INTERMEDIATION VARIETY: BANKS AND PRIVATE EQUITY*

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Abstract

Why do small intermediaries, such as private equity firms (PEs), exist mainly in competitive credit markets and why do they fund mainly risky, innovative investments? In this paper, we build a general equilibrium search-and-matching model of entrepreneurial finance with endogenous intermediary entry. We show that with only bank finance, entrepreneurs make inefficient project choices in competitive credit markets—they forgo innovative projects in favor of traditional ones. However, private equity firms emerge to mitigate this inefficiency. This is because a PE's own capital structure works as a commitment device to not fund traditional projects, which then induces entrepreneurs to invest efficiently in innovative projects. Despite earning high returns, PEs never take over the entire market, and PEs and banks coexist in equilibrium.

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1 Introduction

Motivation and research questions. Banks play a dominant role in the allocation of credit in every country, with significant consequences for corporate investment. Banks have an advantage over other intermediaries because their cost of funding is low due to deposit insurance and bailout guarantees.[1] These government subsidies may inhibit non-bank intermediaries from entering the market and competing with banks to provide credit. However, non-bank providers of finance, such as private equity firms (PEs), have proliferated in the past few decades as credit markets have become more competitive.[2] Whereas banks continue to provide much of the funding for traditional projects, such non-banks have provided an increasing proportion of funding for innovative projects. These non-banks often earn high returns, but, despite their profitability, they still provide a relatively small proportion of funding in the economy. This raises the two main questions we address in this paper, questions that the literature has left relatively unexplored. First, why do small, specialized intermediaries such as PEs exist mainly in competitive credit markets? Second, why do banks and PEs coexist in equilibrium, with banks funding relatively safe, traditional projects and PEs funding relatively risky, innovative projects?

Model preview. To address these questions, we develop a model in which entrepreneurs' project choices and the mix of intermediaries in the market are jointly determined in general equilibrium. In the model, there are two periods. In the first period, penniless entrepreneurs seek funding from creditors. There are two types of creditors, banks and non-banks, which we refer to as "PEs" from now on. In the first period, creditors enter and are matched with entrepreneurs. Then each entrepreneur decides to undertake one of two types of project, a high-NPV innovative project or a low-NPV

[1] See International Monetary Fund (2014).

[2] Boyd and Gertler (1994) point out that "A number of shocks have...jolted the banking industry in recent years, including increased competition," leading to a decline in banks' share of intermediation. Specifically, "In 1974 bank assets amounted to 45 percent of total intermediated claims...falling to 34 percent in 1992, [while other] types of intermediaries...increased their market share dramatically." Shapiro and Pham (2008) highlight the rise in PE transactions in particular, saying "The number...of U.S. private buyout-related deals rose from 12 transactions in 1970...to 2,474 deals in 2007."

traditional project. Entrepreneurs subsequently seek funding for their projects. They may negotiate a funding contract with their incumbent creditors in the first period or may search for a new creditor in the second period. The greater is the credit market competition, the higher is the probability that an entrepreneur finds a creditor.

The analysis relies on the following three key assumptions. (i) Innovative projects require monitoring, whereas traditional projects do not. This is because it is hard to write and enforce contracts about innovative projects, which implement new ideas and practices by definition. Thus, they are likely to be associated with agency frictions due to asymmetric information or moral hazard.[3] (ii) Incumbent creditors have an advantage in monitoring entrepreneurs, as in the relationship banking literature. This reflects the fact that incumbent creditors acquire the necessary monitoring expertise through long-term relationships with entrepreneurs.[4] (iii) Banks have a lower cost of funding than PEs do. This is consistent with the presence of government subsidies coming from deposit insurance and implicit too-big-to-fail guarantees.[5]

Key results. Our first main result is that entrepreneurs innovate too little in competitive credit markets. Since the innovative project requires monitoring and only incumbent creditors can monitor, an entrepreneur who chooses an innovative project becomes *captive* to his incumbent creditor. Thus, the entrepreneur faces a tradeoff between the traditional project and the innovative project: the innovative project has the benefit of generating a higher total payoff, but at the cost of making the entrepreneur captive to his incumbent creditor, a cost that can be avoided with the traditional project. In equilibrium, the entrepreneur chooses the innovative project if and only if credit market competition is sufficiently low. With low competition the entrepreneur is effectively always captive, so he chooses the innovative project in accordance with the NPV rule. In contrast, when credit market competition is high, the entrepreneur

[3] In Subsection 5.3, we model this agency friction explicitly as an asset substitution problem following Holmström and Tirole (1997) to micro-found our assumption that only innovative projects require monitoring.

[4] See Bolton, Freixas, Gambacorta, and Mistrulli (2013), Hachem (2011), Rajan (1992), and von Thadden (1995).

[5] This is also consistent with empirical evidence (see Metrick and Yasuda (2010) and Damodaran (2016)), and the discussion in Subsection 6.1.

chooses the traditional project inefficiently because the relatively high likelihood of finding a new creditor with such a project puts him in a strong bargaining position with his incumbent creditor. He forgoes the NPV benefits of the innovative project in favor of the bargaining benefits of the traditional project. Thus, credit market competition has a dark side in our model—entrepreneurs innovate too little.

Our second main result is that PE funding mitigates this distortion of competitive credit markets. This is because a PE can commit *not* to fund the traditional project and thereby compel an entrepreneur to choose the innovative project, despite the fact that it makes him captive. The PE can do this because it has a relatively high cost of funding itself and hence it imposes a high hurdle rate on its investments, funding only projects with high upside potential, i.e. innovative projects in our model.[6]

This result is special to PEs in our model. Bank credit does not have the same disciplining effect. Why? Like a PE, a bank prefers funding a high-NPV innovative project to a low-NPV traditional project, but, unlike a PE, the bank cannot credibly commit to not fund the traditional project. Because the bank has a relatively low cost of capital itself, it applies a low hurdle rate to its investments. Thus, it will fund the traditional project even though it has a low expected return. This finding that PEs can use their *own* debt to discipline entrepreneurs may cast light on why PEs finance their investments on a deal-by-deal basis—it allows them to make use of the distortion of limited liability for each investment they undertake, and thus to commit not to fund traditional projects.

Our third main result is a characterization of intermediation variety as a function of credit market competition. Specifically, we find a closed-form expression for the equilibrium proportion of PEs in the credit market. We use this expression to show that PEs enter only competitive credit markets and that they perform an increasing proportion of lending as credit market competition increases. However, they may still remain scarce in perfectly competitive credit markets. To see the mechanism behind this result, recall

[6] A PE's own cost of capital determines its hurdle rate for investments in reality; Axelson, Jenkinson, Strömberg, and Weisbach (2013) find that PEs' cost of capital is the best predictor of their returns on deals.

that with bank finance, the entrepreneur's project choice is not distorted when credit market competition is low but is distorted when credit market competition is high. Thus, for low credit market competition, banks lend to entrepreneurs who invest in high-NPV innovative projects. Because banks have access to subsidized funding, they make high profits and there is no room for other intermediaries to enter. However, for high credit market competition, entrepreneurs innovate too little with bank funding. Banks fund low-NPV traditional projects and make little profit. This inefficiency creates room for PEs to enter, and induces entrepreneurs to invest in high-NPV innovative projects. Nonetheless, PEs do not take over the credit market entirely because a higher proportion of PEs in the market effectively decreases competition among banks, allowing banks to capture a higher fraction of the surplus from funding traditional projects. In other words, PE entry has a positive externality on incumbent banks. This results in a *feedback loop* in which high credit market competition leads to PE entry, which increases bank profits, which leads to more bank entry, which increases credit market competition, closing the loop. The feedback loop prevents PEs from taking over the entire market.

Our findings highlight the interaction between the variety of intermediaries in the credit market and the types of projects that entrepreneurs undertake. For high credit market competition, entrepreneurs undertake a mix of different projects, even though all entrepreneurs are ex ante identical. An entrepreneur's project choice is determined by the kind of creditor he has access to—if he anticipates bank funding he chooses a traditional project, whereas if he anticipates PE funding he chooses an innovative project. Likewise, the intermediaries that exist in the market are determined by entrepreneurs' project choices—PEs have incentive to enter *only* because entrepreneurs are making inefficient project choices, which PEs are able to undo thanks to their own high cost of capital. Our model thus suggests a rationale for the coexistence of a variety of intermediaries *even if there is no ex ante heterogeneity among entrepreneurs.* Overall, our findings underscore that intermediation variety and entrepreneurial investment must be examined jointly.

In Figure 1, we illustrate how entrepreneurs' project choices and the variety of intermediaries are determined for different regions of credit market competition. In Subsection 4.5, we do a numerical example to plot these regions for "reasonable" parameters.

