Developing Credit Markets

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To Jenny, Kasper, and Felix

Contents

Acknowledgments

This is a partial account of what turned out *not* to be. As an undergraduate with a passion for development issues and a vague notion of wishing to do good, I found myself choosing between courses in political science, sociology, history, and religion. Deciding that political science was to help me in my quest, I was surprised that a semester of economics was required in order to earn the degree. "Fine", I thought, "I should be able to handle *one* semester of supply and demand curves." That semester is now coming to an end—ten years later and upon the cusp of completing a Ph.D. in economics.

Alia Ahmad was instrumental in sculpting my interest in development economics, and as testimony to this I entered the graduate program at the Stockholm School of Economics (SSE) with the clear aim of becoming an empirical development economist. I foolishly believed that all I would need was a better understanding of a few methodological tools. Jörgen Weibull's introductory math course disabused me of this belief by painfully reminding me of my initial reluctance to study economics: the curves and the math behind them. Fortunately, and thanks to Jörgen's support, this course set me on the path of learning mathematics from scratch, a path I have not regretted.

My next good fortune, and a defining moment for me as a graduate student, came in the form of my supervisor, Tore Ellingsen. Early on, Tore transformed the econometrician-to-be into an applied theorist and in so doing, revealed his foremost quality: that of being enormously persuasive. His enthusiasm and ability to turn scant ideas into well-formulated research agendas has turned thesis-writing into an enjoyable process. Tore has also taught me the importance of clarity through his motto (generously aided by his red marker...): "simplicity is a virtue". I owe great intellectual debt to Tore for his advice, support, and, not least, for introducing me to a co-authored article with Mike Burkart. Mike is evidence of the axiom that good supervision comes in complementary pairs. By taking considerable time to listen, and sometimes discard, my theories, Mike has made a marked impact on the final end product.

Although Tore and Mike have been my mentors, I have received help and comments from many other faculty members at SSE and Stockholm University (SU). Jakob Svensson in particular has kept my empirical ambitions alive by sending me off to Africa and Asia for a variety of fieldwork.

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Family and friends outside the world of academia have also been a constant source of encouragement and a lifeline to help balance the tedious moments in thesis writing.

Without my parents Gun and Jan and my sister Maria, this endeavor would never have begun. Growing up in the Madestam family has shaped me in many ways, perhaps most importantly by nurturing a curiosity for other peoples' circumstances. In recent years I have also been fortunate to be included in the Hjorth and Schönberg clan. Besides being genuinely interested in my work, they have provided invaluable support in the finishing phases of this thesis.

The most important and integral part of my life these past four years has been my wife Jenny. Your love and care for me, at home, work, or in some school in Uganda, means everything to me. It is also truly incredible how you have been able to continuously muster interest in "The Model", even when I myself found it less amusing. Your encouragement and strength has given me the needed energy to finish this undertaking. Kasper and Felix, your arrival into our lives literally came with a blast and has been one ever since. The greatest gift of all is my family and I love all three of you.

Stockholm, October 2005

Andreas Madestam

Summary of Thesis

Introduction

The unifying assumption of the three papers that comprise this thesis is that poor entrepreneurs need credit. A credit market is the essential link between entrepreneurs and savers and in the best of worlds enables individuals to realize the potential of their ideas. However, credit markets are seldom, if ever, perfect. Agency costs associated with providing credit arise because borrowers are unable to commit to using funds in the lenders' interest. These costs are larger when borrowers are poor because the loan accounts for a substantial share of the needed investment funds. The implication is that some valuable investments cannot be financed; in other words, credit rationing arises.

Developing credit markets fit this description. Borrowers are generally poor, which increases the severity of credit rationing. The source of financing becomes relevant as intermediaries differ in their ability to mitigate the agency problem. Because agency costs are usually related to the institutional framework supporting creditors' claims, institutional quality begins to matters. Finally, if agency problems are acute, the market structure governing the interaction between intermediaries also affects inefficiency. The first two papers of the thesis explicitly address all three concerns: source of financing, institutional quality, and market structure. The third paper investigates more closely the consequences of market power.

The premise of Papers 1 and 2 is the observation that formal and informal financial sectors coexist in credit markets characterized by weak legal institutions. Informal transactions, such as loans made by moneylenders, traders, and landlords, account for between one third and three quarters of total credit in Asia (Germidis et al., 1991). Informal lenders provide more credit and attract larger volumes of savings than the formal sector in sub-Saharan Africa (Nissanke and Aryeetey, 1998). Moreover, in developing credit markets, entrepreneurs are observed to take credit from both sectors simultaneously, as well as resort to exclusive contracts (see, for example, Conning, 2001; Giné, 2005). Likewise, informal lenders often obtain formal finance to service their borrowers (see, for example, Ghate et al., 1992; Hoff and Stiglitz, 1993; Irfan et al., 1999). Two key differences distinguish formal sector lenders from informal lenders. First, informal lenders possess a monitoring advantage over their formal counterpart by offering credit to a group of known clients where social ties and social sanctions prevent borrowers from misusing their loan (see, for example, Ghate et al., 1992; Aleem, 1993; Udry, 1993; La Ferrara, 2003). Second, informal lenders frequently lack funds while formal lenders, namely banks, do not.

The observed diversity of lending practices raises a number of issues that the first two papers explore in more detail.

Paper 1: Informal Finance: A Theory of Moneylenders

In the first paper, I address why entrepreneurs in developing credit markets employ multiple lenders and proceed to investigate the link between institutional development and informal lending. The paper also explores the impact of wealth concentration across credit market participants on investment.

