INTERMEDIATION VARIETY*

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Abstract

We explain the endogenous emergence of a variety of lending intermediaries in a model based only on differences in their funding costs. Banks have a lower cost of capital than non-banks due to government safety nets. However, with only bank finance, entrepreneurs make inefficient project choices, forgoing innovative projects for traditional projects. Non-banks emerge to mitigate this inefficiency, using their high cost of capital as a commitment device not to fund traditional projects, thus inducing entrepreneurs to innovate efficiently. Despite earning high returns, non-banks never take over the entire market, but coexist with banks in general equilibrium.

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1 Introduction

Depository financial intermediaries ("banks") have a low cost of capital since they benefit from government safety nets.[1] This gives them an advantage over non-depository intermediaries ("non-banks") that fund themselves with liabilities at market prices.[2] Despite this relative funding-cost disadvantage, non-banks have proliferated as the credit market has become more competitive.[3] Whereas banks continue to provide much of the funding for traditional projects—commercial and industrial loans to firms in established industries—non-banks such as private equity firms and venture capitalists have provided an increasing proportion of funding for innovative projects. Such 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 main questions we address in this paper, questions that the literature has left relatively unexplored. Why do non-bank intermediaries co-exist with banks, even though government safety nets give banks an advantage in the funding market? And why do non-banks remain relatively scarce, even though they earn high returns?

Model preview. To address these questions, we develop a model in which entrepreneurs' project choices and the mix of banks and non-banks in the market are jointly determined in general equilibrium. In the model, there are two periods and two types of creditors, banks and non-banks. In the first period, creditors enter and are matched with entrepreneurs. Then, each entrepreneur decides to undertake one of two projects, a high-NPV innovative project or a low-NPV traditional project. Next, each entrepreneur either negotiates a funding contract with his incumbent creditor in the first period or waits to find a new creditor in the second period. The likelihood with which an entrepreneur finds a new creditor reflects credit market competition.

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 that necessitate creditor monitoring. (ii) Incumbent creditors have an advantage in monitoring entrepreneurs, as in the relationship banking literature. This reflects the

[1] See International Monetary Fund (2014a, 2014b).

[2] See International Monetary Fund (2016).

[3] 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." International Monetary Fund (2016) discusses the rise of non-banks since the 1980s and Shapiro and Pham (2008) highlight the rise in private equity firms in particular, saying "The number...of U.S. private buyout-related deals rose from 12 transactions in 1970...to 2,474 deals in 2007."

fact that incumbent creditors acquire the necessary monitoring expertise through long-term relationships with entrepreneurs.[4] (iii) Banks have a lower cost of capital than non-banks. This is consistent with the presence of government subsidies coming from deposit insurance and too-big-to-fail guarantees.

Results preview. Our first main result is that entrepreneurs innovate too little in competitive credit markets. Since innovative projects require 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 comes with the benefit of a higher total payoff, but the cost of becoming captive. In equilibrium, the entrepreneur chooses the innovative project if credit market competition is sufficiently low. In this case, he is effectively always captive to his incumbent creditor. So he chooses the innovative project because it has the higher payoff. In contrast, the entrepreneur chooses the traditional project (inefficiently) if competition is high. In this case, he can find another creditor to lend to him if he chooses the traditional project. This puts him in a strong bargaining position with his incumbent creditor. So he chooses the traditional project because it allows him to extract more rent even though the total payoff is lower. Thus, credit market competition has a dark side in our model—underinvestment in innovative projects.

Our second main result is that non-bank funding mitigates this distortion of competitive credit markets. This is because a non-bank 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 non-bank 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.[5] With their lower cost of funding, banks are unable to credibly precommit to funding only innovative projects. This finding that non-banks can use their own cost of borrowing to discipline entrepreneurs may shed light on why some non-banks, such as PEs, finance their investments on a deal-by-deal basis: it imposes a fixed hurdle rate for each deal,

[4]See Bolton, Freixas, Gambacorta, and Mistrulli (2013), Boot and Thakor (1994, 2000), Diamond and Rajan (2001), Hachem (2011), Rajan (1992), and von Thadden (1995). The assumption that incumbent creditors have an advantage in monitoring entrepreneurs is in line with the assumption in Diamond and Rajan (2001) in which incumbent creditors have an advantage in identifying alternative uses for the assets:

> The date-0 lender to a project, whom we will call the relationship lender, develops specific skills in identifying alternative uses for the assets; she has been in a relationship with the entrepreneur at an early enough stage to know how the business was built and knows what alternative strategies were considered. Lenders who come later do not have the relationship lender's specific skills in finding the next-best alternative use.

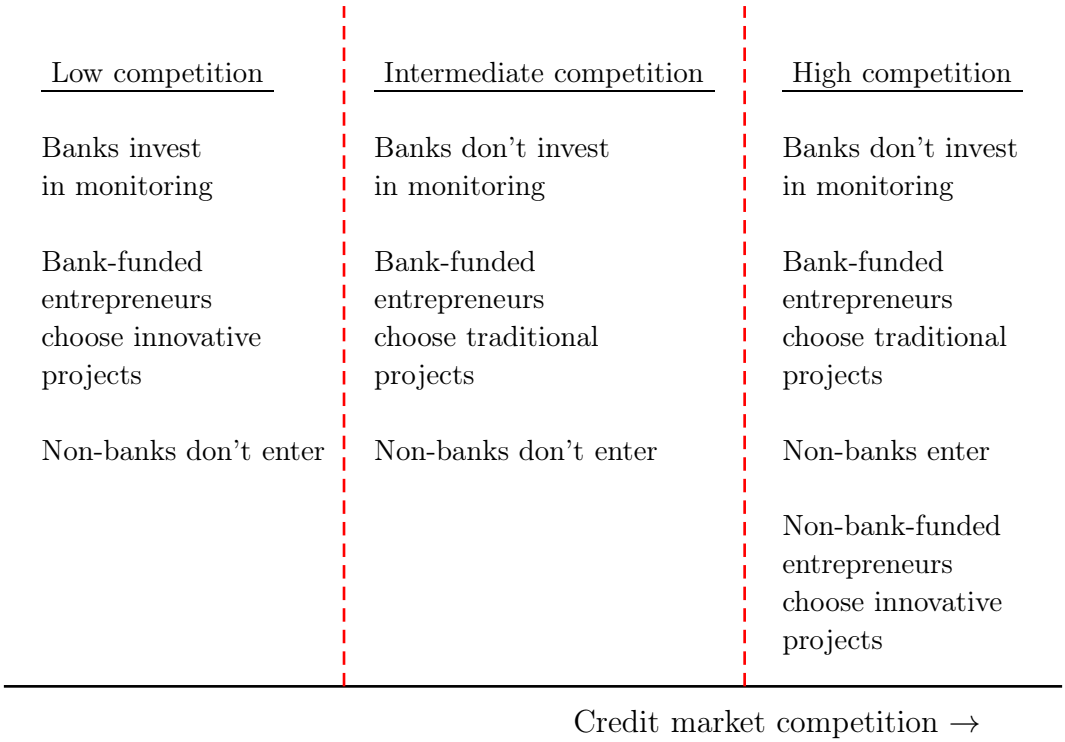
[5]Non-banks' own cost of capital determines their hurdle rates for investments in reality. For the case of PEs, Axelson, Jenkinson, Strömberg, and Weisbach (2013) find that PEs' cost of capital is the best predictor of their returns on deals.