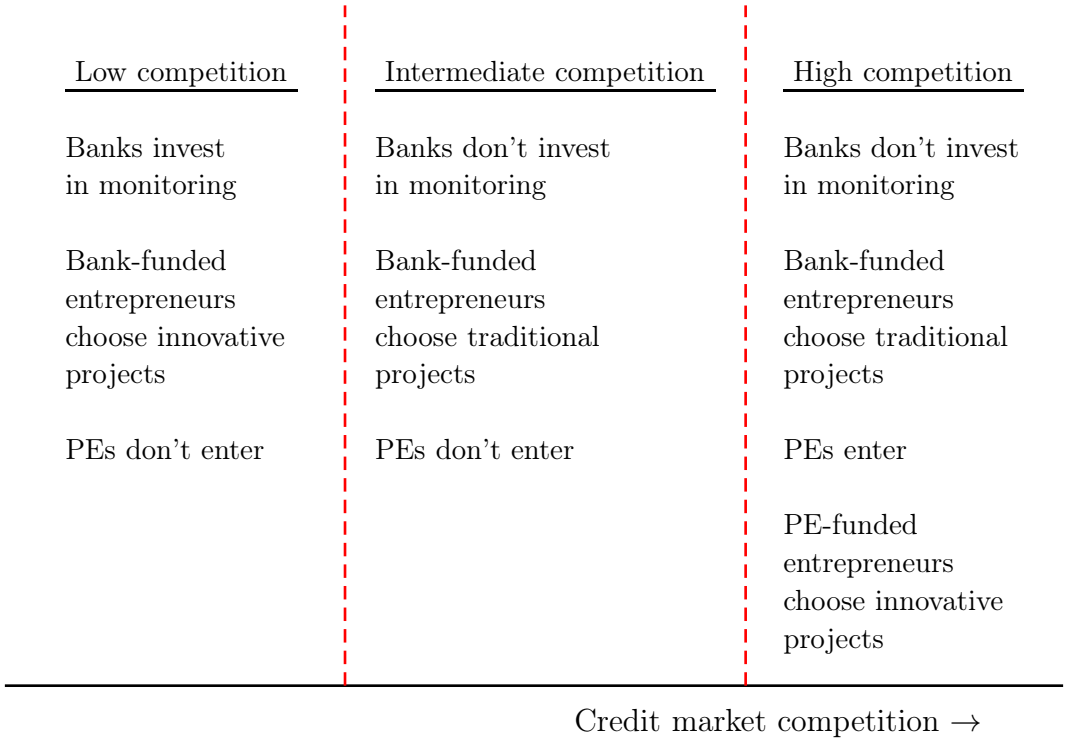

Figure 1: This figure illustrates the financing regions that emerge in response to credit market competition.

Empirical content. Our focus on the choices of both lenders and borrowers in general equilibrium sheds light on numerous stylized facts. First, an increase in credit market competition causes entrepreneurs to innovate less. This is in line with the evidence in Hombert and Matray (2013) that firms invest less in R&D-intensive projects after banking competition increases and the evidence in Cornaggia, Mao, Tian, and Wolfe (2015) that innovation by public firms decreases following deregulations that encourage more intense banking competition. Second, the development of equity markets leads entrepreneurs to innovate more. Hsu, Tian, and Xu (2014) provide evidence in support

of this finding and show that the development of equity markets encourages innovation by high-tech firms, but the development of credit markets seems to discourage it. Third, small intermediaries, such as PEs, seem to exist only in competitive credit markets. See the earlier-cited evidence on how PE transactions have grown with credit-market competition (e.g., Boyd and Gertler (1994) and Shapiro and Pham (2008). Fourth, PEs have high returns. This is consistent with Harris, Jenkinson, and Kaplan (2014) who document that the returns delivered by the PE funds have consistently exceeded those of public equity markets. Fifth, despite these high returns, PEs continue to provide only a relatively small fraction of the funding in the economy. In fact, from 2000–2005, the value of US buyout deals was $100 billion a year on average and the total value of commercial and industrial loans originated exceeded $11 trillion a year on average.[7] Sixth, PEs are highly levered and have a relatively high cost of capital. For example, private equity deals are typically financed with sixty to ninety percent debt.[8] Finally, PEs fund relatively innovative projects compared to banks (see Lerner, Sorensen, and Strömberg (2011)).

Our analysis also generates new empirical predictions. Notably, our model suggests that very competitive banking systems will involve relatively little risk. This sheds light on the country-level empirical evidence presented by Schaeck, Cihak, and Wolfe (2009), who find that more competitive banking systems are less prone to systemic crises. However, our theory suggests the caveat that this safety comes at the cost of too much investment in traditional projects, which sheds light on the empirical finding that firms invest less in R&D-intensive projects when credit competition is high (Cornaggia, Mao, Tian, and Wolfe (2015), Hsu, Tian, and Xu (2014), and Hombert and Matray (2013)).

Further results. In addition to the baseline analysis, we study the following four extensions to confirm the robustness of our findings and provide further results. (i) We

[7]See the data provided by the Federal Reserve Bank of St Louis at the following web address: <https://research.stlouisfed.org/fred2/series/BUSLOANS/downloaddata>.

[8]See Kaplan and Strömberg (2009)); approximately three-quarters of all buy-out funds promise returns of eight percent to their limited partners (Metrick and Yasuda (2010)).

endogenize PE's cost of capital, which we take as exogenous in the baseline analysis. This justifies our assumption that the PE cost of capital is relatively high. (ii) We solve for the interest rate that banks charge entrepreneurs and the size of the equity stake that PEs take in entrepreneurs' projects. We find that the size of the PE's equity stake does not vary with the competitiveness of the credit market. (iii) We micro-found the need to monitor innovative projects by introducing an asset substitution problem following Holmström and Tirole (1997). (iv) We extend the model so that creditors have to pay to acquire a technology to monitor entrepreneurs. We show that this may lead to an inefficiency when credit market competition is low: creditors may underinvest in monitoring.

Layout. The rest of the paper is organized as follows. Section 2 has a discussion of the related literature. In Section 3, we present the model. In Section 4, we solve the model and present the main analysis. In Section 5, we explore several extensions. In Section 6, we discuss the main assumptions that drive our results. Section 7 is the Conclusion.

2 Related Literature

To the best of our knowledge, our paper is the first to study the coexistence of banks and PEs in a general equilibrium model. The most related paper is Ueda (2004), which explains why some firms find funding from VCs as an alternative to banks. That paper presents a corporate-finance-style model, in which an entrepreneur seeks funding from a VC if it fails to get a loan from a bank. Our model has several features that are not present in Ueda's, including the following. (i) All entrepreneurs are ex ante identical in our model. Thus, our results thus suggest that heterogeneity in creditors may cause heterogeneity in entrepreneurs' investments. (ii) The only exogenous distinction between banks and PEs in our model is that banks' liabilities are guaranteed by the government. The other realistic differences between banks and PEs that we outline in the introduction arise endogenously. (iii) Banks and PEs coexist in general equilibrium.

PEs compete with banks effectively despite banks' access to subsidized funding.

In our model, PEs' high cost of capital passes though to the hurdle rate PEs apply to their own investments (consistent with evidence in Axelson, Jenkinson, Strömberg, and Weisbach (2013)), which induces entrepreneurs to choose the efficient project. Another paper in which a PE's capital structure mitigates the agency problem between a PE and an entrepreneur is Axelson, Strömberg, and Weisbach (2009). Their focus is on how a single PE's capital structure affects its investments, whereas ours is on how PEs' capital structure affects investments in general equilibrium. Moreover, our focus is different in that we seek to explain how this capital structure effect allows PEs to compete with banks, generating intermediation variety.

Another literature studies the coexistence of bank credit and market credit. Relevant papers in this literature include Allen and Gale (2004), Besanko and Kanatas (1993), Bolton and Freixas (2000), Boot and Thakor (1997), Chemmanur and Fulghieri (1994), Gersbach and Uhlig (2007) Holmström and Tirole (1997), Hoshi, Kashyap, and Scharfstein (1993), Rajan (1992), Repullo and Suarez (2000), and von Thadden (1999). Our first incremental contribution relative to this literature is to explain the coexistence of banks and PEs rather than of banks and markets. Moreover, unlike these papers, we assume no heterogeneity among entrepreneurs and little heterogeneity among intermediaries—the only formal difference between banks and PEs is that banks' liabilities are guaranteed by the government. In our model, heterogeneity in project choice is an equilibrium outcome resulting from search frictions in the credit market, not an exogenously-specified attribute difference among entrepreneurs. Haddad (2014) resembles our model in that all investors pursue heterogenous strategies in equilibrium even though they are ex ante identical. His focus, however, is on how the equilibrium mix of investor strategies interacts with equilibrium asset prices.

A large literature studies the effects of credit market competition on banking outcomes. Petersen and Rajan (1995) suggest credit market competition can undermine banks' willingness to engage in relationship lending. Boot and Thakor (2000) question this result in a richer model, which includes banks' decisions about the *nature* of

relationship lending. In Rajan (1992), Sharpe (1990), and Dell'Ariccia and Marquez (2004), an informational advantage gives incumbent banks monopoly over borrowers, leading to inefficient outcomes. Cao and Shi (2000), Dell'Ariccia (2000), and Marquez (2002) study the effects of credit market competition on bank screening and Guzman (2000) studies its effects on credit rationing and growth (see Pagano (1993) for a survey of the literature on finance and growth). Hellmann, Murdock, and Stiglitz (2000), Matutes and Vives (2000), and Repullo (2004) study how credit market competition affects bank risk-taking and Boyd and De Nicolò (2005), in contrast, consider how it affects *borrowers'* risk-taking. Wagner (2009) extends this model, considering the interaction between bank risk-taking and borrower risk-taking. Whereas most of this literature focuses on the effects of credit market competition on either lenders' choices *or* borrowers' choices in isolation, we examine the two-way bridge between them, like Boyd and De Nicolò (2005) and Wagner (2009). Unlike these papers, however, we include different types of intermediaries in our analysis.

Finally, other papers have studied credit market competition in general equilibrium within a search-and-matching set-up. These include Inderst and Mueller (2004), Jovanovic and Szentes (2013)), Nanda and Rhodes-Kropf (2012), and Wasmer and Weil (2004). None of these papers, however, includes different types of intermediaries.

3 Model Set-up

There are two periods, Period 1 and Period 2. There are three types of players: entrepreneurs and two types of creditors, banks and PEs. In Period 1, each entrepreneur chooses a project. If he finds funding from a creditor, he implements the project in Period 2. Projects are either innovative or traditional. Innovative projects have the higher NPV, but require monitoring, an assumption that will be micro-founded later. Only incumbent creditors can acquire the monitoring expertise necessary to fund innovative projects. As a result, innovative entrepreneurs may be captive to their incumbent creditors.

The following subsections describe the model in detail.