Existing theory has modeled informal lenders either as competitors of the bank sector (Bell et al., 1997; Jain, 1999; Varghese, 2005) or as a channel of formal funds (Floro and Ray, 1997; Bose, 1998; Hoff and Stiglitz, 1998). However, this literature is lacking in two respects. First, it is not clear whether informal lenders compete with formal lenders or primarily engage in channeling funds. Second, it neglects the dual role of informal lenders—simultaneously giving and taking credit—thus failing to address the role of supply constraints in informal lending. The paper's main theoretical innovation is to provide a unified theoretical framework by considering monitoring problems between formal and informal lenders, as well as between formal lenders and entrepreneurs. The theory thus reconciles existing approaches by allowing for both competition and channeling of funds while deriving endogenous constraints on informal lending.

When neither the informal lender nor the entrepreneur is sufficiently affluent to support first-best investment, my model demonstrates that the two complement one another in drawing on formal funds. However, if the informal lender's debt capacity does not constrain investment, the entrepreneur substitutes away from informal to formal finance, as she prefers the latter. In the model, entrepreneurs contract with banks to gain a stronger bargaining position vis-à-vis the informal lender. Meanwhile, informal lenders provide entrepreneurs with a commitment device that improves their relationship with the bank sector.

The theory predicts that the share of informal in total intermediation increases as legal protection of creditors deteriorates. Intuitively, as informal lenders have an edge over banks, they become the lender of choice as creditor protection weakens. Finally, in contrast to some related work (see, for example, Banerjee and Newman, 1993; Galor and Zeira, 1993), the model suggests that an unequal wealth distribution promotes investment. Specifically, wealth concentration that benefits informal lenders increases efficiency, due to informal lenders' advantage in preventing entrepreneurs from misusing their loan. For example, reallocating wealth from entrepreneurs to informal lenders facilitates higher investment as lenders interact with multiple entrepreneurs. If lending also entails repeated bank interaction, the informal lender attaches more value to such a relationship, enabling banks to extend funds more generously.

Paper 2: Monopoly Banks, Moneylenders, and Usury

Market segmentation is another phenomenon that characterizes developing credit markets. Despite the coexistence of banks and informal lenders, entrepreneurs frequently obtain credit in the informal sector alone—credit that informal lenders themselves acquire from banks. Whereas previous work has explored the consequences of credit-market segmentation (Floro and Ray, 1997; Bose, 1998; Hoff and Stiglitz, 1998), existing models do not justify the existence of segmentation per se. In this second paper, I provide a theory that helps explain *why* this kind of credit-market segmentation occurs.

The paper extends the framework developed in Paper 1 by allowing for market power in the formal banking sector rather than assuming perfect competition. My theory demonstrates that a monopoly bank extracts more rent by channeling funds through informal lenders than by lending directly to entrepreneurs. When informal lenders are sufficiently rich relative to entrepreneurs, they are less prone to divert bank funds. Therefore, a monopoly bank need not share rents when it lends through the informal lender.

The segmented outcome offers a simple explanation for the usury rates sometimes observed in the informal sector (Bhaduri, 1973, 1977; Banerjee, 2003). Within the paper's framework, the price of informal credit is a decreasing function of the entrepreneur's reservation payoff. The fact that the entrepreneur has no real outside option in the segmented equilibrium—other than investing her own wealth—rationalizes why the informal lender is able to charge high rates of interest. Banking competition is the key to both eliminating usurious interest rates charged by informal lenders and promoting investment.

Paper 3: The Social Costs of a Credit Monopoly

A common belief about the relationship between banking and development is that banks' market power is conducive to the growth of firms (see, for example, Petersen and Rajan, 1995; Hellman et al., 2000). In the third and final paper of the thesis, I challenge this view and abstract from informal lenders to take a closer look at the market structure in the bank market. In the paper, I recognize that banks perform multiple tasks by providing credit and taking deposits simultaneously. Whereas a high price in the credit market increases banks' retained earnings and attracts more deposits, it also reduces lending if borrowers are sufficiently poor to be tempted by diversion. Optimal bank market structure therefore trades off the benefits of monopoly banking in attracting deposits against losses due to tighter credit.

I find that market structure is irrelevant if both banks and borrowers lack resources. Monopoly banking induces tighter credit rationing if borrowers are poor and banks are wealthy, and increases lending if borrowers are wealthy and banks lack resources.

The findings rationalize Beck et al.'s (2004) observation that small firms face higher financing obstacles in banking markets characterized by market power and a low level of institutional development. The growth-impeding effects of market power are largest for small firms, while the effect vanishes for larger firms. In my model it is precisely the smaller entrepreneurs that are most adversely affected by banks' market power, while larger entrepreneurs do equally well in either system, or better under monopoly banking if the banking sector lacks resources.

The results indicate that improved legal protection of creditors is a more efficient policy choice than improved legal protection of depositors, and that subsidies to firms lead to better outcomes than subsidies to banks. There are also likely to be sizable gains from promoting banking competition in developing countries.

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Papers

Paper 1

Informal Finance: A Theory of Moneylenders*

Abstract

This paper argues that weak legal institutions explain the coexistence of formal and informal financial sectors in developing credit markets. Informal finance emerges as a response to the formal sector's inability to perfectly enforce its claims in an environment with poor creditor protection. Given this setting, the theory incorporates the possibility of a credit-rationed informal sector to show that entrepreneurial and informal sector assets can be either complements or substitutes. The theory rationalizes the observation that entrepreneurs employ multiple lenders and suggests that an unequal wealth distribution promotes investment in poor societies.