committing them 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 non-banks in the credit market. We use this expression to show that non-banks enter only competitive credit markets and that they perform an increasing proportion of lending as credit market competition increases. However, they do not take over the whole market, but co-exit with banks even in perfectly competitive credit markets. The reason is that non-bank entry has a positive externality on incumbent banks: increasing the proportion of non-banks in the market effectively decreases competition among banks, making banks' core business of funding traditional projects more profitable.

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—he chooses a traditional project if he anticipates bank funding, and an innovative project if he anticipates non-bank funding. Likewise, the intermediaries that exist in the market are determined by entrepreneurs' project choices—non-banks have incentive to enter *only* because entrepreneurs are making inefficient project choices, an inefficiency which non-banks are able to undo thanks to their own high cost of capital. In Figure 1, we illustrate how entrepreneurs' project choices and the variety of intermediaries are determined for different regions of credit market competition. (We do a numerical example to plot these regions for "reasonable" parameters in Subsection 3.5.)

FIGURE 1: FINANCING REGIMES AS A FUNCTION OF CREDIT MARKET COMPETITION



Empirical content of our theory. Non-banks in our model could represent a variety of institutions that compete with traditional banks, such as private equity firms and venture capitalists, as well as other other specialist lenders, like insurance companies, commercial mortgage banks, and hard money lenders. Our focus on the choices of both borrowers and lenders in general equilibrium sheds light on a number of stylized facts about entrepreneurial investment and bank versus non-bank funding. (i) An increase in bank 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 interbank competition. (ii) The development of equity markets leads entrepreneurs to innovate more. Hsu, Tian, and Xu (2014) provide evidence in support of this finding: the development of equity markets encourages innovation by high-tech firms, but the development of debt markets seems to discourage it. (iii) Non-bank intermediaries seem to exist mainly in competitive credit markets. This is in line with International Monetary Fund (2016) and the evidence on how PE transactions have grown with credit-market competition cited above (e.g., Boyd and Gertler (1994)

and Shapiro and Pham (2008)). (iv) PEs have high returns. This is consistent with Harris, Jenkinson, and Kaplan (2014) who document that the returns delivered by PE funds have consistently exceeded those of public equity markets. (v) Despite these high returns, non-banks continue to provide only a relatively small fraction of the funding in the economy. For example, from 2000–2005, the value of US private equity buyout deals was $100 billion a year on average. In contrast, the total value of commercial and industrial loans originated exceeded $11 trillion a year on average.[6] (vi) Non-banks such as PEs and VCs fund relatively innovative projects compared to banks (see, for example, Kortum and Lerner (2000) and Lerner, Sorensen, and Strömberg (2011)).

Further results. We study four extensions. (i) We show that if creditors' cost of monitoring entrepreneurs is sufficiently high, there may be a new inefficiency: creditors may underinvest in monitoring when credit market competition is low. (ii) We micro-found the need to monitor innovative projects by introducing an asset substitution problem following Holmström and Tirole (1997). (iii) We endogenize non-banks' cost of capital. This justifies our assumption that non-banks' cost of capital is relatively high. (iv) Under the assumption that banks invest with debt and non-banks invest with equity (as PEs and VCs do), we solve for the interest rate that banks charge entrepreneurs and the size of the equity stake that non-banks take in entrepreneurs' projects. We find that the size of the non-banks' equity stake does not vary with the competitiveness of the credit market.

Related Literature. Our paper contributes to the literature on competition among different types of creditors.[7] Although a number of papers study the interaction between bank and market finance,[8] few papers study the interaction of bank and non-bank finance. Two papers that do are Ueda (2004), which studies the interaction between banks and VCs, and Begenau and Landvoigt (2017), which studies the interaction between regulated "banks" and unregulated "shadow banks." Moreover, Martinez-Miera and Repullo (2017) studies the interaction between "monitoring banks" and "non-monitoring banks," which, for high competition, correspond to our "banks" and "non-banks" in equilibrium. None of these papers studies entrepreneurs' project choices, which are at the heart of our analysis.

[6] 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>.

[7] Many papers study credit market competition *without* different types of creditors; see Boot and Thakor (2000), Boyd and De Nicolò (2005), Cao and Shi (2000), Dell'Ariccia (2000), Dell'Ariccia and Marquez (2004), Guzman (2000), Hellmann, Murdock, and Stiglitz (2000), Marquez (2002), Martinez-Miera and Repullo (2010), Matutes and Vives (2000), Petersen and Rajan (1995), Rajan (1992), Repullo (2004) Sharpe (1990), and Wagner (2009).

[8] See, e.g., 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 main results also add to the contracting and intermediation theory literature more generally. Our first main result (too little innovation when credit competition is high) reflects a general intuition from the hold-up problem, that there is too little relationship-specific investment when outside options are high (see, e.g., Grossman and Hart (1986)). Our insight is that innovation can make entrepreneurs captive to their incumbent creditors, and thus the risk of hold-up incentivizes entrepreneurs to undertake traditional projects too much. Our second main result (non-banks use their high cost of capital advantageously to discipline entrepreneurs) complements the intuition that intermediaries use their own leverage as commitment device to prevent borrower opportunism (e.g. as in Diamond and Rajan (2001)).[9] Unlike in that paper, the disciplining mechanism works even without the risk of depositor runs. Our third main result (non-bank entry has an externality on banks) relies on multiple types of intermediaries in a search-and-matching set-up, something new to the literature, to the best of our knowledge.[10] For high competition, this generates endogenous market segmentation in which entrepreneurs borrow from monitoring non-banks to fund innovative projects and from non-monitoring banks to fund traditional projects. This complements Martinez-Miera and Repullo's (2017) result that risky entrepreneurs borrow from monitoring banks and safe entrepreneurs borrow from non-monitoring banks. Unlike that model, in which entrepreneurs are exogenously different in their riskiness, all entrepreneurs are ex ante identical in our model, with the only exogenous heterogeneity being in intermediaries' cost of capital.