3.1 Players: Projects and Monitoring

Entrepreneurs. There is a unit continuum of penniless risk-neutral entrepreneurs. Each entrepreneur chooses one of two projects, a traditional (safe) project called Project S and an innovative (risky) project called Project R, each of which requires capital investment I. Project S pays off Y_S for sure. Project R pays off Y_R with probability p and zero otherwise. We use the shorthands $\text{NPV}_S := Y_S - I$ and $\text{NPV}_R := pY_R - I$ for the projects' net present values. Both projects have positive NPV, but NPV_R is greater than NPV_S. Thus, Project R is the efficient project choice.[9] We denote the efficiency gain from choosing Project R by $\Delta := \text{NPV}_R - \text{NPV}_S$.

Whereas Project R is the efficient investment from the point of view of NPV, it has the downside that it is associated with agency frictions and therefore it requires monitoring. We model the specifics of this agency friction in Subsection 5.3, in which we incorporate an asset-substitution problem following Holmström and Tirole (1997), but we abstract from these details for now.

Creditors. There are large continua of two types of penniless, risk-neutral creditors, called banks and PEs. Each creditor can pay a non-pecuniary entry cost e to enter the credit market. φ denotes the proportion of entering creditors that are PEs. Upon entry, each creditor raises capital I to fund itself. Banks raise I at net rate zero, whereas PEs raise I at net rate $r > 0$. This difference in the cost of capital is the only formal difference between banks and PEs. This difference is realistic, since banks benefit from government guarantees and PEs do not, and we take it as exogenous in the baseline analysis; however, in Subsection 5.1 we derive PEs' funding rate r in equilibrium to close the model.

If a creditor is matched with an entrepreneur in Period 1, we refer to it as the entrepreneur's *incumbent creditor*. Incumbent creditors have an advantage in financ-

[9] That the innovative project is alway efficient is not necessary for our main results. See Subsection 6.2 for further discussion.

ing entrepreneurs: they can acquire expertise to monitor the entrepreneur at (non-pecuniary) cost k. Thus, incumbent creditors are "relationship lenders" in the language of the relationship banking literature.

Finally, we make the following technical assumption on creditor preferences: a creditor never invests in a project that causes it to default with probability one. This just serves as a tie-breaking rule to ensure creditors prefer not to invest then to invest and default for sure. We use it only to simplify the proof of Lemma 3. Other natural assumptions would generate the same behavior, for example including an arbitrarily small cost of originating loans.

3.2 The Credit Market: Search and Competition

Creditors and entrepreneurs find one another by searching in a decentralized market. Call θ_t the ratio of the mass of searching creditors to the mass of searching entrepreneurs in Period t. Since there is a unit mass of entrepreneurs, θ_1 coincides with the mass of entering creditors. We use $q_t \equiv q(\theta_t)$ to denote the probability that a creditor is matched with an entrepreneur and we use $Q_t \equiv Q(\theta_t)$ to denote the probability that an entrepreneur is matched with a creditor. If an entrepreneur is matched with a creditor, he is matched with a PE or a bank with probabilities proportional to the number of PEs and banks in the market. Thus, the probability that an entrepreneur is matched with a bank is $(1-\varphi)Q$ and the probability he is matched with a PE is φQ.

We now define credit market competition formally.

DEFINITION 1. *The ratio θ_t of creditors to entrepreneurs in Period t is the credit market competition in Period t.*

In Subsection 3.4, we restrict the functional forms of the matching probabilities so that q is a decreasing function of θ_t and Q is an increasing function of θ_t. In other words, as credit market competition increases, it is harder for a creditor to find an entrepreneur and easier for an entrepreneur to find a creditor.

In the analysis, it is useful to have a measure of interbank competition, i.e. competition among only banks, rather than among all creditors. We define interbank competition as the probability that an entrepreneur finds a bank in the market.

DEFINITION 2. *The probability* $(1-\varphi)Q_t$ *that an entrepreneur is matched with a bank in Period* t *is the interbank competition in Period* t*.*

Finally, we note that θ_t is endogenous. We solve for it in equilibrium based on the entry decisions of banks and PEs. In equilibrium, θ_1 and θ_2 are decreasing functions of the creditors' entry cost e, which is exogenous. Thus, $-e$ can serve as an exogenous measure of credit market competition, since a decrease in e corresponds to an increase in θ_1.

3.3 Timeline

In this subsection, we describe the timing of the game more formally. The sequence of moves is as follows.

Period 1.

- Each creditor either enters and raises I or stays out.
- Creditors and entrepreneurs are matched in a decentralized market.
- Each incumbent creditor acquires monitoring expertise or does not.
- Each entrepreneur chooses Project S or Project R.
- Matched creditors and entrepreneurs Nash bargain over funding terms.[10]

Period 2.

- Unmatched creditors and entrepreneurs are matched in a decentralized market.
- Newly matched creditors and entrepreneurs Nash bargain over funding terms.
- Funded projects are implemented and pay off; entrepreneurs and creditors repay or default.

[10]Our results do not depend on the forms of funding contracts; in Subsection 5.2, we calculate the equilibrium funding contracts for banks and PEs under the assumption that banks fund via debt and PEs fund via equity.

3.4 Parameter Restrictions

In this section, we impose a number of restrictions on parameters.

We assume specific functional forms on the matching probabilities, which allow us to solve the model in closed form.

PARAMETER RESTRICTION 1. *The matching probabilities Q and q have the following forms*

$$Q(\theta) = \frac{\theta}{1+\theta} \quad \textit{and} \quad q(\theta) = \frac{1}{1+\theta}. \tag{1}$$

We impose the following restriction on PEs' cost of capital r.

PARAMETER RESTRICTION 2. *PEs' cost of capital r is neither too low nor too high,*

$$\text{NPV}_S < rI < \frac{\Delta + (1-p)I}{p}. \tag{2}$$

Recall that for now we take r as given, giving banks an exogenous advantage in funding due to government guarantees. However, in Subsection 5.1, we derive an equilibrium expression for r.

We impose a restriction on the cost acquiring monitoring expertise. This ensures it is always efficient for creditors to invest in it.

PARAMETER RESTRICTION 3. *The monitoring cost k is neither too low nor too high,*

$$\eta\big(\Delta - [p(1+r)-1]I\big) < k < \min\Big\{\eta\big(\Delta + (1-p)I\big)\,,\, \eta p\big(Y_R - (1+r)I\big)\Big\}. \tag{3}$$

We relax this restriction in Subsection 4.5, where we analyze the model with higher monitoring costs.

In Subsection 4.5, we present a numerical example which suggests that our assumptions on exogenous parameters are not overly restrictive, as all of the parameter restrictions above are satisfied.

3.5 Equilibrium

The model is a finite-horizon extensive game of complete information. The solution concept we use is subgame perfect equilibrium. We solve for the entrepreneurs' project choices, the creditors' decisions whether to acquire monitoring expertise, and the creditors' entry decisions by backward induction. (Note that the funding contracts between entrepreneurs and creditors are not strategic decisions, but rather are determined by Nash bargaining.)

4 Results

In this section, we present the analysis of the model. We first establish some preliminary results that will allow us to write down the continuation values of players. These constitute the outside options for Nash bargaining in Period 1. We then solve for entrepreneurs' project choices and creditors' decisions whether to acquire monitoring expertise as functions of credit market competition. We then solve for creditors' entry decisions and solve for the equilibrium mix of banks and PEs. Under an additional technical condition, we provide a characterization of the equilibrium for all levels of credit market competition.

4.1 Preliminaries and Continuation Values

In this section, we establish some preliminary results that allow us to write down players' continuation values.

First we solve for an entrepreneur's best response when his creditor does not acquire monitoring expertise.

Lemma 1. (Funding From Creditors with No Monitoring Expertise) *If a creditor does not acquire monitoring expertise, it never funds Project R.*

Hence, if an entrepreneur is either unmatched or matched with a creditor that does not acquire monitoring expertise in Period 1, then the entrepreneur chooses Project S.

The lemma follows from the fact that a creditor without monitoring expertise cannot fund Project R, but can still fund Project S. This implies that if an entrepreneur's incumbent creditor does not acquire monitoring expertise, the entrepreneur can find funding only for Project S. Hence, he undertakes Project S.

We now state the continuation values of all players in terms of credit market competition θ_1 and the ratio φ of PEs to banks in the credit market.

LEMMA 2. (CONTINUATION VALUES WITH TRADITIONAL AND INNOVATIVE PROJECTS) *The Period-1 continuation values of banks, PEs, entrepreneurs with traditional projects, and entrepreneurs with innovative projects are as follows.*

- *A bank's Period-1 continuation value π_b is given by*

$$\pi_b = q_2 \eta \mathrm{NPV}_S. \tag{4}$$

- *A PE's Period-1 continuation value is zero, $\pi_{\mathrm{PE}} = 0$.*
- *If an entrepreneur has chosen Project S, his Period-1 continuation value is given by*

$$\pi_S = (1-\varphi) Q_2 \left(1-\eta\right) \mathrm{NPV}_S. \tag{5}$$

- *If an entrepreneur has chosen Project R, his Period-1 continuation value is zero, $\pi_R = 0$.*

Further, credit market competition in Period 2, θ_2 (i.e. the argument of $q_2 = q(\theta_2)$ and $Q_2 = Q(\theta_2)$ above) is given by

$$\theta_2 = \theta_1^2. \tag{6}$$

Observe that an entrepreneur has a higher outside option with Project S than with Project R, because with Project R the entrepreneur's incumbent creditor is the only one with the expertise necessary to monitor his project. An entrepreneur who has chosen Project S, in contrast, has a positive continuation value, since traditional projects do not require monitoring. Intuitively, there is a market in which an entrepreneur with a

traditional project can find a "transaction loan" from an "arm's length" creditor.

4.2 Inefficiency of Bank Funding

In this section, we analyze the actions of entrepreneurs and banks in Period 1. We show the inefficiency of bank funding in competitive credit markets.