1 Introduction

A common characteristic of credit markets with weak legal institutions is the coexistence of formal and informal financial sectors. Informal transactions, such as loans made by moneylenders, traders, landlords, and family, account for between one third and three quarters of total credit in Asia (Germidis et al., 1991). Informal lenders provide more credit and attract a larger volume of savings than the formal sector in sub-Saharan Africa (Nissanke and Aryeetey, 1998). In India, as much as 70 percent

*I am grateful to Tore Ellingsen and Mike Burkart for their advice and encouragement. I also thank Abhijit Banerjee, Chloé Le Coq, Avinash Dixit, Bård Harstad, Elena Paltseva, Jakob Svensson, Jean Tirole, Robert Townsend, Adel Varghese, and Fabrizio Zilibotti for valuable comments, as well as seminar participants at the CEPR workshop on Globalization and Contracts: Trade, Finance and Development (Paris), EEA Congress 2004 (Madrid), ENTER Jamboree 2004 (Barcelona), IUI (Stockholm), NEUDC Conference 2004 (Montréal), Nordic Conference in Development Economics (Gothenburg), SITE (Stockholm), and Stockholm School of Economics. The Jan Wallander and Tom Hedelius Foundation is gratefully acknowledged for financial support.

of all entrepreneurs obtain finance from both sectors at the same time (Jain, 1999, also see Conning, 2001 and Giné, 2005 for similar evidence from Chile and Thailand). Moreover, informal lenders who offer credit frequently acquire formal funds to service entrepreneurs' financing needs, with formal credit totaling two thirds of the informal sector's liabilities in many Asian countries (Ghate et al., 1992; Hoff and Stiglitz, 1993; Irfan et al., 1999).

Such financing arrangements raise a number of issues. First, why do entrepreneurs resort to multiple lenders simultaneously in developing credit markets? Second, is there a causal link between institutional development and informal lending? If so, precisely what is the connection? A third question concerns the relation between investment and the distribution of income. Should assets be allocated equally across credit markets participants, as proposed in recent growth models (Banerjee and Newman, 1993; Galor and Zeira, 1993), or is wealth concentration more efficient as in the tradition of Kuznets (1955)?

Following recent work on the effect of institutions on economic performance (La Porta et al., 1997, 1998), I view legal protection of creditors as essential to ensure availability of credit.[1] In what follows, reduced creditor vulnerability is thus synonymous with institutional development. To address my questions in a systematic fashion, I construct a model in which credit rationing is a result of creditor vulnerability in the formal sector. Specifically, entrepreneurial moral hazard at the investment stage prevents formal lenders from extending sufficient funds. In contrast, the informal sector is able to monitor borrowers and induce investment by offering credit to a group of known clients within a small community where strong social ties and social sanctions prevent borrowers from deliberately misusing their loan.[2]

The rich variety of lender-borrower constellations that characterize developing credit markets has been explored theoretically in two mutually exclusive ways; by modeling informal lenders as competitors with their formal counterparts (Bell et al., 1997; Jain, 1999; Varghese, 2005) or as a channel of formal funds (Floro and Ray, 1997; Bose, 1998; Hoff and Stiglitz, 1998). While both strands of the literature share the notion

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[1] By legal protection I mean more than simply written law, but also functioning law-enforcement bodies and supportive political institutions.

[2] For evidence of the highly personal character of informal lending see, for example, Udry (1993), Steel et al. (1997), and La Ferrara (2003) for the case of Africa and Ghate et al. (1992), Aleem (1993), and Bell (1993) for the case of Asia. See also Besley et al. (1993) and Banerjee et al. (1994) for theoretical work on rotating savings and credit associations stressing the importance of social sanctions. Anderson et al. (2004) and Karlan (2005, forthcoming) provide related empirical evidence. Note that my aim is not to explain informal lenders ability to prevent opportunistic behavior, but to understand its implications as in Besley and Coate (1995).

that informal lenders hold a monitoring (or screening) advantage over formal lenders, existing theory suffers from two main drawbacks. First, it is not clear whether informal lenders compete with formal lenders or primarily engage in channeling funds. Second, it neglects the dual role of informal lenders—simultaneously giving and taking credit—thus failing to address the role of supply constraints in informal lending.

In this paper I provide a unified theoretical framework by considering monitoring problems between formal and informal lenders, as well as between formal lenders and entrepreneurs. I also allow for lending and competition between the informal and the formal sector to arise endogenously, thereby establishing the precise conditions under which each regime appears. The model is thus consistent with both underlying motivations in the existing literature. The driving factor of the model is the interplay between the different constraints that formal and informal lenders face. Whereas the formal sector has access to unlimited funds, it is unable to prevent opportunistic behavior. Meanwhile, the informal sector can control the use of funds, but may instead be credit constrained. The challenge is thus to investigate how the interaction between these constraints defines the pattern of lending.

By allowing for the possibility of a credit-rationed informal sector, the theory establishes that entrepreneurial and informal lender assets are complements for low levels of wealth and substitutes when informal assets increase. Intuitively, when neither the informal lender nor the entrepreneur is sufficiently affluent to support first-best investment, the two complement one another by drawing on formal funds. However, if the informal lender's debt capacity does not constrain investment, the entrepreneur substitutes away from informal to formal finance, as she prefers the latter.

