Thus, the entrepreneur's best response is

$$\mathcal{BR}_E^{\mathbf{B-2}} = \begin{cases} VC & \text{if } r^\star K - C > 0 \\ \{B, VC\} & \text{if } r^\star K - C = 0 \\ B & \text{otherwise.} \end{cases} \tag{A-17}$$

Case B-3 ($\lambda_{VC} < \lambda_{r^\star} < \lambda_E < \lambda_C$): An entrepreneur's return by choosing bank-financing is $\Phi_1 + \lambda_E^2\Phi_2 - (\Phi_1 - \lambda_E^2\Phi_2) = 2\lambda_E^2\Phi_2 > 0$. On the other hand, his return by choosing VC-financing is $\Phi_1 + \lambda_E^2\Phi_2 - (K + C)$, which is positive because $\lambda_{VC} < \lambda_E < \lambda_C$. Thus, bank-financing cannot be a strict best response, because if it were $2\lambda_E^2\Phi_2 > \Phi_1 + \lambda_E^2\Phi_2 - (K + C)$ would result in $\Phi_1 - \lambda_E^2\Phi_2 - (K + C) < 0$, a contradiction to the condition $\lambda_E < \lambda_C$. Thus, the entrepreneur's best response is

$$\mathcal{BR}_E^{\mathbf{B-3}} = VC. \tag{A-18}$$

Case B-4 ($\lambda_{VC} < \lambda_{r^\star} < \lambda_C < \lambda_E$): An entrepreneur's return by choosing bank-financing is $2\lambda_E^2\Phi_2$, which is positive because $\lambda_{r^\star} < \lambda_E$. On the other hand, his return by choosing VC-financing is $2\rho^\star\lambda_E(\rho^\star\lambda_E + (1 - \rho^\star)\lambda_{VC})\Phi_2 > 0$ where $\rho^\star$ is the maximal real number in $[0, 1]$ that satisfies the equation $((1 - \rho^\star)^2\lambda_{VC}^2 - \rho^{\star 2}\lambda_E^2)\Phi_2 = K + C - \Phi_1$. We have that

$$2\rho^\star\lambda_E(\rho^\star\lambda_E + (1 - \rho^\star)\lambda_{VC})\Phi_2 < 2\rho^\star\lambda_E^2\Phi_2 \leq 2\lambda_E^2\Phi_2, \tag{A-19}$$

as a result of $\lambda_{VC} < \lambda_E$. This also implies $\rho^\star < 1$ because $\lambda_E > \lambda_C$. Thus, the entrepreneur's best response is

$$\mathcal{BR}_E^{\mathbf{B-4}} = B. \tag{A-20}$$

Case C ($\lambda_{VC} < \lambda_C < \lambda_{r^\star}$):

Case C-1 ($\lambda_E < \lambda_{VC} < \lambda_C < \lambda_{r^\star}$): An entrepreneur's return by choosing bank-financing is $\Phi_1 + \lambda_E^2\Phi_2 - (1+r^\star)K$, which is positive because $\lambda_E < \lambda_{r^\star}$. On the other hand, his return by choosing VC-financing is $\Phi_1+\lambda_{VC}^2\Phi_2-(K+C)$, which is positive because $\lambda_E < \lambda_{VC} < \lambda_C$. Hence, choosing VC-financing instead of bank-financing delivers the entrepreneur a net payoff of $(\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + r^\star K - C$. Thus, the entrepreneur's best response is

$$\mathcal{BR}_E^{\mathbf{C-1}} = \begin{cases} VC & \text{if } (\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + r^\star K - C > 0 \\ \{B, VC\} & \text{if } (\lambda_{VC}^2 - \lambda_E^2)\Phi_2 + r^\star K - C = 0 \\ B & \text{otherwise.} \end{cases} \tag{A-21}$$

Case C-2 ($\lambda_{VC} < \lambda_E < \lambda_C < \lambda_{r^\star}$): An entrepreneurs return by choosing bank-financing is $\Phi_1 + \lambda_E^2\Phi_2 - (1+r^\star)K > 0$, which is positive because $\lambda_E < \lambda_{r^\star}$. On the other hand, his return by choosing VC-financing is $\Phi_1+\lambda_E^2\Phi_2-(K+C)$, which is positive because $\lambda_{VC} < \lambda_E$. Thus, the entrepreneur's best response is

$$\mathcal{BR}_E^{\mathbf{C-2}} = \begin{cases} VC & \text{if } r^\star K - C > 0 \\ \{B, VC\} & \text{if } r^\star K - C = 0 \\ B & \text{otherwise.} \end{cases} \tag{A-22}$$

Case C-3 ($\lambda_{VC} < \lambda_C < \lambda_E < \lambda_{r^\star}$): An entrepreneur's return by choosing bank-financing is $\Phi_1 + \lambda_E^2\Phi_2 - (1+r^\star)K > 0$, which is positive because $\lambda_E < \lambda_{r^\star}$. On the other hand, his return by choosing VC-financing is $2\rho^\star\lambda_E(\rho^\star\lambda_E+(1-\rho^\star)\lambda_{VC})\Phi_2 > 0$ where $\rho^\star$ is the maximal real number in $[0,1]$ that satisfies the equation $((1-\rho^\star)^2\lambda_{VC}^2 - \rho^{\star 2}\lambda_E^2)\Phi_2 = K + C - \Phi_1$. But, because that

$$\Phi_1 + \lambda_E^2\Phi_2 - (1+r^\star)K < 2\rho^\star\lambda_E(\rho^\star\lambda_E + (1-\rho^\star)\lambda_{VC})\Phi_2 < 2\lambda_E^2 \tag{A-23}$$

due to $\rho^\star \leq 1$ and $\lambda_{VC} \leq \lambda_C < \lambda_E$, we obtain

$$\Phi_1 - \lambda_E^2\Phi_2 - (1+r^\star)K < 0, \tag{A-24}$$

implying $\lambda_E > \lambda_{r^\star}$, a contradiction. Thus, the entrepreneur's best response is

$$\mathcal{BR}_E^{\mathbf{C-3}} = B. \tag{A-25}$$

Case C-4 ($\lambda_{VC} < \lambda_C < \lambda_{r^\star} < \lambda_E$): An entrepreneur's return by choosing bank-financing is $2\lambda_E^2\Phi_2$, which is positive because $\lambda_{r^\star} < \lambda_E$. On the other hand, his return by choosing

VC-financing is $2\rho^\star\lambda_E(\rho^\star\lambda_E + (1-\rho^\star)\lambda_{VC})\Phi_2 > 0$ where $\rho^\star$ is the maximal real number in $[0,1]$ that satisfies the equation $((1-\rho^\star)^2\lambda_{VC}^2 - \rho^{\star 2}\lambda_E^2)\Phi_2 = K + C - \Phi_1$. We have that

$$2\rho^\star\lambda_E(\rho^\star\lambda_E + (1-\rho^\star)\lambda_{VC})\Phi_2 < 2\rho^\star\lambda_E^2\Phi_2 \leq 2\lambda_E^2\Phi_2 \tag{A-26}$$

as a result of $\lambda_{VC} < \lambda_E$. This also implies $\rho^\star < 1$ because $\lambda_E > \lambda_C$. Thus, the entrepreneur's best response is

$$\mathcal{BR}_E^{\mathbf{C-4}} = B. \tag{A-27}$$

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