Proposition 1. (The Inefficiency of Competitive Credit Markets: Too Little Innovation) *Whenever interbank competition in Period 2 is sufficiently high, entrepreneurs matched with banks undertake Project S inefficiently. Specifically, they undertake Project S if and only if*

$$(1-\varphi)Q_2 > \frac{\Delta + (1-p)I}{\eta \text{NPV}_S}. \tag{7}$$

The intuition for this result is as follows. Suppose that credit market competition is high and consider an entrepreneur matched with a bank that has monitoring expertise. Because any creditor can fund Project S, competition among banks generates a high outside option for an entrepreneur with Project S. On the other hand, if the entrepreneur chooses Project R, no new creditor will lend to him, since only his incumbent creditor has the technology to monitor his project. Hence his outside option is zero. As a result, the entrepreneur chooses Project S when credit market competition is high.

4.3 The Disciplining Role of PE Leverage

In this section, we examine PE funding and its effect on entrepreneurs' project choices.

Lemma 3. *A PE never funds Project S.*

This result follows from the fact that PEs have a relatively high cost of capital. Thus, in order to fund a project, a PE must receive a return greater than its hurdle rate r. But, since $(1+r)I > Y_S$ by Parameter Restriction 2, it is impossible for an entrepreneur to promise a PE a high enough repayment if he chooses Project S.

Proposition 2. (PE Capital Structure Disciplines Entrepreneurs) *If an entrepreneur is matched with a PE, he always chooses Project R.*

The intuition for this result is as follows. Since a PE never funds Project S (Lemma 3), an entrepreneur who is matched with a PE in Period 1 must either choose Project R and obtain funding from a PE today or choose Project S and potentially obtain funding from a bank tomorrow. If he chooses Project R, he is captive to the PE, since he cannot find a creditor with monitoring expertise in Period 2. However, if he chooses Project S and finds a bank to fund it in Period 2, he is also captive, since it is the final period and has no opportunity to find funding in the future.[11] The entrepreneur therefore chooses Project R, because it is better to be captive in Period 1 with a high-NPV project than be captive in Period 2 with a low-NPV project.

These results suggest a reason that intermediaries such as PEs may be able to compete with banks, despite a funding-cost disadvantage. A PE's relatively high cost of capital generates an effective commitment device for the PE *not* to fund inefficient traditional projects, giving it a competitive advantage over banks in funding such projects.

4.4 Intermediation Variety

In this section, we discuss the variety of intermediaries that exist in equilibrium. We first describe the cross-sectional differences between the projects that banks fund and those that PEs fund. Then we turn to the equilibrium mix of banks and PEs in the market. The findings underscore that entrepreneurs' project choices and the variety of intermediaries in the market must be determined jointly.

In the preceding sections, we established that whenever interbank competition is high, banks fund Project S and PEs fund Project R (Proposition 1 and Proposition 2). We now have:

Lemma 4. (Cross-sectional Differences between Projects Funded by Banks

[11] It may seem like this result is sensitive to our two-period setup. However, in Subsection 6.2 we argue that the intuition is robust.

AND PEs) *In competitive credit markets, PEs fund more innovative and more profitable entrepreneurs than banks do.*

The findings in the lemma above are consistent with evidence in the empirical literature on banks and private equity discussed eralier.

We now turn to the equilibrium mix of intermediaries in the market.

PROPOSITION 3. (INTERMEDIATION VARIETY) *Define the constant*

$$C := \frac{k/\eta + \big(p(1+r) - 1\big)I - \Delta}{\mathrm{NPV}_S}. \tag{8}$$

Given a competitive interbank market, the proportion of PEs is given by

$$\varphi = 1 - \frac{1}{1-\eta}\left(C + \frac{1 - \eta + C + \theta_1}{\theta_1^2}\right) \tag{9}$$

as long as the expression is between zero and one. If the expression is less than zero, there are no PEs. If the expression is greater than one, there are only PEs.

Thus we have the following:

(i) PEs are present only in sufficiently competitive credit markets.

(ii) The proportion of PEs is increasing in credit market competition.

(iii) PEs never take over the entire credit market and may even remain scarce in the perfect competition limit: as $\theta_1 \to \infty$*,*

$$\varphi \to 1 - \frac{C}{1-\eta} < 1. \tag{10}$$

The proposition above addresses the variety of intermediaries in the market. Since an entrepreneur chooses Project S when matched with a bank and chooses Project R when matched with a PE (by Lemma 4), the equilibrium exhibits a variety of projects as well as a variety of intermediaries, even though all entrepreneurs are ex ante identical.

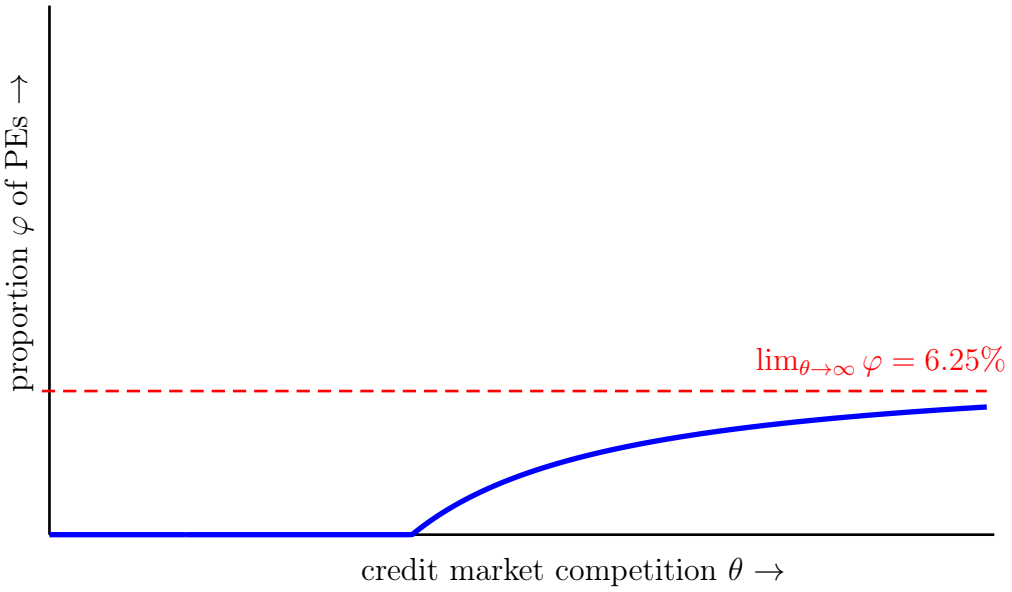

Figure 2: The graph depicts the proportion of PEs φ as given in Proposition 3. The parameters used to make the plot are given in Subsection 4.5.

The intuition for the results in Proposition 3 builds on two observations. The first is that PEs enter the market to mitigate the inefficiency of entrepreneurs choosing Project S in competitive credit markets. The second is that an increase in the proportion of PEs in the credit market has a *positive externality* on banks, by decreasing the competition to fund Project S in Period 2. We now explain how these observations lead to the results above.

The reason that PEs enter only competitive credit markets is that if banks are funding Project R, there is no room for PEs to enter, since their higher cost of capital is a disadvantage. However, when credit market competition is high, entrepreneurs choose Project S inefficiently when matched with banks, which enables PEs to enter and induce entrepreneurs to undertake Project R (Proposition 2).

The reason that PEs do not take over the entire market, and in so doing restore efficiency entirely, is that an increase in the proportion of PEs makes banking less competitive, i.e. PE entry has a positive externality on banks. This is because the higher

the proportion of PEs, the less likely it is that an entrepreneur is matched with a bank in Period 2. This lowers the continuation value of an entrepreneur when he is matched with a bank in Period 1 and thereby strengthens the bank's bargaining position. In other words, when there are more PEs in the market, banks can capture more of the surplus from funding traditional projects in Period 1. This externality generates a *feedback loop* that works as follows. An increase in credit market competition weakens a bank's bargaining position, inducing more PEs to enter the market. But, when these PEs enter, they improve a bank's bargaining position, inducing more banks to enter as well. In equilibrium, these effects offset each other in such a way that the proportion of PEs increases at a decreasing rate and the proportion of PEs levels off to a constant as credit markets become perfectly competitive. The equilibrium proportion of PEs in the market is depicted in Figure 2.

4.5 Characterization of Financing Regimes and Numerical Example

In this subsection, we characterize funding regimes as a function of credit market competition θ_1. Specifically, in Proposition 4 below, we characterize the equilibrium mix of intermediaries in the market and entrepreneurs' associated project choices for all levels of credit market competition.

Proposition 4. (Characterization of Financing Regimes) *Define the constants*

$$\theta^* := \sqrt{\frac{\Delta + (1-p)I}{\eta \mathrm{NPV}_S - \Delta - (1-p)I}}, \tag{11}$$

$$\theta^{**} := \frac{1 + \sqrt{1 + 4\big((1-\eta)^2 - C^2\big)}}{2(1-\eta-C)}, \tag{12}$$

where C is defined in Proposition 3.

As long as $\theta^* < \theta^{**}$ and $k + \eta prI > \Delta + (1-p)I$, we have the following characterization of financing regimes:

(i) For low levels of credit market competition, $\theta_1 < \theta^*$, banks acquire monitoring expertise and fund only Project R. There are no PEs.

(ii) For intermediate levels of credit market competition, $\theta^* \leq \theta_1 < \theta^{**}$, banks do not acquire monitoring expertise and fund only Project S. There are no PEs.

(iii) For high levels of credit market competition, $\theta_1 \geq \theta^{**}$, banks do not acquire monitoring expertise and fund only Project S. PEs enter, acquire monitoring expertise and fund only Project R.

Proposition 4 puts all our other results together. Intuitively, for low levels of credit market competition, entrepreneurs are always captive to their incumbent creditors, so their project choice has little effect on their bargaining position. As a result, they choose the higher-NPV project (Project R). For higher levels of credit market competition, entrepreneurs prefer project S to strengthen their bargaining positions with banks. This leads to under-innovation, an inefficiency that creates the opportunity for PEs to enter. PEs mitigate the inefficiency by funding only innovative projects. The equilibrium described in Proposition 4 is consistent with numerous stylized facts, as we point out in the Introduction.