Entrepreneurs' preference for formal funds partly explains why they borrow from multiple lenders simultaneously. In the model, each entrepreneur utilizes the maximum amount of formal credit extended since the supply of formal funds yields a stronger bargaining position with the informal lender. At the same time, credit from the informal lender serves as an implicit commitment device for the entrepreneur in her dealings with the formal sector since, by assumption, the informal loan is always invested. In fact, the formal sector's willingness to directly fund an entrepreneur increases in tandem with the informal lender's wealth, as it makes the entire project less prone to opportunistic behavior.[3] Hence, in this framework all but the wealthiest entrepreneurs resort to both the formal and informal financial sector, a finding consistent with em-

[3] This differs from other theories of multiple lending. In Berglöf and von Thadden (1994), Dewatripont and Tirole (1994), and Bolton and Scharfstein (1996) the optimal contract distributes the project claims as to avoid strategic default, while also preventing costly liquidation of the firm.

pirical evidence provided by Ghate et al. (1992), Bell et al. (1997), Conning (2001), and Giné (2005).

With sufficiently improved institutions, the model predicts that informal finance becomes obsolete. For low levels of creditor vulnerability, entrepreneurs borrow exclusively from the formal sector. Indeed, the ratio of informal to total intermediation decreases as legal protection of creditors improves. These predictions, unique to the present model, explain why informal lending is virtually non-existent in developed credit markets with well-functioning creditor protection, while prominent in developing markets.

The paper also contributes to the ongoing debate of how to allocate wealth across credit market participants, demonstrating that the same level of investment is obtained when one entrepreneur and one informal lender interact, regardless of whom the wealth belongs to. Extending the theory to capture the difference in technology endowments between the lender and the entrepreneur yields additional insight. Specifically, while entrepreneurs' production technology applies to one project, lenders' monitoring technology is applicable to many entrepreneurs. Reallocating wealth from entrepreneurs to informal lenders thus facilitates higher investment as lenders interact with multiple entrepreneurs. If lending also entails repeated formal sector interaction, the informal lender attaches more value to such a relationship, enabling the formal sector to extend funds more generously. Finally, as it is optimal for informal lenders to equalize their return across entrepreneurs, a more affluent lender—as opposed to a wealthy entrepreneur—increases the likelihood that entrepreneurs are efficiently served. Moreover, increasing the informal sector's share of total intermediation at the expense of the formal sector further improves investment at low levels of wealth. The reason is that more formal funds induce unsound behavior while extra informal funds encourage investment. The significance of the informal sector's assets underscores the importance of wealth concentration over an equal distribution of income when markets are underdeveloped, an idea that dates back to Lewis (1954), Kuznets (1955), and Kaldor (1956). My conclusion differs from recent dynamic growth models that emphasize the negative effects of inequality on growth (Banerjee and Newman, 1993; Galor and Zeira, 1993).[4] Whereas this literature stresses the effects of formal sector credit rationing, it does not consider the importance of informal sector assets.

The model's findings offer important policy implications. In general, better functioning institutions improve efficiency and ease access to formal sector financing. As institutional deficiency is difficult to affect in the short-run, policies that explicitly or

[4] See also Aghion and Bolton (1997), Piketty (1997), and Mookherjee and Ray (2002).

implicitly tax wealth at low levels of income should be avoided. Indeed, allowing the informal sector to accumulate wealth to be used in multiple projects and to attract more formal capital improves intermediation. In addition, policies such as land reforms with a clear intention of redistributing assets may in fact reduce the aggregate level of investment in the economy if informal lenders are made worse off. Finally, more liquidity in the financial system is not good per se. If scarce resources of the informal sector are a bottleneck, a response such as mobilizing domestic savings will not necessarily translate into more funds invested.

Finally, existing theoretical work has rationalized multiple lending from formal and informal lenders as an outcome either of exogenous formal credit limits set by the government (Bell et al., 1997) or because the formal sector co-finances projects to benefit from the informal sector's advantage in screening out bad loans (Jain, 1999; Conning, 2001) or recovering repayments (Varghese, 2005). While all contributions abstract from formal lending to the informal sector, Kochar (1997) further empirically invalidates the existence of exogenous constraints as proposed by Bell et al.[5]

The model builds on Burkart and Ellingsen's (2004) analysis of trade credit in a perfectly competitive banking and input supplier market.[6] The bank and the entrepreneur in their model are analogous to the formal lender and the entrepreneur in my setting. However, their input supplier and my informal lender differ substantially. While the input supplier, and the bank, offer a simple debt contract, the informal lender offers a more sophisticated project-specific contract, where the investment and subsequent repayment are determined using the Nash Bargaining Solution. More importantly, the informal lender is assumed to be able to ensure that investment is guaranteed, something that the trade creditor is unable to do.

The remainder of the paper is structured as follows. In the next section I introduce the model then in Section 3 present equilibrium outcomes. Section 4 examines the link between institutions and informal lending. Section 5 analyzes the effect of different wealth distributions on investment. In the concluding remarks I discuss implications of the paper's main assumptions and consider some extensions.

[5] Another point of difference is that formal-informal coexistence arises as an equilibrium outcome in my setting, while Jain, Conning, and Varghese derive it by allowing the formal sector to contract on the informal lenders' presence.

[6] Burkart and Ellingsen's theory is based on the notion that it is less profitable for the borrower to divert inputs than to divert cash. Thus, input suppliers may lend when banks are limited due to potential agency problems.