Layout. The rest of the paper is organized as follows. In Section 3, we solve the model and present the main analysis. In Section 4, we explore several extensions. In Section 5, we conclude. The Appendix contains all proofs and a glossary of notations.

2 Model Set-up

There are two periods, Period 1 and Period 2. In each period, entrepreneurs are matched with creditors, which can be banks or non-banks. If a creditor is matched with an entrepreneur in Period 1, we refer to it as the "incumbent" creditor. Each entrepreneur chooses a project in Period 1, which he can implement in Period 2 if he gets funding from a creditor. Projects are either innovative or traditional. Innovative projects have higher NPV, but require monitoring, and only incumbent creditors can acquire the monitoring expertise necessary to fund them.

[9] Axelson, Strömberg, and Weisbach (2009) also show that intermediary leverage can mitigate agency problems focusing on the conflict of interest between a private equity fund and its investors.

[10] Papers that study credit market competition in search-and-matching set-ups without heterogeneous creditors include Inderst and Mueller (2004), Jovanovic and Szentes (2013)), Nanda and Rhodes-Kropf (2012), and Wasmer and Weil (2004).

The following subsections describe the model in detail.

2.1 Players: Projects and Monitoring

Entrepreneurs. There is a unit continuum of penniless risk-neutral entrepreneurs. Each entrepreneur chooses one of two projects, a traditional project or an innovative project, each of which requires capital investment K. The traditional project pays off Y_T for sure and the innovative project pays off Y_I with probability p and zero otherwise. We use the shorthands $\text{NPV}_T := Y_T - K$ and $\text{NPV}_I := pY_I - K$ for the projects' net present values. Both projects have positive NPV, but NPV_I is greater than NPV_T.[11] We denote the NPV gain from innovation by $\Delta := \text{NPV}_I - \text{NPV}_T$. Whereas the innovative project has higher NPV, it has the downside that it is associated with agency frictions[12] and therefore it requires monitoring. This assumption that innovation necessitates monitoring defines the main difference between the projects; the (realistic) assumption that innovation is also risky plays a less important role, but it is necessary for our results on the coexistence of banks and non-banks.[13]

Creditors. There are large continua of two types of penniless, risk-neutral creditors, called banks and non-banks. Each creditor can pay a non-pecuniary entry cost e to enter the credit market. φ denotes the proportion of entering creditors that are non-banks. Upon entry, each creditor must raise capital K to fund itself. Thus, banks and non-banks are both borrowers and lenders—they are intermediaries. Banks raise K at net rate zero, whereas non-banks raise K at net rate $r > 0$. This difference in the cost of capital is the only formal difference between banks and non-banks. We take it as exogenous in the baseline analysis, but in Subsection 4.3 we derive non-banks' 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 can acquire expertise to monitor the entrepreneur at (non-pecuniary) cost c; they are "relationship lenders" in the language of the relationship banking literature.

Finally, we make the technical assumption that a creditor never invests in a project that will cause it to default on its own debt with probability one.[14]

[11] Our assumption that the innovative project has higher NPV serves to restrict attention to interesting cases; if the innovative project had lower NPV, it would never be chosen in equilibrium.

[12] We abstract from the details of these agency frictions for now, taking them as synonymous with the need for monitoring in the baseline model. However, we micro-found this in the extension in Subsection 4.2, where we incorporate an asset-substitution problem following Holmström and Tirole (1997).

[13] Specifically, the hypotheses of Proposition 4, which says that there is a region in which banks and non-banks co-exist, and Parameter Restriction 3 together rule out the case in which $p = 1$, i.e. in which the innovative project is riskless. However, it is not necessary for our results that the traditional project is completely riskless; it is just simpler.

[14] This assumption just serves as a tie-breaking rule to ensure creditors prefer not to invest then to invest

2.2 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 bank or a non-bank with probabilities proportional to the number of banks and non-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 non-bank 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 2.4, 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.

Below, 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 should emphasize that θ_t is endogenous. This might look improper below, when we phrase some results as comparative statics with respect to θ_1. However, we solve for the equilibrium θ_1 explicitly. It is a decreasing function of the creditors' entry cost e, which is exogenous. Thus, $-e$ can serve as an exogenous measure of credit market competition, generating equivalent comparative statics. We choose to use θ_1 as our baseline measure of credit market competition because we think it is more intuitive, and possibly easier to measure empirically.

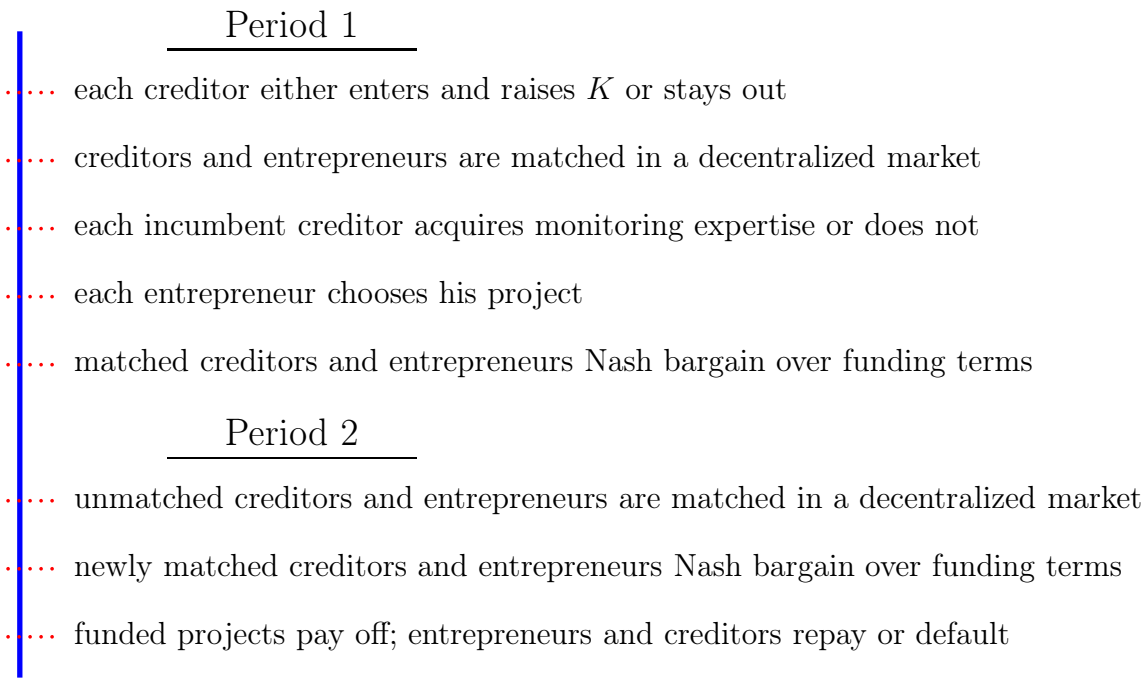
2.3 Timeline

The timing, which is illustrated in Figure 2, is as follows. In the first period, creditors either enter and raises capital K or stay out. They match or not with entrepreneurs

and default for sure. We use it only to simplify the proof of Lemma 3. Other natural assumptions would generate the same behavior, e.g. including an arbitrarily small cost of originating loans.