Numerical example: To illustrate the regimes we find in Proposition 4, we provide a numerical example and plot the financing regimes. Figure 3 represents the financing regimes in Proposition 4 for the following parameterization: $k = 9, \eta = 0.8, \text{NPV}_S = 60, \text{NPV}_R = 67.5, p = 0.75, F = 210$, and $I = 150$. This also suggests that our assumptions on exogenous parameters are not overly restrictive, as all of the parameter restrictions in Subsection 3.4 and the hypotheses of Proposition 4 are satisfied. Given these parameters, the values for the regime thresholds are as follows: $\theta^* \approx 3.9$ and $\theta^{**} \approx 80$.

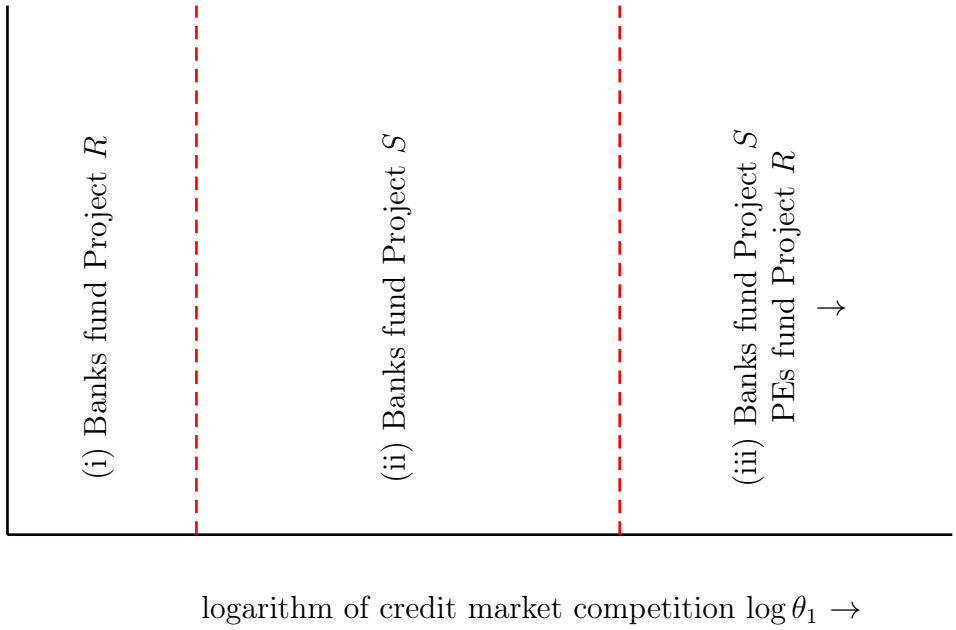

Figure 3: This figure illustrates the financing regions described Proposition 4. The numbers used to make the plot and the values for θ^* and θ^{**} are given in Subsection 4.5.

5 Extensions

In this section, we extend the model in four ways. First, we include a bargaining game between PEs and their limited partners to endogenize PEs' cost of capital r. Second, we assume that banks raise capital via debt and PEs raise capital via equity to solve for creditors' equilibrium funding contracts. Third, we assume that the innovative project is associated with an asset-substitution problem as in Holmström and Tirole (1997) to formalize the role of creditors' monitoring. Finally, we relax Parameter Restriction 3 to explore the effects of high costs of acquiring monitoring expertise.

5.1 Endogenizing the Intermediary's Cost of Capital

In this subsection, we turn to intermediaries' cost of capital. So far, we have assumed that banks fund themselves at rate zero, since banks benefit from government guarantees in reality, and that PEs fund themselves at positive rate exogenous $r > 0$. Below, we

endogenize this rate at which PEs fund themselves. We assume that r is determined by bargaining between the PE's general partners (GPs), who are effectively equityholders, and the PE's limited partners (LPs), who are effectively debtholders, given the binary distribution of project cash flows in the model.[12] The main result of this subsection is that PEs' equilibrium funding rate is relatively high. This provides a theoretical justification for our assumption that r is high (Parameter Restriction 2).

When a PE is matched with an entrepreneur, the GPs and LPs negotiate r via Nash bargaining. This assumption that the terms of finance are negotiated between the GPs and LPs after the PE has found an investment project reflects the fact that PE financing is typically raised on a deal-by-deal basis (see Axelson, Strömberg, and Weisbach (2009)). The total ex post surplus that the PE captures is

$$\text{PE surplus } = \eta p\big(Y_R - (1+r)I\big). \tag{13}$$

Call the GPs' bargaining power $1-\beta$, so, by the Nash bargaining protocol, the LPs receive their outside option I plus a fraction β of the surplus. This must equal $p(1+r)I$, their expected payoff. Thus,

$$\beta\eta p\big(Y_R - (1+r)I\big) + I = p(1+r)I. \tag{14}$$

Solving for the PE's cost of capital r gives us the next lemma.

Lemma 5. *The PE's cost of capital r is given by*

$$1 + r = \frac{\beta\eta p Y_R + I}{p(1+\beta\eta)I}. \tag{15}$$

The lemma implies that PEs do indeed have a high cost of capital in equilibrium. This

[12]Formally, PEs are partnerships between GPs and LPs. However, the decision rights rest with GPs, and GPs' cash flows strongly resemble those of levered equityholders. Typically, the division of surplus between GPs and LPs is as follows. For low profits, GPs get a management fee, and all profits go to LPs. For higher profits, the profit is divided, with GPs getting a twenty percent share. Thus, from the point of view of incentives, GPs effectively hold equity in a levered PE firm. See Axelson, Strömberg, and Weisbach (2009) for a detailed description and model of PE funding.

is the case even if GPs have all the bargaining power—if $\beta = 0$, then $r = 1/p - 1$, which is higher than banks' cost of capital of zero. This difference reflects the fact that the LPs anticipate that PEs fund innovative projects. Thus, there is a self-fulfilling aspect in PEs' investment strategy: because the LPs believe that PEs fund risky projects, they impose a high cost of capital on PEs. Thus, PEs impose a high hurdle rate on their own investments, which forces entrepreneurs to innovate, making PEs' investments risky, consistent with the LPs' beliefs.[13]

This difference in the cost of capital, which arises naturally given government guarantees of bank liabilities, is the only exogenous difference between PEs and banks in our analysis. As we touched on in the Introduction, this leads PEs in our model to share a number of features with real-world private equity firms in equilibrium; for example, PEs fund risky and innovative projects, they make high returns, they are relatively highly levered, they are expert monitors, and they are relatively scarce.

5.2 Equilibrium Funding Contracts: Implementation with Debt and Equity

In this subsection, we write down the equilibrium funding contracts used by PEs and banks. So far, we have abstracted from the forms of these contracts by relying on the division of surplus given by the Nash bargaining solution. Here we show how our equilibrium can be implemented with debt and equity contracts. We assume that PEs fund entrepreneurs with equity and banks fund them with debt.[14] To solve for the equilibrium contracts, we start from the Nash bargaining solution and find the equity stake or face value of debt that implements that division of surplus. For brevity, we characterize the funding contracts only for the case in which competition is high so PEs

[13] One could conjecture another self-fulfilling equilibrium in which PEs fund traditional investments and LPs impose a low cost of capital. However, in order to compete with banks in funding traditional projects, PEs must fund themselves at rate zero. Thus, any such equilibrium is not robust to introducing a small amount of risk in the traditional project or a small probability that matches with entrepreneurs break down.

[14] Note, however, that there is no substantive theoretical difference between debt and equity contracts in our setting in which the division of surplus is determined by Nash bargaining; we assume these contractual forms only for realism.

and banks coexist; we can use the same technique to solve for the face value of bank debt for any level of competition.

Lemma 6. (Equity Stakes of PEs and Debt Claims of Banks) *In competitive credit markets, the equity stake that a PE takes in Project R is given by*

$$\text{PE equity stake} = \eta + (1-\eta)\frac{(1+r)I}{Y_S} \tag{16}$$

and the face value of the debt with which a bank funds Project S is given by

$$\text{face value of bank debt} = \eta\Big(1 + (1-\eta)\big[q_2 - (1-\varphi)Q_2\big]\Big)\text{NPV}_S. \tag{17}$$

Note that the equity stake that a PE takes does not depend on credit market competition. This is because when an entrepreneur is matched with a PE, both parties always have the outside option of zero, independent of credit market competition. The face value of bank debt, in contrast, is decreasing in credit market competition, since the more competitive is the credit market, the higher is the outside option of an entrepreneur when he is matched with a bank.

5.3 Asset Substitution and Rationalizing Monitoring of Innovative Projects

In this subsection, we provide one specific micro-foundation for the need to monitor innovative projects and that incumbent creditors have a monitoring advantage, although others are possible (see Subsection 6.1).

Suppose that there is an asset-substitution problem as in Holmström and Tirole (1997) associated with Project R but not with Project S.[15] Specifically, if the entrepreneur chooses Project R in Period 1, he has the possibility of substituting it with another project, called Project B. Project B is "bad" in the sense that it has negative

[15]This may be because Project S is more familiar to lenders, making it easier to detect if the entrepreneur has switched to something different. Project R is less familiar and its newness may make it difficult for lenders to detect its substitution with another project, unless the lender monitors.

NPV. However, it gives the entrepreneur private benefits b, where b is large enough that the entrepreneur prefers to do Project B and repay nothing rather than to do Project R and repay his debt.[16] Following the definition of monitoring in Holmström and Tirole (1997), a creditor can make a costly investment in monitoring expertise, where monitoring allows the creditor to prevent the entrepreneur from undertaking Project B. The lemma below follows immediately from the setup.