2 Model

Consider a credit market consisting of risk-neutral entrepreneurs, banks (who provide formal finance), and moneylenders (who provide informal finance). As noted in the Introduction, moneylenders have a monitoring advantage over banks. In particular, I assume that banks are unable to control the way their borrowers use extended funds, whereas moneylenders can ensure that credit granted is fully invested.[7] The entrepreneur is endowed with observable wealth $\omega_E \geq 0$. She has access to a deterministic production function, $Q(I)$, where I is the volume of investment. The production function is assumed to be concave and twice continuously differentiable. To ensure the existence of an interior solution, it is assumed that $Q(0) = 0$ and $Q'(0) = \infty$. In a perfect credit market with interest rate r, the entrepreneur would like to invest enough to attain the first-best level of investment given by $Q'(I^*) = 1 + r$.[8] However, the entrepreneur lacks sufficient capital to realize this level, $\omega_E < I^*(r)$, and is thus forced to resort to the bank and/or the moneylender for the remaining funds.[9]

The moneylender is endowed with observable wealth $\omega_M \geq 0$. To capture his superior ability in monitoring investment, the lender is assumed to be a monopolist.[10] For simplicity, the moneylender's occupational choice is restricted to lending.[11] A contract between the moneylender and the entrepreneur is given by a pair $(B, R) \in \mathbb{R}^2_+$, where B is the amount borrowed by the entrepreneur and R the repayment obligation. The contract terms are settled in a bilateral bargain, given by the generalized Nash Bargaining Solution. Assume for now that $R(B)$ is a primitive that shares the same properties as the production function.[12] Finally, if the moneylender requires additional funding he turns to the bank.

The bank is competitive and has access to unlimited funds at a constant unit cost, ρ. As stressed above, however, investment or informal lending of bank funds cannot be taken for granted. Specifically, I assume that entrepreneurs (moneylenders) are unable to commit to invest bank funds (offer credit) and that diversion of assets

[7] See Section for 6 for a discussion of alternative ways of modeling the moneylender's advantage.

[8] The output price, p, is normalized to one.

[9] As a tie-breaking rule, I assume that the entrepreneur prefers higher investment for the same level of utility and one lender over two lenders for the same level of utility and investment. I also assume that bank borrowing ceases when a borrower's debt capacity exceeds the first-best investment level.

[10] The assumption of exclusivity is also in line with empirical evidence, see Aleem (1993) and Siamwalla et al. (1993).

[11] Additional sources of income would not alter the main insights. See Section 6 for a discussion.

[12] Any simple sharing rule would do as long as the payment is increasing (decreasing) in the moneylender's (entrepreneur's) outside option.

yields private benefits. With diversion I denote any activity that is less productive than investment (lending), for example, using the assets for consumption or financial saving. The diversion activity yields benefit $\phi < 1$ for every unit diverted. While investment (lending) is unverifiable, the outcome of the entrepreneur's project (moneylender's lending operation) may be verified. Entrepreneurs and moneylenders thus face the following trade-off: either the entrepreneur invests, in which case she realizes the net benefit of production after repaying the bank (and possibly the moneylender), or she profits directly from diverting bank funds (the entrepreneur will still have to pay the moneylender if she has borrowed from him).[13] In the case of partial diversion, the remaining amount must be repaid in full. Likewise, the moneylender may either extend a loan to the entrepreneur, realizing the net-lending profit after compensating the bank, or benefit directly from diverting the loan. In the case of partial diversion, the moneylender repays the remaining amount to the bank in full. The bank is assumed not to derive any benefit from resources that are diverted.

When ϕ is equal to zero, legal protection of banks is perfect and there is no agency problem. To make the problem interesting, assume that

$$\phi > \underline{\phi} \equiv \frac{Q\left(I^*\left(r\right)\right) - \left(1+r\right)\left(I^*\left(r\right) - \omega_E\right)}{I^*\left(r\right)}. \tag{1}$$

In other words, the marginal benefit of diversion yields higher utility than the average rate of return to a first-best investment. Finally, without loss of generality the bank offers a contract $\{(L_i, (1+r)\, L_i)\}_{L_i \leq \bar{L}_i}$, where L_i is the loan, $(1+r)\, L_i$ the amount to be repaid, and $\bar{L}_i$ the credit limit, $i = E, M$.[14] The contract implies that a borrower may withdraw any amount of funds until the bank credit limit binds. To keep things simple, borrowers only borrow from one bank at a time. In sum, lenders differ on two accounts: while the bank cannot ensure that investment actually takes place, the moneylender is able to control the entrepreneur's use of funds. Importantly, the bank has access to unlimited funds while the moneylender may be credit constrained.

As a bank loan is the entrepreneur's outside option in her bargaining with the moneylender, it is optimal for the entrepreneur to visit the bank before turning to the moneylender.[15] After viewing both contract offers the entrepreneur decides how much to borrow and from whom. Likewise, if wealth constrained, the moneylender also considers the bank contract before bargaining with the entrepreneur.

[13] The entrepreneur repays the moneylender an amount corresponding to the specific investment of informal funds.

[14] Burkart and Ellingsen (2002) show that $\{(L_i, (1+r)\, L_i)\}_{L_i \leq \bar{L}_i}$ constitutes an optimal contract.

[15] The timing is also empirically supported by Bell et al. (1997).

The timing is depicted as follows:[16]

1. The bank offers a contract to the entrepreneur and the moneylender, specifying the credit limits, $\bar{L}_E$ and $\bar{L}_M$, respectively.
2. The entrepreneur decides how much she wants to borrow from the moneylender, B, and they bargain over the repayment, R.
3. The moneylender makes his lending/diversion decision.
4. The entrepreneur makes her investment/diversion decision.
5. Repayments are made.