according to the matching technologies described above. Next, if a creditor is matched with an entrepreneur, it can acquire monitoring expertise or not, after which each entrepreneur chooses the traditional or innovative project irreversibly.[15] At the end of the first period, matched creditors and entrepreneurs Nash bargain over funding terms.[16] If bargaining breaks down, then entrepreneurs and creditors can be matched again in a decentralized market at the beginning of the second period. There is no new creditor entry in the second period, but entrepreneurs and creditors who were not matched in Period 1 may be matched in Period 2. If a creditor and an entrepreneur are matched in Period 2, they Nash bargain over funding terms (in Period 2, it is too late for creditors to acquire monitoring expertise, but they may still invest in traditional projects).[17] Finally, funded projects are implemented. Projects pay off and borrowers repay or default.

FIGURE 2: TIMELINE



[15] 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.

[16] Our results do not depend on the forms of funding contracts; in Subsection 4.4, we calculate the equilibrium funding contracts for banks and non-banks under the assumption that banks fund via debt and non-banks fund via equity.

[17] The fact that our model has only two periods will play an important role in the proof of Proposition 2. However, we argue in footnote 18 below that this assumption is not strictly necessary for that result.

2.4 Parameter Restrictions

In this subsection, 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 non-banks' cost of capital r.

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

$$\text{NPV}_T < rK < \frac{\Delta + (1-p)K}{p}. \tag{2}$$

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 c is neither too low nor too high,*

$$\eta\big(\Delta - [p(1+r)-1]K\big) < c < \min\Big\{\eta\big(\Delta + (1-p)K\big)\,,\, \eta p\big(Y_I - (1+r)K\big)\Big\}. \tag{3}$$

We relax this restriction in Subsection 4.1, where we analyze the model with higher monitoring costs, which creates the possibility that banks underinvest in monitoring. We abstract from this case in the baseline model to focus on the results we think are more novel.

In Subsection 3.5, we present a numerical example with parameters satisfying the restrictions above.

2.5 Equilibrium

The model is a finite-horizon extensive game of complete information and the solution concept 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.)

3 Results

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. Finally, we solve for creditors' entry decisions and solve for the equilibrium mix of banks and non-banks. Under an additional technical condition, we provide a characterization of the equilibrium for all levels of credit market competition.

3.1 Preliminaries and Continuation Values

First we solve for an entrepreneur's best response if he does not have an incumbent creditor with monitoring expertise.

LEMMA 1. *If an entrepreneur is not matched with a creditor with monitoring expertise in Period 1 (i.e. he is unmatched or his incumbent creditor does not acquire expertise), then he chooses the traditional project.*

Since innovative projects require monitoring, the entrepreneur can find funding only for a traditional project if matched with a creditor lacking monitoring expertise.

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

LEMMA 2. *The Period-1 continuation values of banks, non-banks, entrepreneurs with traditional projects, and entrepreneurs with innovative projects are as follows.*

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

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

- *A non-bank's Period-1 continuation value is zero, $\pi_{\mathrm{nb}} = 0$.*
- *If an entrepreneur has chosen the traditional project, his Period-1 continuation value is given by*

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

- *If an entrepreneur has chosen the innovative project, his Period-1 continuation value is zero, $\pi_I = 0$.*

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

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

An entrepreneur has a higher outside option with the traditional project than with the innovative project, because it he may be able to finance it with another creditor, but only his incumbent creditor has the monitoring expertise to finance the innovative

project. In contrast, other creditors can monitor the traditional project. Intuitively, there is a market in which an entrepreneur with a traditional project can find a "transaction loan" from an "arm's length" creditor. Further, increasing competition increases this outside option because it makes him more likely to find a new creditor.

3.2 Inefficiency of Bank Funding

We now analyze entrepreneurs' and banks' Period-1 behavior.

Proposition 1. (The Inefficiency of Competitive Credit Markets: Too Little Innovation) *Entrepreneurs matched with banks choose the traditional project (inefficiently) in Period 1 if and only if Period-2 interbank competition is sufficiently high, i.e. if and only if*

$$(1-\varphi)Q_2 > \frac{\Delta + (1-p)K}{\eta \mathrm{NPV}_T}. \tag{7}$$

To see the intuition, recall that competition among banks generates a high outside option for an entrepreneur with the traditional project, because any creditor can fund it. On the other hand, competition does not affect the outside option of an entrepreneur with an innovative project, because only the incumbent creditor can monitor such a project, regardless of competition. Thus, increasing competition distorts the entrepreneur's choice toward the traditional project. For high competition, this distortion is so severe that the entrepreneur chooses the traditional project despite its low NPV.

3.3 The Disciplining Role of Non-banks' High Cost of Capital

We now turn to non-bank funding and its effect on entrepreneurs' project choices.

Lemma 3. *A non-bank never funds a traditional project.*

This result follows from the fact that non-banks have to make high enough returns to repay their own creditors $(1+r)K$. The return on the traditional project is too low to make the traditional project profitable for a non-bank, given its relatively high hurdle rate r—indeed, $(1+r)K > Y_T$ by Parameter Restriction 2.

Proposition 2. (Non-banks' Cost of Capital Disciplines Entrepreneurs) *If an entrepreneur is matched with a non-bank, he always chooses the innovative project.*

To see the the intuition, recall that a non-bank never funds the traditional project (by Lemma 3 above). Thus, an entrepreneur matched with a non-bank in Period 1 has the following choice: he can either (i) choose the innovative project and get funding from a non-bank today, in Period 1, or (ii) choose the traditional project and get funding from a bank tomorrow, in Period 2, if he is matched. If he chooses the innovative project, he

is captive to the non-bank, since he cannot find a creditor with monitoring expertise in Period 2. However, if he chooses the traditional project and finds a bank to fund it in Period 2, he is also captive, since it is the final period and he has no opportunity to find funding in the future. The entrepreneur therefore chooses the innovative project—it is better to be captive today with a high-NPV project than captive tomorrow with a low-NPV project.[18] Non-banks, therefore, are able to convert their funding cost disadvantage into a competitive advantage—it allows them to precomit to fund only innovative projects (something banks cannot do, by Proposition 1).