LEMMA 7. *Only creditors that have monitoring expertise fund Project R.*

This says that if an entrepreneur chooses the innovative project, he can obtain finance only from a creditor with monitoring expertise. The reason is that the innovative project is prone to asset substitution. Unless the creditor can prevent it, funding an innovative entrepreneur is a negative-NPV investment (since Project B has negative NPV). Realistically, a creditor must invest in monitoring *before* the entrepreneur makes his project choice—monitoring can prevent asset substitution but not undo it once Project B has been chosen. Thus, only incumbent creditors can monitor entrepreneurs, and only they can fund innovative projects. This provides one explanation for incumbent creditors' monitoring advantage.

5.4 Costs of Monitoring and Possible Underinvestment in Monitoring

Above we have assumed that intermediaries' monitoring cost k is sufficiently low that intermediaries are always willing to invest in monitoring (Parameter Restriction 3), so incumbent creditors always have a monitoring advantage. In this subsection we relax this assumption. We show that for sufficiently high k, banks may under-invest in monitoring expertise for low credit market competition.

LEMMA 8. (UNDERINVESTMENT IN MONITORING) *If* $k/\eta > \Delta + (1-p)I$*, then banks do not invest in monitoring when Period-2 bank competition is low, leading entrepreneurs*

[16] A sufficient condition for this is that $Y_R - I < b$.

to undertake Project S inefficiently. Specifically, entrepreneurs matched with banks choose Project S if

$$\frac{k/\eta - \Delta - (1-p)I}{(1-\eta)\text{NPV}_S} \leq (1-\varphi)Q_2. \tag{18}$$

The intuition for this result is as follows. If k is sufficiently large, low credit market competition distorts the bank's decision to acquire monitoring expertise. Specifically, banks inefficiently choose not to acquire expertise, which leads entrepreneurs to invest inefficiently (excessively) in the traditional project in order to obtain funding. There is a hold-up problem because the bank pays the cost of investing in monitoring expertise before it bargains over the project NPV with the entrepreneur—the bank thus bears a *private* cost for a *shared* benefit. For low levels of credit market competition, the increased NPV of the innovative project may not justify bearing the private cost. Note that this hold-up is not present for high levels of credit market competition. This is because in that case the bank wants to induce the entrepreneur to choose the innovative project not only to increase the project NPV, but also to improve its own bargaining position.

6 Discussion of Assumptions

In this section, we discuss the main assumptions we make in the model. As stated in the Introduction, there are three main assumptions driving the results: (i) that the innovative projects require monitoring, (ii) that incumbent creditors have a monitoring advantage, and (iii) that PEs have a higher cost of capital than banks. We make a number of other modeling choices that we think are worth commenting on. Notably, we discuss the following more minor assumptions of the model: (i) that the innovative project is efficient, (ii) that the entrepreneur's project choice is irreversible, and (iii) that the horizon is two periods.

6.1 Key Assumptions: Monitoring, Incumbents, and Cost of Capital

Innovative projects require monitoring. As mentioned earlier, we assume that innovative projects require monitoring and traditional projects do not because, almost by definition, innovative projects implement new methods, ideas, or products. Thus, creditors must invest time to understand them and mitigate information or agency frictions. Traditional projects, in contrast, implement established practices. Thus, the efficient outcomes are likely to be implementable with contracts. Thus, creditors probably do not need to acquire monitoring expertise to fund traditional projects.

Innovative entrepreneurs are captive. In our model, we assume that incumbent creditors have an advantage in monitoring entrepreneurs. This may arise for a number of reasons. In Subsection 5.3, we advocate the interpretation that incumbent creditors can prevent asset substitution, but other micro-foundations for the idea that relationship lenders have an advantage in providing credit are abundant in the relationship banking literature (see, for example, Bolton, Freixas, Gambacorta, and Mistrulli (2013), Boot and Thakor (1994, 2000) Hachem (2011), and von Thadden (1995)). For example, Rajan (1992) argues that an incumbent creditor "can obtain information about the firm in the course of lending which the firm cannot easily communicate to others" (p. 1368), which gives the incumbent bank an advantage in lending going forward.

PEs' cost of capital is high. We assume that the only difference between banks and PEs is that PEs pay a relatively high cost of capital to finance their deals. This is realistic: PEs promise their limited partners about 8% return and banks' promise their debt holders about 2% (see Metrick and Yasuda (2010), and Damodaran (2016)). In our baseline model, we take this difference as exogenous, reflecting the presence of government guarantees for banks. This is indeed one reason that banks' cost of capital is lower than PEs (International Monetary Fund (2014)), but it is not the only reason. The difference also reflects risk, consistent with our analysis in Subsection 5.1. Further, the fact that this high cost of capital induces PEs to set high hurdle rates for their investments finds support in the empirical literature (Axelson, Jenkinson, Strömberg, and Weisbach (2013)).

6.2 Minor Assumptions: NPV, Irreversibility, and Finite Horizon

Innovative project has higher NPV. We assume that the NPV of the innovative project is greater than that of the traditional project, but this assumption is not necessary for our main results. In fact, an inefficient innovative project would never be chosen in equilibrium. This is because choosing the inefficient innovative project is worse for the entrepreneur along every dimension: it has low NPV and makes the entrepreneur captive to his incumbent creditor. Thus, the entrepreneur always prefers the traditional project.[17]

Project choice is irreversible. In our model, an entrepreneur decides his project choice before he invests outside funds. This reflects (i) that creditors do not lend to firms that have no elements of their projects visibly in place and (ii) that it is costly for an entrepreneur to do an about-face and change from an innovative to a traditional business model or vice versa. In fact, Berk (1999) suggests that "[f]ew people would argue that real investments are fully reversible" (p. 1319). Further, our results do not depend on the assumption that switching projects is impossible, but only on the assumption that it is costly.

Two-period horizon. Our model has only two periods. As a result, in Period 2 an entrepreneur is always captive to his creditor, even if he has chosen a traditional project. This plays an important role in the proof of Proposition 2, which says that an entrepreneur always chooses the innovative project if he is matched with a PE. Recall that the argument hinges on the fact that it is better to be captive today with a high-NPV innovative project than be captive tomorrow with a low-NPV traditional project. With a longer horizon, the entrepreneur may not be captive tomorrow, and therefore he may choose the innovative project to avoid being captive, even if he is matched with

[17]This argument glosses over one subtlety. Since the PE is highly levered, it may be unwilling to fund the traditional project but willing to fund the inefficient innovative project if it has a sufficiently high upside. This could be bilaterally efficient between the PE and the entrepreneur, since the PE's limited partners would bear the downside risk of the investment. However, this cannot happen in equilibrium, because the LPs would charge a high interest rate and PEs would make low returns on average. Thus, these PEs funding the inefficient innovative project could not compete with banks funding the traditional project and as a result PEs would not enter in the first place.

a PE. However, what matters is not the fact that the entrepreneur is captive tomorrow, but rather that it is costly for him to wait to invest. This gives him the incentive to undertake a project today—be it innovative or traditional. The fact that waiting is costly is realistic and can be generated by several other natural assumptions. For example, we could assume that the entrepreneur discounts the future and finding a new creditor takes time. Alternatively, we could assume that projects are time sensitive and depreciate each period, for example because the entrepreneur loses the opportunity to invest or that projects require maintenance.

7 Conclusion

This paper has developed an equilibrium theory of intermediation variety. The theory explains why banks and private equity firms co-exist, and how their emergence attenuates the inefficiencies associated with the investment choices of entrepreneurs. In particular, when credit market competition is high, entrepreneurs make inefficient project choices with bank financing, choosing safe, traditional projects instead of risky, innovative projects. Private equity firms enter the market and induce the efficient project choice. They do this by using the absence of government guarantees to their advantage; their high cost of capital is a commitment device to fund only risky, innovative projects. The idea that the *intermediary's* capital structure can induce an efficient project choice by the *borrower* is one novel insight that distinguishes our paper from previous research. Another new feature of our model is that not only the variety of intermediaries in the market but also the variety of entrepreneurial investments can result entirely from the heterogeneity in intermediaries' cost of funding that, in turn, results from heterogeneity in the extent to which they receive government guarantees.

While much of the previous literature has focused on the entrepreneur's choice between bank and capital market financing, we have focused on the choice between financing from different types of intermediaries. The two-way interaction between project choices of entrepreneurs and the variety of intermediaries that arise to fund

these projects means that the debate about whether the credit market affects economic growth or is merely affected by it (see, for example, Beck, Levine, and Loayza (2000)) may be focusing on the wrong question—our analysis implies that the real project choices and intermediation variety are endogenously co-determined in equilibrium.

A Proofs

A.1 Proof of Lemma 1

The first statement in the lemma is immediate: without monitoring expertise, a creditor can collect nothing from Project R, since Project R has minimum payoff zero. Thus, the creditor will not invest I in the project.

The second statement in the lemma follows from the first. If an entrepreneur is not matched with a creditor with monitoring expertise, he knows he will never find funding for Project R. He may, in contrast, find funding for Project S. Thus, he chooses Project S. □

A.2 Proof of Lemma 2

Before computing the continuation values, we first note that no match formed in Period 1 breaks down. This is because the Nash bargaining solution ensures that players reach agreement whenever there is surplus created by a match. In our model, there is always surplus created by creditors' funding entrepreneurs. This is important to note, because it implies that any player that is newly matched in the second period was unmatched in the first period. This implies that all entrepreneurs that are newly matched in the second period have chosen Project S, by Lemma 1.

A bank's Period-1 continuation value is given by

$$\pi_b = q_2 \eta \left(Y_S - I \right) \tag{19}$$

$$= q_2 \eta \text{NPV}_S. \tag{20}$$

The expression follows from the following logic. With probability q_2 the bank is matched with an entrepreneur in Period 2. In this case, the bank and entrepreneur Nash bargain over the surplus. The surplus is given by $Y_S - I$, since the match creates output Y_S and the bank must repay I to its own creditors. The bank's bargaining power is η. With

probability $1 - q_2$, the bank is unmatched and gets zero.