3 Equilibrium Outcomes

I solve for the subgame perfect equilibrium outcome and begin with the entrepreneur's borrowing and investment decisions. If wealth constrained, she chooses the amount of bank funds to invest, I_B, and the amount of credit, L_E, by maximizing

$$U_E = \max\left\{0, Q\left(I_B + B\right) - (1+r)\,L_E - R(B)\right\} + \phi(\omega_E + L_E - I_B), \qquad (2)$$

subject to

$$\begin{aligned} \omega_E + L_E &\geq I_B, \\ \bar{L}_E &\geq L_E. \end{aligned}$$

The first part of expression (2) is the profit from investing. The second part denotes the profit from diversion. The full expression is maximized subject to available funds and the credit limit posted by the bank. Note that B, the amount borrowed from the moneylender, is free from the entrepreneur's potential opportunistic behavior. It can be shown that the choice is essentially binary; either the entrepreneur chooses to invest all the money or she diverts the maximum possible.[17] The entrepreneur will not be tempted to behave opportunistically if the contract satisfies the incentive constraint

$$Q\left(\omega_E + L_E^u + B\right) - (1+r)\,L_E^u - R(B) \geq \phi\left(\omega_E + \bar{L}_E\right), \qquad (3)$$

[16] To distinguish the bank from the moneylender, I assume that the bank is unable to condition its contract on the moneylender's contract offer, an assumption empirically supported by Giné (2005).

[17] Neither partial investment nor diversion are optimal. Investing yields the entrepreneur at least $1+r$ on every dollar invested, while diversion leaves her with only ϕ. If the entrepreneur plans to divert resources, there is no reason to invest either borrowed or internal funds as the bank would claim all of the returns.

where $L_E^u = \min\left\{I^*(r) - \omega_E - B, \bar{L}_E\right\}$. In other words, either the entrepreneur borrows and invests such that the first-best level of investment is achieved or she exhausts the maximum credit line extended by the bank.

Similarly, the moneylender chooses the amount to lend to the entrepreneur, B, and the amount of credit, L_M, by maximizing

$$U_M = \max\{0, R(B) - (1+r)L_M\} + \phi(\omega_M + L_M - B),$$

subject to

$$\begin{aligned} \omega_M + L_M &\geq B, \\ \bar{L}_M &\geq L_M. \end{aligned}$$

The outcome is analogous to that of the entrepreneur, yielding the critical incentive constraint

$$R(\omega_M + L_M^u) - (1+r)L_M^u \geq \phi\left(\omega_M + \bar{L}_M\right), \tag{4}$$

where $L_M^u = \min\left\{I^*(r) - \omega_M - \omega_E - L_E^u, \bar{L}_M\right\}$. In sum, whereas the entrepreneur contemplates whether or not she should invest the bank funds (expression (3) above), the moneylender's decision problem concerns whether or not he should lend the bank funds to the entrepreneur (expression (4) above).

So far the repayment function has been considered a primitive; it remains to determine its actual form as shaped by Nash Bargaining. The entrepreneur's inside option is given by the net benefit of investing the funds extended from the bank and the moneylender, while her outside option is the residual return from investing the bank funds alone. The moneylender's inside option is the repayment less the cost of borrowing the money from the bank, while the outside option is the utility from diverting all the funds.[18] The equilibrium repayment is given by

$$\begin{aligned} \max_{\{R\}} & \left[Q(I) - (1+r)L_E^u - R - \left(Q(\omega_E + L_E^u) - (1+r)L_E^u\right)\right]^\alpha \\ & \times \left[R - (1+r)L_M^u - \phi\left(\omega_M + \bar{L}_M\right)\right]^{1-\alpha}, \end{aligned} \tag{5}$$

where $\alpha \in (0,1)$ represents the bargaining power of the entrepreneur.[19] The investment level with credit extended by the bank and the moneylender equals $I = \omega_E + L_E^u + B =$

[18] The outside option of the entrepreneur is given by borrowing from the bank alone. The reason is that the relationship with the moneylender builds on exclusivity. See Sutton (1986) and Binmore et al. (1989), for work where the outside option implies breaking up the current relationship.

[19] As it turns out, any division of the surplus leads to qualitatively similar results.

$\omega_E + L_E^u + \omega_M + L_M^u$, while the stand-alone investment level utilizing only bank funds is given by $\omega_E + L_E^u$. The bargaining outcome that solves (5) is

$$R^* = (1-\alpha)\left(Q(I) - Q\left(\omega_E + L_E^u\right)\right) + \alpha\left((1+r)L_M^u + \phi\left(\omega_M + \bar{L}_M\right)\right).^{20} \tag{6}$$

Finally, the perfectly competitive bank market yields the equilibrium zero-profit interest rate of ρ.