3.4 Intermediation Variety

We now turn to the variety of intermediaries that exist in equilibrium. We first describe the cross-sectional differences between the projects that banks fund and those that non-banks fund. Then we turn to the equilibrium mix of banks and non-banks in the market. The findings underscore the importance of studying entrepreneurs' project choices and the variety of intermediaries jointly.

Our next result summarizes Proposition 1 and Proposition 2 above.

LEMMA 4. *In competitive credit markets, non-banks fund more innovative and more profitable entrepreneurs than banks do.*

This is consistent with evidence in the empirical literature on banks and non-banks such as private equity firms, as discussed in the Introduction.

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

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

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

Given a competitive interbank market, the proportion of non-banks is given by

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

[18] It may seem like this result is sensitive to our two-period set-up: 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 a non-bank. 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.

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

Thus we have the following:

(i) Non-banks are present only in sufficiently competitive credit markets.

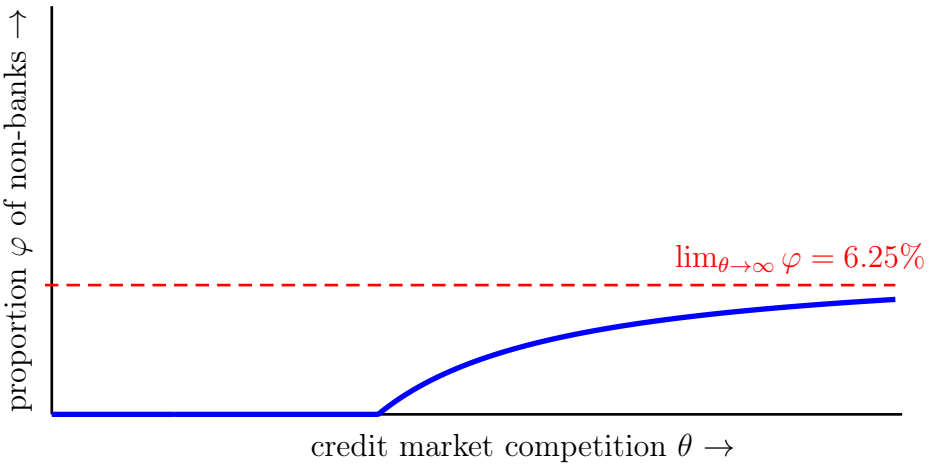
(ii) The proportion of non-banks is increasing in credit market competition.

(iii) Non-banks never take over the entire credit market even in the perfect competition limit: as $\theta_1 \to \infty$,

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

This proposition addresses the variety of intermediaries in the market. Since an entrepreneur chooses the traditional project when matched with a bank and chooses the innovative project when matched with a non-bank (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 3: PROPORTION OF NON-BANKS AS A FUNCTION OF CREDIT COMPETITION



Proposition 3 follows from two observations. The first is that non-banks enter competitive credit markets to mitigate entrepreneurs' over-investment in traditional projects. The second is that an increase in the proportion of non-banks in the market has a positive externality on banks; it decrease the competition to fund traditional projects in Period 2. We now explain how these observations lead to the results above.

The reason that non-banks enter only competitive credit markets is that, in uncompetitive credit markets, banks are already funding innovative projects. Thus, there is no room for non-banks to enter, since their higher cost of capital puts them at a strict competitive disadvantage. However, when credit market competition is high, en-

trepreneurs choose traditional projects inefficiently when matched with banks, which enables non-banks to enter and induce entrepreneurs to innovate (Proposition 2).

The reason that non-banks do not take over the entire market, and in so doing restore efficiency entirely, is that an increase in the proportion of non-banks makes banking less competitive, i.e. non-bank entry has a positive externality on banks. This is because the higher the proportion of non-banks, 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 non-banks in the market, banks can capture more of the surplus from funding entrepreneurs in Period 1.

The externality described above generates a feedback loop that works as follows. An increase in credit market competition weakens a bank's bargaining position, inducing more non-banks to enter the market. But, when these non-banks 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 non-banks increases at a decreasing rate and the proportion of non-banks levels off to a constant as credit markets become perfectly competitive. The equilibrium proportion of non-banks in the market is depicted in Figure 3 (the parameter values we used are listed in the next subsection).

3.5 Characterization of Financing Regimes and Numerical Example

We now characterize the equilibrium mix of intermediaries in the market and entrepreneurs' associated project choices for all levels of credit market competition θ_1.

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

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

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

where C is defined in Proposition 3.

As long as $\theta^* < \theta^{**}$ and $c + \eta prK > \Delta + (1-p)K$, 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 innovative projects. There are no non-banks.

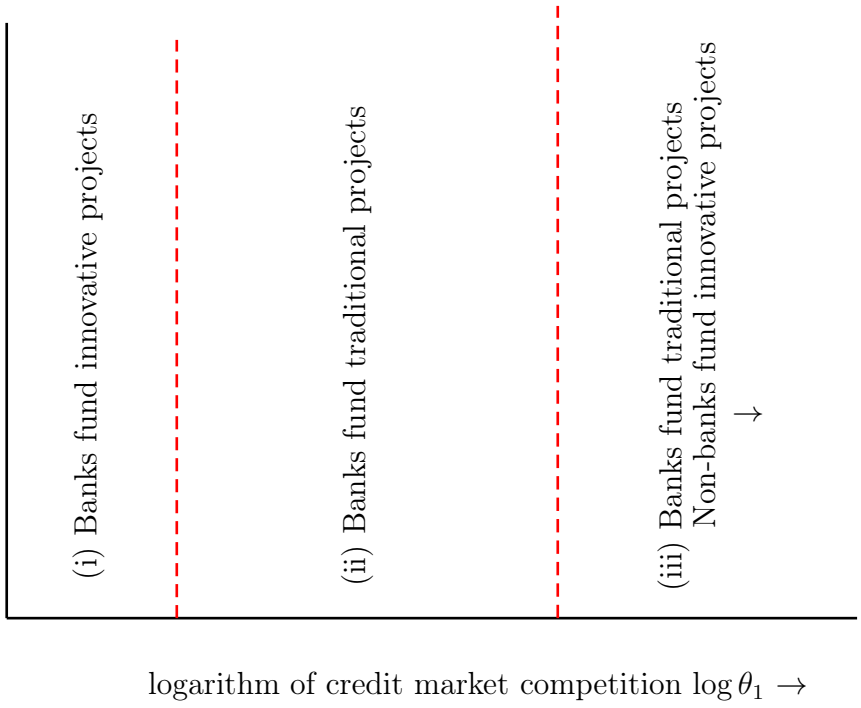
(ii) For intermediate levels of credit market competition, $\theta^* \leq \theta_1 < \theta^{**}$, banks do not acquire monitoring expertise and fund only traditional projects. There are no non-banks.