A PE's Period-1 continuation value is zero. The reason is as follows. First note that by Lemma 3 below a PE never funds Project S.[18] Further, if a PE is matched in Period 2, it is matched with an entrepreneur who has chosen Project S. This follows from Lemma 1 and from the comment at the beginning of this proof that no match formed in Period 1 breaks down. Thus, a PE searching in Period 2 never funds a project and its continuation value is zero.

An entrepreneur's Period-1 continuation value from choosing Project S is given by

$$\pi_S = (1-\varphi)Q_2(1-\eta)\left(Y_S - I\right) \tag{21}$$

$$= (1-\varphi)Q_2(1-\eta)\text{NPV}_S. \tag{22}$$

This expression follows from the following logic. With probability $(1-\varphi)Q_2$ the entrepreneur is matched with a bank in Period 2. In this case, the entrepreneur and the bank Nash bargain over the surplus $Y_S - I$. The entrepreneur's bargaining power is $1-\eta$. With probability $1-(1-\varphi)Q_2$, the entrepreneur is either matched with a PE or is unmatched. In this case, his project goes unfunded and he gets zero.

An entrepreneur's Period-1 continuation value from choosing Project R is zero because he will not be able to obtain funding. This follows from Lemma 1.

We now turn to the computation of θ_2. The Period-2 credit market competition is determined by the unmatched entrepreneurs and creditors in Period 1 according to the following:

$$\theta_2 = \frac{|\#\text{ creditors }|(1-q_1)}{|\#\text{ entrepreneurs }|(1-Q_1)}. \tag{23}$$

Now note that

$$\frac{|\#\text{ creditors }|}{|\#\text{ entrepreneurs }|} \equiv \theta_1 \tag{24}$$

by definition and substitute in for the expressions for Q and q from Parameter Restriction 1 to recover that $\theta_2 = \theta_1^2$. □

[18] Note that Lemma 3 does not depend on this proof, so we can employ it freely here even though it comes later in the text.

A.3 Proof of Proposition 1

We first show that if interbank competition is high in Period 2, the entrepreneur chooses Project S even if the bank has monitoring expertise. Then we proceed to show that the entrepreneur chooses Project S only for high levels of interbank competition. That is, that for low levels of interbank competition, banks invest in monitoring and entrepreneurs choose Project R.

If matched with a bank that has monitoring expertise, the entrepreneur chooses Project S if it gives a higher payoff than Project R, or

$$(1-\eta)\big(Y_S - I - \pi_b - \pi_S\big) + \pi_S > (1-\eta)\big(p(Y_R - I) - \pi_b - \pi_R\big) + \pi_R. \tag{25}$$

Substituting for the continuation values from Lemma 2, this inequality rewrites as

$$(1-\varphi)Q_2 > \frac{\Delta + (1-p)I}{\eta \mathrm{NPV}_S}, \tag{26}$$

which is the inequality in the statement of the proposition. So, for high levels of interbank competition the entrepreneur chooses to invest in Project S.

It follows that for low levels of interbank competition, the entrepreneur is willing to invest in Project R. However, for entrepreneurs to invest in this project, the bank must be willing to fund it. The bank is willing to fund Project R as long as it is willing to bear the cost k acquiring monitoring experties. This is the case whenever

$$\eta\big(p(Y_R - I) - \pi_R - \pi_b\big) + \pi_b - k \geq \eta\big(Y_S - I - \pi_S - \pi_b\big) + \pi_b. \tag{27}$$

Substituting for the continuation values from Lemma 2, this inequality rewrites as

$$(1-\varphi)Q_2 \geq \frac{k/\eta - \Delta - (1-p)I}{(1-\eta)\mathrm{NPV}_S}. \tag{28}$$

By Parameter Restriction 3 the right-hand-side of the inequality is negative, so it is always satisfied. This proves the proposition. □

A.4 Proof of Lemma 3

The result follows from Parameter Restriction 2, which says that $Y_S < (1+r)I$, or that the payoff of a traditional project is too low to cover a PE's debt. Thus, if a PE funds Project S, it necessarily receives payoff zero. Since the PE never funds projects that give it payoff zero (see the comment on the tie-breaking rule in Subsection 3.1), the PE never funds Project S. □

A.5 Proof of Proposition 2

In this proof, we note first that a PE always acquires monitoring expertise and, as a result, can always fund Project R. We then show that an entrepreneur who is matched with a PE always prefers to undertake Project R than to undertake Project S.

The reason that a PE always acquires monitoring expertise is that if it does not it can fund neither Project R (it cannot monitor to collect) nor Project S (by Lemma 3). Parameter Restriction 3 ensures that the payoff from investing in monitoring is positive.

We now show that an entrepreneur who is matched with a PE prefers Project R to Project S. Since the PE never funds Project S (Lemma 3), the entrepreneur must prefer investing in Project R in Period 1 to his continuation value π_S if he chooses Project S, or

$$(1-\eta)\big(p(Y_R-(1+r)I)-\pi_{\text{PE}}-\pi_R\big)+\pi_R \geq \pi_S. \tag{29}$$

Substituting for the continuation values from Lemma 2, we can rewrite the inequality as

$$(1-\eta)p(Y_R-(1+r)I)-(1-\varphi)Q_2(1-\eta)\text{NPV}_S \geq 0. \tag{30}$$

This is always satisfied. To see see why, notice that it is minimized when $(1-\varphi)Q_2 = 1$. Substituting in for this and rearranging gives a positive lower bound:

$$(1-\eta)p(Y_R-(1+r)I)-(1-\varphi)Q_2(1-\eta)\text{NPV}_S \geq (1-\eta)\left(\Delta+(1-p)I-prI\right) \geq 0 \tag{31}$$

by Parameter Restriction 2. □

A.6 Proof of Lemma 4

The result follows immediately from Proposition 1 and Proposition 2. □

A.7 Proof of Proposition 3

Before proving the proposition, we prove two lemmata about creditor entry. These establish conditions for entry in terms of the entry cost e.

LEMMA 9. *Given a competitive credit market, a bank enters if and only if*

$$\Big(\eta q_1\big[1-(1-\eta)(1-\varphi)Q_2\big]+\eta(1-\eta q_1)q_2\Big)\mathrm{NPV}_S \geq e. \tag{32}$$

Proof. In a competitive credit market, an entrepreneur chooses Project S when he is matched with a bank. Thus, a bank anticipates funding Project S. A bank enters when its expected payoff from entering is greater than its entry cost e, or

$$q_1\big(\eta(Y_S-I-\pi_b-\pi_S)+\pi_b\big)+(1-q_1)\pi_b \geq e. \tag{33}$$

Substituting in for π_b and π_S from Lemma 2 and rearranging gives the expression in the statement of the lemma. □

LEMMA 10. *A PE enters if and only if*

$$q_1\Big[\eta p\big(Y_R-(1+r)I\big)-k\Big] \geq e. \tag{34}$$

Proof. A PE's payoff from investing is $\eta p\big(Y_R-(1+r)I\big)$, since it must repay its debt $(1+r)I$ out of its cash flow. In order to obtain this payoff it must be matched, which occurs with probability q_1, and pay k to acquire monitoring expertise. Note that if the PE does not find a match in Period 1, which occurs with probability $1-q_1$, it is too late for it to fund an innovative project and therefore it receives payoff zero. Thus, its

expected payoff upon entry is $q_1\Big[\eta p\big(Y_R-(1+r)I\big)-k\Big]$. As stated in the lemma, a PE enters when this expected payoff exceeds its entry cost e. $\square$

We now turn to the proof of the proposition, beginning with the expression for the equilibrium proportion of PEs in the market φ. For banks and PEs to coexist in equilibrium, both banks and PEs must be indifferent toward entering. Thus, in competitive credit markets, the inequalities in equations (32) and (34) must bind. We can eliminate the entry cost e, and observe the following condition for banks and PEs to coexist:

$$q_1\Big[\eta p\big(Y_R-(1+r)I\big)-k\Big]=\Big(\eta q_1\big[1-(1-\eta)(1-\varphi)Q_2\big]+\eta(1-\eta q_1)q_2\Big)\text{NPV}_S. \quad (35)$$

Recall that $q(\theta)=1/(1+\theta)$ and $Q(\theta)=\theta/(1+\theta)$ from Parameter Restriction 1 and that $\theta_2=\theta_1^2$ from Lemma 2. We now substitute for q_1, q_2, and Q_2 as well as C from the statement of the proposition and rearrange to find

$$-\frac{C}{1+\theta_1}=\left(-(1-\eta)(1-\varphi)\frac{1}{1+\theta_1}\cdot\frac{\theta_1^2}{1+\theta_1^2}+\left(1-\frac{\eta}{1+\theta_1}\right)\frac{1}{1+\theta_1^2}\right). \quad (36)$$

Solving for φ gives

$$\varphi=1-\frac{1}{1-\eta}\left(C+\frac{1-\eta+C+\theta_1}{\theta_1^2}\right), \quad (37)$$

as stated in the proposition. This is the expression for φ when it is between zero and one.

We now prove the additional statements in the proposition. Throughout the proof below, we make use of the fact that $C>0$. This follows immediately from Parameter Restriction 3.

Statement (i). First, we prove statement (i) that PEs are present only in sufficiently competitive credit markets. Since the expression for φ above is continuous and approaches $-\infty$ as $\theta_1\to 0^+$, for low levels of competition, $\varphi=0$. In other words, PEs are not present when credit markets are not sufficiently competitive, as desired. (In the argument above, we have glossed over one subtlety: it remains to confirm that

PEs never enter for low credit market competition when entrepreneurs choose Project R when matched with banks. We establish this formally in Lemma 11 below.)