I now proceed by stating resulting equilibrium constellations (Figure 1 depicts the different outcomes). Specifically, for low levels of wealth the entrepreneur and the moneylender will be credit rationed by the bank. Here the temptation to divert for each of them is too strong to permit bank lending supporting a first-best investment. In this situation, the entrepreneur exhausts her credit line with the bank in addition to borrowing the maximum amount made available to her from the moneylender. Similarly, the moneylender utilizes all available bank funds and his own capital to service the entrepreneur.[21] Hence, the credit limits will be given by the following binding constraints of the entrepreneur and the moneylender, depending on the bargaining outcome:

$$\begin{aligned}\alpha Q(I) + (1-\alpha)Q\left(\omega_E + \bar{L}_E\right) - (1+r)\bar{L}_E - \alpha(1+r)\bar{L}_M \\ -\alpha\phi\left(\omega_M + \bar{L}_M\right) - \phi\left(\omega_E + \bar{L}_E\right) = 0\end{aligned} \tag{7}$$

and

$$Q(I) - Q\left(\omega_E + \bar{L}_E\right) - (1+r)\bar{L}_M - \phi\left(\omega_M + \bar{L}_M\right) = 0, \tag{8}$$

with $I = \omega_E + \bar{L}_E + \omega_M + \bar{L}_M$.[22] The lower left corner of Figure 1 depicts the situation. As the moneylender becomes wealthier (moving up the vertical axis in Figure 1), his bank credit limit no longer binds and he is able to borrow and lend enough

[20] R^* satisfies the incentive constraints of the entrepreneur and the moneylender. R^* also captures the empirical regularity that interest rates tend to be much higher in the informal sector than the formal sector (see Banerjee, 2003 and references therein) and that wealthier entrepreneurs pay lower rates of informal interest. To see the last point, note that $d[(R^* - B)/B]d\omega_E < 0$.

[21] Although optimal, this choice represents the second-best outcome for both the entrepreneur and the moneylender. In fact, the entrepreneur would prefer to borrow from the bank and the moneylender, where the latter only lends his own capital. This increases the entrepreneur's outside option while keeping the outside option of the moneylender to a minimum. In other words, the entrepreneur would prefer to borrow less at a more favorable rate. Similar logic yields the result that the moneylender favors being the exclusive borrower of the bank, thus reducing the value of the entrepreneur's threat point. However, as each agent has access to bank funding, the common second-best option for both is to borrow from the bank. Note that the bank has no influence over resulting constellations as long as it breaks even.

[22] Interestingly, when the moneylender's incentive constraint binds, he receives exactly his outside option in the bargaining, implying that the bargaining power of the entrepreneur has no effect on the final outcome.

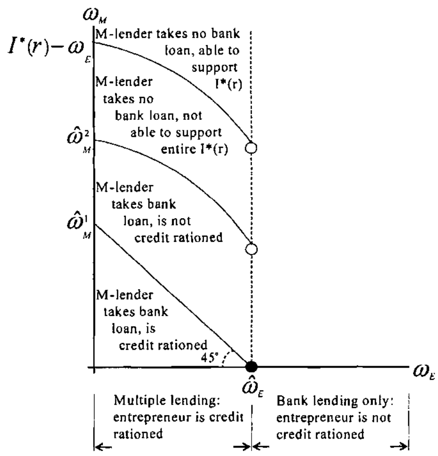

Figure 1: Lender Constellations and Wealth Thresholds

to satisfy the first-best level of investment. The outcome in this situation resembles the previous equilibrium, in which the entrepreneur borrows from both a bank and a moneylender who lends his own and bank funds.[23] Hence, in this equilibrium, the entrepreneur's credit limit is still given by equation (7), while the moneylender's credit line is determined by

$$Q'(I) - (1+r) = 0. \tag{9}$$

That is, the equation $I^*(r) = \omega_E + \bar{L}_E + \omega_M + L_M$ determines L_M.

When the moneylender is wealthy enough to self-finance larger parts (or the entire amount) of a first-best investment, he no longer acquires bank funds. In this case, the entrepreneur borrows from both a bank and a moneylender, where the moneylender now services the entrepreneur with his own capital (upper left corner of Figure 1). In this instance, the entrepreneur's incentive constraint yields

$$\alpha Q(I^*(r)) + (1-\alpha) Q\left(\omega_E + \bar{L}_E\right) - (1+r)\bar{L}_E - \alpha(1+r)B - \phi\left(\omega_E + \bar{L}_E\right) = 0, \tag{10}$$

with $I^*(r) = \omega_E + \bar{L}_E + B$ and $B \leq \omega_M$. As the informal lender has no bank loan, his outside option changes from $\phi\left(\omega_M + \bar{L}_M\right)$ to $(1+r)B$.[24] Finally, a sufficiently

[23] Note that the entrepreneur's and moneylender's preferences diverge in similar spirit to the previous equilibrium.

[24] The moneylender's outside option is now given by the equivalent of depositing the funds in the bank instead of lending them to the entrepreneur. The deposit and lending rates will equal the alternative cost of funds in the economy, ρ, if deposits and bank funds are in excess supply.

wealthy entrepreneur will realize the first-best level by borrowing exclusively from the bank (moving along the horizontal axis in Figure 1). Equilibrium outcomes are summarized in Proposition 1.[25]

Proposition 1: *There are wealth thresholds* $\hat{\omega}_E(r,\phi) > 0$ *and* $\hat{\omega}_M^2(r,\phi) > \hat{\omega}_M^1(r,\phi) > 0$ *such that:*

(i) If $\omega_E < \hat{\omega}_E$ *and* $\omega_M < \hat{\omega}_M^1$ *then investment is credit constrained* $(I < I^*(r))$*. The entrepreneur borrows from both a bank and a moneylender and this moneylender borrows from a bank.*

(ii) If $\omega_E < \hat{\omega}_E$ *and* $\omega_M \in [\hat{\omega}_M^1, \hat{\omega}_M^2)$ *then the first-best level is invested* $(I = I^*(r))$*. The entrepreneur borrows from both a bank and a moneylender and this moneylender borrows from a bank.*

(iii) If $\omega_E < \hat{\omega}_E$ *and (a)* $\omega_M \in [\hat{\omega}_M^2, I^*(r) - \omega_E)$ *or (b)* $\omega_E + \omega_M \geq I^*(r)$ *then the first-best level is invested* $(I = I^*(r))$*. The entrepreneur borrows from both a bank and a moneylender and this moneylender does not borrow from a bank.*

(iv) If $\omega_E \geq \hat{\omega}_E$ *then the first-best level is invested* $(I = I^*(r))$ *and the entrepreneur borrows exclusively from a bank.*

Proof: See Appendix.