(iii) For high levels of credit market competition, $\theta_1 \geq \theta^{**}$, banks do not acquire monitoring expertise and fund only traditional projects. Non-banks enter, acquire monitoring expertise and fund only innovative projects.

Proposition 4 puts all of 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 high-NPV innovative projects. For higher levels of credit market competition, entrepreneurs prefer traditional projects to strengthen their bargaining positions with banks. This leads to under-innovation, an inefficiency that creates the opportunity for non-banks to enter. Non-banks mitigate the inefficiency by funding only innovative projects. The equilibrium described in Proposition 4 is consistent with a number of stylized facts, as we pointed out in the Introduction.

Numerical example. To illustrate the financing regimes in Proposition 4, we plot them in a numerical example. Figure 4 represents the financing regimes in Proposition 4 for the following parameterization: $c = 9, \eta = 0.8, \text{NPV}_T = 60, \text{NPV}_I = 67.5, p = 0.75, r = 0.4$, and $K = 150$. This also suggests that our assumptions on exogenous parameters are not overly restrictive, as all of the parameter restrictions in Subsection 2.4 and the hypotheses of Proposition 4 are satisfied. Given these parameters, the values for the regime thresholds are $\theta^* \approx 3.9$ and $\theta^{**} \approx 80$.

FIGURE 4: FINANCING REGIMES AS A FUNCTION OF CREDIT MARKET COMPETITION



4 Extensions

In this section, we extend the model in four ways. (i) We relax Parameter Restriction 3 to explore the effects of high costs of acquiring monitoring expertise. (ii) We assume that the innovative project is associated with an asset-substitution problem to formalize the role of creditor monitoring. (iii) We endogenize non-banks' cost of capital r for the special case in which non-banks are private equity firms. And (iv) we solve for creditors' equilibrium funding contracts under the assumption that banks raise capital via debt and non-banks raise capital via equity.

4.1 Costs of Monitoring and Possible Underinvestment in Monitoring

We have assumed thus far that intermediaries' monitoring cost c is sufficiently low to induce investment in monitoring (see Parameter Restriction 3), so incumbent creditors always have a monitoring advantage. We now relax this assumption and show that for sufficiently high c, banks may under-invest in monitoring expertise.

LEMMA 5. *If $c/\eta > \Delta + (1-p)K$, then banks do not invest in monitoring when Period-2 bank competition is low, leading entrepreneurs to undertake traditional projects in-*

efficiently. Specifically, entrepreneurs matched with banks choose traditional projects whenever

$$\frac{c/\eta - \Delta - (1-p)K}{(1-\eta)\text{NPV}_T} \leq (1-\varphi)Q_2. \tag{13}$$

The intuition is as follows. If c is sufficiently large, low credit market competition distorts banks' decision to acquire monitoring expertise—they inefficiently choose not to acquire expertise. As a result, entrepreneurs must invest in the traditional project 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.

4.2 Asset Substitution: Rationalizing Monitoring of Innovative Projects

In this subsection, we provide one micro-foundation for our assumption that innovative projects require monitoring by incumbent creditors.

Suppose that there is an asset-substitution problem as in Holmström and Tirole (1997) associated with innovative projects but not with traditional projects.[19] I.e. if the entrepreneur chooses an innovative project in Period 1, he has the possibility of substituting it with another "bad" project, which has negative NPV, but gives the entrepreneur private benefits b (where b is large enough that the entrepreneur prefers to do the bad project and repay nothing rather than to do the innovative project and repay his debt.[20] 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 the bad project. The lemma below follows immediately from the set-up.

Lemma 6. *Only creditors that have monitoring expertise fund innovative projects.*

This says that if an entrepreneur chooses the innovative project, he can obtain finance only from a creditor with monitoring expertise; such a creditor can prevent asset substitution. Realistically, a creditor must invest in monitoring *before* the entrepreneur makes his project choice—monitoring can prevent asset substitution but not undo it

[19] This may be because traditional projects are more familiar to lenders, making it easier to detect if the entrepreneur has switched to something different.

[20] A sufficient condition for this is that $Y_I - K < b$.

after the fact. Thus, only incumbent creditors can monitor entrepreneurs, and only they can fund innovative projects. This provides one explanation for incumbent creditors' monitoring advantage.

4.3 Endogenizing the Non-banks' Cost of Capital

So far, we have assumed that banks fund themselves at rate zero, since banks benefit from government guarantees, and that non-banks fund themselves at exogenous positive rate $r > 0$. Here, we endogenize this rate at which non-banks fund themselves for the special case in which non-banks are PEs so 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.[21] 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 (see 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

$$\text{PE surplus } = \eta p\big(Y_I - (1+r)K\big). \tag{14}$$

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

$$\beta\eta p\big(Y_I - (1+r)K\big) + K = p(1+r)K. \tag{15}$$

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

Lemma 7. *The PE's cost of capital r is given by*

$$1 + r = \frac{\beta\eta p Y_I + K}{p(1+\beta\eta)K}. \tag{16}$$

[21] 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.

The lemma implies that PEs do indeed have a high cost of capital in equilibrium. This 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.[22]

4.4 Equilibrium Funding Contracts: Implementation with Debt and Equity

We now write down funding contracts for banks and non-banks. So far, we have abstracted from the forms of these contracts, relying only 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 banks fund entrepreneurs via debt and non-banks fund entrepreneurs via equity.[23] For brevity, we characterize the funding contracts only for the case in which competition is high, so banks and non-banks coexist (it is easy to solve analogously for low competition).

LEMMA 8. *In competitive credit markets, the face value of the debt with which a bank funds a traditional project is given by*

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

and the equity stake that a non-bank takes in an innovative project is given by

$$\text{non-bank equity stake} = \eta + (1-\eta)\frac{(1+r)K}{Y_T}. \tag{18}$$

Note that the equity stake that a non-bank takes does not depend on credit market competition. This is because when an entrepreneur is matched with a non-bank, 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 competi-

[22] 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, the existence of such an equilibrium is sensitive to the assumption that the traditional project is completely riskless. Introducing a small amount of risk in the traditional project or a small probability that matches with entrepreneurs break down would prevent PEs from entering.