Statement (ii). Second, we prove statement (ii) that the proportion of PEs is increasing in credit market competition. This follows from differentiating the expression for φ with respect to θ_1:

$$\varphi' = \frac{2(1-\eta+C)+\theta_1}{(1-\eta)\theta_1^3} > 0. \tag{38}$$

Statement (iii). Third, we prove statement (iii) that PEs never take over the market. To do this, we take the limit of φ as $\theta_1 \to \infty$:

$$\varphi = 1 - \frac{1}{1-\eta}\left(C + \frac{1-\eta+C+\theta_1}{\theta_1^2}\right) \to 1 - \frac{C}{1-\eta} \tag{39}$$

as $\theta_1 \to \infty$. □

A.8 Proof of Proposition 4

Here we prove statements (i) to (iii) in the proposition in reverse order. This is because it simplifies the proof to begin with the case in which competition is high and work toward the case in which competition is low.

As in the proof of Proposition 3 above, we make use of the fact that $C > 0$, which follows immediately from Parameter Restriction 3.

Statement (iii). Begin by recalling Proposition 3, which says that if interbank competition is high, PEs enter. Equation (9) gives the proportion φ of PEs that enter in equilibrium. When $\varphi = 0$ in the expression, PEs are indifferent between entering and not entering. For larger φ the proportion of PEs is positive. Thus, $\varphi = 0$ gives an equation for θ^{**}, the threshold above which PEs enter (conditional on entrepreneurs choosing Project S when matched with banks). This equation reads

$$(1-\eta-C)\theta_1^2 - \theta_1 - 1 + \eta - C = 0. \tag{40}$$

This is a quadratic equation with two roots. If the roots are real, the smaller root is

negative, so we can restrict attention to the larger root, which is θ^{**} as stated in the proposition.

Note that here we have found the lowest level of credit market competition in which PEs enter conditional on entrepreneurs choosing Project S when matched with banks. It remains to show that for $\theta_1 > \theta^{**}$, entrepreneurs do indeed choose Project S. This comes from comparison with the bounds in Proposition 1. Specifically, as long as

$$(1-\varphi)Q_2 > \frac{\Delta + (1-p)I}{\eta \text{NPV}_S}, \tag{41}$$

entrepreneurs choose Project S when matched with banks. We proceed to show that this condition is always satisfied for $\theta_1 > \theta^{**}$. To do so, we argue that it is sufficient to show that it is satisfied for large θ_1 and then show that it holds in the limit as $\theta_1 \to \infty$.

The reason that it suffices to we show that the condition is satisfied for large θ_1 is that it is satisfied (it holds with equality) at $\theta_1 = \theta^*$ and for $\theta_1 > \theta^*$ it is either decreasing or increasing then decreasing. This implies that it is hardest to satisfy either at θ^* or in the limit as $\theta_1 \to \infty$. Since we already know that it is satisfied at θ^*, it suffices to show that it is satisfied in the limit.

First, we show that $(1-\varphi)Q_2$ is either decreasing or increasing then decreasing in θ_1. We show this by direct computation:

$$\frac{\partial}{\partial \theta_1}(1-\varphi)Q_2 = \frac{\partial}{\partial \theta_1}\left(\frac{1}{1-\eta}\left(C + \frac{1-\eta+C+\theta_1}{\theta_1^2}\right)\frac{\theta_1^2}{1+\theta_1^2}\right) \tag{42}$$

$$= \frac{1-2(1-\eta)\theta_1 - \theta_1^2}{(1-\eta)\left(1+\theta_1^2\right)^2}. \tag{43}$$

Thus, $(1-\varphi)Q_2$ is increasing whenever $1-2(1-\eta)\theta_1 - \theta_1^2$ is positive. This is a negative quadratic with exactly one positive root, so for $\theta_1 > 0$ it is first positive and then negative. Thus $(1-\varphi)Q_2$ is either decreasing or increasing then decreasing for $\theta_1 > \theta^{**}$.

We now show that the condition is satisfied in the limit.

$$(1-\varphi)Q_2 = \frac{1}{1-\eta}\left(C + \frac{1-\eta+C+\theta_1}{\theta_1^2}\right)\frac{\theta_1^2}{1+\theta_1^2} \to \frac{C}{1-\eta} \tag{44}$$

as $\theta_1 \to \infty$. Now

$$\frac{C}{1-\eta} = \frac{k/\eta + p(1+r)I - I - \Delta}{(1-\eta)\text{NPV}_S}. \tag{45}$$

Thus, entrepreneurs choose Project S whenever

$$\frac{k/\eta + p(1+r)I - I - \Delta}{(1-\eta)\text{NPV}_S} > \frac{\Delta + (1-p)I}{\eta\text{NPV}_S} \tag{46}$$

or,

$$k + \eta pr I > \Delta + (1-p)I, \tag{47}$$

which is satisfied by the hypothesis in the proposition.

Statement (ii). We now turn to statement (ii). Again, we exploit the result in Proposition 1 that entrepreneurs choose Project S whenever

$$(1-\varphi)Q_2 > \frac{\Delta + (1-p)I}{\eta\text{NPV}_S}. \tag{48}$$

We show that there exists a region before PEs enter in which entrepreneurs are standardized when matched with banks. This follows from substituting for $Q_2 = \dfrac{\theta_1^2}{1+\theta_1^2}$ and $\varphi = 0$ in the inequality above, giving

$$\frac{\theta_1^2}{1+\theta_1^2} > \frac{\Delta + (1-p)I}{\eta\text{NPV}_S}. \tag{49}$$

Solving for θ_1 in the equation above, we find that entrepreneurs choose Project S whenever $\theta_1 > \theta^*$ given in the proposition. Hence, since by the hypothesis that $\theta^{**} > \theta^*$, we have that $\varphi = 0$ for all $\theta^* < \theta_1 < \theta^{**}$.

Statement (i). Before proving statement (i), we state a lemma that says that if banks are funding Project R, PEs never enter.

LEMMA 11. *Given that banks are funding Project R, PEs do not enter.*

Proof. Given that banks are funding Project R, their entry condition implies that

$$q_1\big[\eta(p(Y_R - I) - \pi_b) + \pi_b - k\big] + (1 - q_1)\pi_b = e, \tag{50}$$

since the total surplus is $p(Y_R - I)$ due to government guarantees.

To show that no PEs enter, we show that a PE's expected profit is less than the entry cost e, or that

$$q_1\big[\eta p(Y_R - (1 + r)I) - k\big] < e. \tag{51}$$

Substituting in for e from the bank's entry condition gives the sufficient condition

$$q_1\big[\eta p(Y_R - (1 + r)I) - k\big] < q_1\big[\eta(p(Y_R - I) - \pi_b) + \pi_b - k\big] + (1 - q_1)\pi_b, \tag{52}$$

which simplifies to

$$(1 - q_1\eta)\pi_b > -q_1\eta p r I. \tag{53}$$

This is always satisfied since the righthand side above is negative. □

We now prove statement (i) of the proposition. The proof of statement (ii) above, implies that for $\theta_1 < \theta^*$ banks acquire monitoring expertise and entrepreneurs choose Project R. The proof of Lemma 11 shows that PEs do not enter whenever $\theta_1 < \theta^*$. □

A.9 Proof of Lemma 6

To solve for the equilibrium contracts, we start from the Nash bargaining solution. Then we find the financial contract that implements the division of surplus.

We start with the PE's equity stake. For the proof, refer to it as α. In the event of success, the PE gets αY_R and otherwise it gets zero. Thus, α solves

$$\eta p(Y_R - (1 + r)I) = p(\alpha Y_R - (1 + r)I), \tag{54}$$

which gives

$$\alpha = \eta + (1-\eta)\frac{(1+r)I}{Y_R} \tag{55}$$

as stated in the lemma.

We now solve for the bank's face value of debt. For the proof, refer to it as F_{bank}. Since there is no risk, the face value of debt is just the total surplus allocated to the bank in bargaining. Thus, F_{bank} is given by

$$\begin{aligned} F_{\text{bank}} &= \eta\big(Y_S - I - \pi_S - \pi_b\big) + \pi_b && (56)\\ &= \eta\Big(1 + (1-\eta)\big[q_2 - (1-\varphi)Q_2\big]\Big)\text{NPV}_S, && (57) \end{aligned}$$

where we have substituted for π_b and π_S from Lemma 2. This is the expression given in the statement of the lemma. □

A.10 Proof of Lemma 7

The lemma follows immediately from the following two assumptions: (i) that the private benefits B are sufficiently large that asset substitution is always desirable and (ii) Project B has negative NPV.

A.11 Proof of Lemma 8

The bank acquires monitoring expertise if

$$\eta\big(p(Y_R - I) - \pi_R - \pi_b\big) + \pi_b - k \geq \eta\big(Y_S - I - \pi_S - \pi_b\big) + \pi_b. \tag{58}$$

Substituting for the continuation values from Lemma 2, this inequality rewrites as

$$(1-\varphi)Q_2 \geq \frac{k/\eta - \Delta - (1-p)I}{(1-\eta)\text{NPV}_S}, \tag{59}$$

which is the left-hand side inequality in the statement of the proposition. □

A.12 Table of Notations

	Projects
I	required capital investment
Y_S	Project S payoff
NPV_S	NPV of Project S
Y_R	Project R success payoff
p	Project R success probability
NPV_R	NPV of Project R
Δ	difference in project NPVs, $\text{NPV}_R - \text{NPV}_S$
	Players
π_b	a bank's Period-1 continuation value
π_{PE}	a PE's Period-1 continuation value
π_S	an entrepreneur's continuation value if he has chosen Project S
π_R	an entrepreneur's continuation value if he has chosen Project R
	Credit Market
θ_t	credit market competition at Period t
$Q_t \equiv Q(\theta_t)$	probability an entrepreneur is matched with a creditor
$q_t \equiv q(\theta_t)$	probability a creditor is matched with an entrepreneur
φ	proportion of PEs
$(1-\varphi)Q_2$	Date-2 bank competition
	Parameters
k	cost of acquiring monitoring technology
e	creditors' entry cost
η	creditors' bargaining power
β	LPs' bargaining power when funding PEs
r	PEs' cost of capital
C	constant defined in equation (8)

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