[23] Note, however, that there is no substantive theoretical difference between debt and equity contracts in our setting, since a variety of contracts can implement the utility transfers implied by the Nash bargaining solution. We focus on these contractual forms only for realism.

tion, 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 Conclusion

We develop a theory of intermediation variety in which banks and non-banks co-exist, even though banks benefit from government subsidies but non-banks do not. It suggests that non-bank funding mitigates entrepreneurs' inefficient investment. 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. Non-banks 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 that 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

If an entrepreneur is not matched with a creditor with monitoring expertise (i.e. he is either unmatched or matched with a creditor that has not acquired monitoring expertise), he knows he will never find funding for the innovative project (remember only the incumbent creditor can acquire monitoring expertise). Thus, he chooses the traditional project, which he can get funded. □

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 implies that any player that is newly matched in the second period was unmatched in the first period and thus that all entrepreneurs that are newly matched in the second period have chosen traditional projects, by Lemma 1.

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

$$\pi_b = q_2\eta\left(Y_T - K\right) \tag{19}$$

$$= q_2\eta \mathrm{NPV}_T. \tag{20}$$

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 $Y_T - K$, since the match creates output Y_T and the bank must repay K to its own creditors. The bank's bargaining power is η. With probability $1 - q_2$, the bank is unmatched and gets zero.

A non-bank's Period-1 continuation value is zero. The reason is as follows. A non-bank never funds a traditional project (see Lemma 3 below).[24] And if a non-bank is matched in Period 2, it is matched with an entrepreneur who has chosen a traditional project (by from Lemma 1 and the comment at the beginning of this proof that no match formed in Period 1 breaks down). Thus, a non-bank searching in Period 2 never funds a project; its continuation value is zero.

[24]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.

An entrepreneur's Period-1 continuation value with a traditional project is given by

$$\pi_T = (1-\varphi)Q_2(1-\eta)\,(Y_T - K) \tag{21}$$

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

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 $Y_T - K$. The entrepreneur's bargaining power is $1-\eta$. With probability $1-(1-\varphi)Q_2$, the entrepreneur is either matched with a non-bank or is unmatched. In this case, his project goes unfunded and he gets zero.

An entrepreneur's Period-1 continuation value with an innovative project is zero because he will not be able to obtain funding from a new creditor, given only his incumbent creditor can monitor an innovative project by definition.

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 $\theta_2 = \theta_1^2$. □

A.3 Proof of Proposition 1

We first show that if interbank competition is high in Period 2, an entrepreneur chooses the traditional project even if the bank has monitoring expertise. Then we proceed to show that for low levels of interbank competition, banks invest in monitoring and the entrepreneur chooses the innovative project.

If matched with a bank that has monitoring expertise, an entrepreneur chooses the traditional project if it gives a higher payoff than the innovative project, or

$$(1-\eta)\big(Y_T - K - \pi_b - \pi_T\big) + \pi_T > (1-\eta)\big(p(Y_I - K) - \pi_b - \pi_I\big) + \pi_I. \tag{25}$$

Substituting for the continuation values from Lemma 2, this inequality can be rewritten as

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

which is the inequality in the statement of the proposition. So, for high levels of

interbank competition the entrepreneur chooses the traditional project.

This argument also implies that, on the other hand, for low levels of interbank competition, the entrepreneur is willing to invest in the innovative project as long as a bank is willing to fund it, i.e. it is willing to bear the cost c of acquiring monitoring expertise. This is the case whenever

$$\eta\big(p(Y_I - K) - \pi_I - \pi_b\big) + \pi_b - c \geq \eta\big(Y_T - K - \pi_T - \pi_b\big) + \pi_b. \tag{27}$$

(Note that the non-bank has limited liability, so the bank and the entrepreneur bargain over bilateral surplus is $p(Y_I - K)$; they do not internalize the cost $(1-p)K$ that is borne by the non-bank's own creditors.) Substituting for the continuation values from Lemma 2, this inequality can be rewritten as

$$(1-\varphi)Q_2 \geq \frac{c/\eta - \Delta - (1-p)K}{(1-\eta)\mathrm{NPV}_T}. \tag{28}$$

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 $Y_T < (1+r)K$, or that the payoff of a traditional project is too low to cover a non-bank's debt. Thus, if a non-bank funds a traditional project, it necessarily receives payoff zero. Thus it does not fund the project (recall that the non-bank never funds projects that give it payoff zero (see footnote 14)). □

A.5 Proof of Proposition 2

In this proof, we note first that a non-bank always acquires monitoring expertise and, as a result, can always fund the innovative project. We then show that an entrepreneur who is matched with a non-bank always prefers to do the innovative project than to do the traditional one.

The reason that a non-bank always acquires monitoring expertise is that if it does not it can fund neither the innovative project (which requires monitoring my definition) nor the traditional project (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 non-bank prefers the innovative project to the traditional project. Since the non-bank never funds a traditional project (Lemma 3), the entrepreneur must prefer to choose the innovative project in

Period 1 than to choose the traditional project and get the continuation value π_T, or

$$(1-\eta)\big(p(Y_I-(1+r)K)-\pi_{\text{nb}}-\pi_I\big)+\pi_I\geq\pi_T. \tag{29}$$

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

$$(1-\eta)p\big(Y_I-(1+r)K\big)-(1-\varphi)Q_2(1-\eta)\text{NPV}_T\geq 0. \tag{30}$$

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

$$(1-\eta)p\big(Y_I-(1+r)K\big)-(1-\varphi)Q_2(1-\eta)\text{NPV}_T\geq(1-\eta)\left(\Delta+(1-p)K-prK\right)\geq 0 \tag{31}$$

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*

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

Proof. In a competitive credit market, an entrepreneur chooses the traditional project when matched with a bank. Thus, a bank enters when its entry cost e is less than expected payoff from entering and funding the traditional project when matched with an entrepreneur:

$$e\leq q_1\big(\eta(Y_T-K-\pi_b-\pi_T)+\pi_b\big)+(1-q_1)\pi_b. \tag{33}$$

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

LEMMA 10. *A non-bank enters if and only if*

$$q_1\Big[\eta p\big(Y_I-(1+r)K\big)-c\Big]\geq e. \tag{34}$$

Proof. A non-bank's payoff from investing is $\eta p\big(Y_I - (1+r)K\big)$, since it must repay its debt $(1+r)K$ out of its cash flow. In order to obtain this payoff it must be matched, which occurs with probability q_1, and pay c to acquire monitoring expertise. Note that if the non-bank 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 $q_1\Big[\eta p\big(Y_I - (1+r)K\big) - c\Big]$. As stated in the lemma, a non-bank enters when this expected payoff exceeds its entry cost e. □

We now turn to the proof of the proposition, beginning with the expression for the equilibrium proportion of non-banks in the market φ. For banks and non-banks to coexist in equilibrium, both banks and non-banks 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 non-banks to coexist:

$$q_1\Big[\eta p\big(Y_I - (1+r)K\big) - c\Big] = \Big(\eta q_1\big[1-(1-\eta)(1-\varphi)Q_2\big] + \eta(1-\eta q_1)q_2\Big)\mathrm{NPV}_T. \quad (35)$$

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 non-banks 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, non-banks 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 non-banks never enter for low credit market competition when entrepreneurs choose the innovative project when matched with banks. We establish this formally in Lemma 11 below.)

Statement (ii). Second, we prove statement (ii) that the proportion of non-banks 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 non-banks 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, which simplifies the presentation.

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, non-banks enter. Equation (9) gives the proportion φ of non-banks that enter in equilibrium. When $\varphi = 0$ in the expression, non-banks are indifferent between entering and not entering. For larger φ the proportion of non-banks is positive. Thus, $\varphi = 0$ gives an equation for θ^{**}, the threshold above which non-banks enter (conditional on entrepreneurs choosing the traditional project 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 for which non-banks enter conditional on entrepreneurs choosing the traditional project when matched with banks. It remains to show that for $\theta_1 > \theta^{**}$, entrepreneurs do indeed choose the traditional project. This comes from comparison with the bounds in Proposition 1. Specifically, entrepreneurs matched with banks choose the traditional project as long as

$$(1-\varphi)Q_2 > \frac{\Delta + (1-p)K}{\eta \mathrm{NPV}_T}. \tag{41}$$

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 show that the condition is satisfied for large θ_1 is as follows: (i) it is satisfied (it holds with equality) at $\theta_1 = \theta^*$ and (ii) for $\theta_1 > \theta^*$ the term $(1-\varphi)Q_2$ on the left is either decreasing or increasing then decreasing in θ_1. 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

$$\frac{C}{1-\eta} = \frac{c/\eta + p(1+r)K - K - \Delta}{(1-\eta)\mathrm{NPV}_T}. \tag{45}$$

Thus, entrepreneurs choose traditional projects whenever

$$\frac{c/\eta + p(1+r)K - K - \Delta}{(1-\eta)\mathrm{NPV}_T} > \frac{\Delta + (1-p)K}{\eta\mathrm{NPV}_T} \tag{46}$$

or

$$c + \eta prK > \Delta + (1-p)K, \tag{47}$$

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 traditional projects whenever

$$(1-\varphi)Q_2 > \frac{\Delta + (1-p)K}{\eta\mathrm{NPV}_T}. \tag{48}$$

We show that there exists a region before non-banks enter in which entrepreneurs choose traditional projects 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

$$\frac{\theta_1^2}{1+\theta_1^2} > \frac{\Delta + (1-p)K}{\eta \mathrm{NPV}_T}. \tag{49}$$

Solving for θ_1 in the equation above, we find that entrepreneurs choose traditional projects 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 innovative projects, non-banks never enter.

LEMMA 11. *Given that banks are funding innovative projects, non-banks do not enter.*

Proof. Given that banks are funding innovative projects, their entry condition implies that

$$q_1\big[\eta(p(Y_I - K) - \pi_b) + \pi_b - c\big] + (1-q_1)\pi_b = e, \tag{50}$$

since the total surplus is $p(Y_I - K)$ due to government guarantees.

To show that no non-banks enter, we show that a non-bank's expected profit is less than the entry cost e, or that

$$q_1\big[\eta p(Y_I - (1+r)K) - c\big] < e. \tag{51}$$

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

$$q_1\big[\eta p(Y_I - (1+r)K) - c\big] < q_1\big[\eta(p(Y_I - K) - \pi_b) + \pi_b - c\big] + (1-q_1)\pi_b, \tag{52}$$

which simplifies to

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

This is always satisfied since the right-hand 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 innovative projects. The proof of Lemma 11 shows that non-banks do not enter whenever $\theta_1 < \theta^*$. □

A.9 Proof of Lemma 5

The bank acquires monitoring expertise if

$$\eta\big(p(Y_I - K) - \pi_I - \pi_b\big) + \pi_b - c \geq \eta\big(Y_T - K - \pi_T - \pi_b\big) + \pi_b. \tag{54}$$

Substituting for the continuation values from Lemma 2, this inequality can be rewritten as

$$(1-\varphi)Q_2 \geq \frac{c/\eta - \Delta - (1-p)K}{(1-\eta)\text{NPV}_T}, \tag{55}$$

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

A.10 Proof of Lemma 6

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

A.11 Proof of Lemma 7

The lemma follows immediately from equation (15). □

A.12 Proof of Lemma 8

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 non-bank's equity stake. For the proof, refer to it as α. In the event of success, the non-bank gets αY_I and otherwise it gets zero. Thus, α solves

$$\eta p(Y_I - (1+r)K) = p(\alpha Y_I - (1+r)K), \tag{56}$$

which gives

$$\alpha = \eta + (1-\eta)\frac{(1+r)K}{Y_I} \tag{57}$$

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

$$F_{\text{bank}} = \eta\big(Y_T - K - \pi_T - \pi_b\big) + \pi_b \tag{58}$$

$$= \eta\Big(1 + (1-\eta)\big[q_2 - (1-\varphi)Q_2\big]\Big)\text{NPV}_T, \tag{59}$$

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

A.13 Table of Notations

	Projects
K	required capital investment
Y_T	traditional project payoff
NPV_T	traditional project NPV
Y_I	innovative project success payoff
p	innovative project success probability
NPV_I	innovative project NPV
Δ	difference in project NPVs, $\text{NPV}_I - \text{NPV}_T$

	Players
π_b	a bank's Period-1 continuation value
π_{nb}	a non-bank's Period-1 continuation value
π_T	an entrepreneur's continuation value with a traditional project
π_I	an entrepreneur's continuation value with an innovative project

	Credit Market
θ_t	credit market competition in 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 non-banks
$(1-\varphi)Q_2$	Date-2 bank competition

	Parameters
c	cost of acquiring monitoring technology
e	creditors' entry cost
η	creditors' bargaining power
β	LPs' bargaining power when funding PEs in Subsection 4.3
r	non-banks' cost of capital
C	constant defined in equation (8)

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