The entrepreneur's threshold, $\hat{\omega}_E$, refers to the debt capacity at which a first-best investment is realized without informal funds, whereas $\hat{\omega}_M^1$ denotes the level of moneylender wealth where first-best is attained given a bank-rationed entrepreneur. The moneylender's upper threshold, $\hat{\omega}_M^2$, shows the amount of informal wealth that satisfies the first-best level when the rationed entrepreneur alone takes bank credit. (Part (b) states that the same outcome is obtained when the moneylender is able to self-finance larger parts of the needed investment.)

Strikingly, the result indicates that a poor entrepreneur prefers utilizing the maximum amount of bank funding—regardless of the informal sector's wealth—as this choice increases the entrepreneur's outside option, keeping the repayment to the moneylender at a minimum. Since a wealthier entrepreneur needs less informal funds to

[25] The equilibrium outcomes are robust to collusion between the bank's borrowers. When the entrepreneur and the moneylender are constrained, the option of investing and lending is individually *and* jointly incentive compatible (the former is given by equations (7) and (8) and the latter by keeping the bargaining weights on the moneylender's utility and adding the utility of the two borrowers, resulting in $Q(I) - (1+r)(\bar{L}_E + \bar{L}_M) = \phi I$). If the entrepreneur is constrained while the moneylender is sufficiently wealthy, it is never rational for the moneylender to pretend to give the entrepreneur a loan that does not materialize but boosts the entrepreneur's credit line. The reason for this is that actual lending leaves the informal lender with a greater return than his outside option of either diverting the funds or depositing them with the bank.

satisfy first-best, and $\bar{L}_E$ is increasing in ω_E (shown below), this also explains the negative slope of the moneylender's thresholds depicted in Figure 1.[26]

Proposition 1 is consistent with a series of empirical studies on formal-informal sector interactions (Bell et al., 1997; Conning, 2001; Giné, 2005). For example, in Giné's study of 2880 households and 606 small businesses in rural Thailand, the wealthiest borrowers (measured both by wealth and income) resort exclusively to the formal sector. As wealth declines, borrowers take credit from both sectors.[27] Conning provides similar evidence from his study on rural Chile.[28]

With the lender constellations established, I now examine the sensitivity of equilibria to changes in the model's parameters, a summary of which is contained in Table 1. In particular, I explore implications of a credit-rationed informal sector and reasons for employing multiple lenders simultaneously.

Table 1: Properties of Bank Credit

	Entrepreneur and moneylender are credit rationed			Entrepreneur is credit rationed		
Parameters	I	$\bar{L}_E$	$\bar{L}_M$	I	$\bar{L}_E$	L_M
Wealth of entrepreneur, ω_E	+	+	−	0	+	−
Wealth of moneylender, ω_M	+	0	+	0	+	−
Creditor vulnerability, ϕ	−	−	±	0	−	+
Interest rate, r	−	−	±	−	−	±
Bargaining power of entrepreneur, α	0	0	0	0	+	−

Notes: I denotes aggregate investment; L_E and L_M bank credit extended to the entrepreneur and the moneylender. For proofs, see Appendix.

First, permitting opportunistic behavior by the informal sector shows that entrepreneurial and informal assets are complements when both agents are poor and substitutes when informal assets increase. Notably, when the entrepreneur and the moneylender are credit rationed, an increase in the entrepreneur's wealth, ω_E, positively affects the credit line, $\bar{L}_E$, by: (i) raising the return to investment and (ii) by strengthening the entrepreneur's outside option in her bargaining with the moneylender, thereby decreasing the repayment. As these two changes simultaneously make it

[26] The properties of the thresholds are provided in Lemma A4 in the Appendix.

[27] See Table 5 in Giné (2005).

[28] The empirical evidence further shows that poor entrepreneurs sometimes borrow from the informal sector alone. This is accommodated in the present framework by introducing a transaction cost associated with bank borrowing; see Section 6 for a discussion. See also Madestam (2005*a*) for an alternative explanation in which segmentation arises as a consequence of a banking monopoly in the formal sector.

less tempting to divert resources, the bank extends more funds to the entrepreneur. (The wealth of the moneylender, ω_M, has a similar effect on $\bar{L}_M$.) The assets ω_E and ω_M thus complement each other in raising investment at low levels of wealth.[29] Also note that the way in which the surplus is split, α, has no effect on the amount of bank credit that is extended because all available resources are used to cater the entrepreneur's project.

When the moneylender is wealthy enough to support first-best investment but needs bank funds to do so, the moneylender's and entrepreneur's wealth are substitutes in terms of credit lines and subsequent investment (Table 1, right panel). This can be seen by noting that an increase in the moneylender's wealth, ω_M, induces the moneylender to borrow less from the bank (L_M decreases). In addition, it makes the entire project less prone to opportunistic behavior, allowing extra bank credit to be extended to fund the venture. Since the entrepreneur prefers bank funds to moneylender funds, the additional increase in ω_M allows the entrepreneur to borrow more from the bank, explaining the increase in $\bar{L}_E$. Finally, the division of the surplus now makes a difference. A higher α leaves the entrepreneur a larger share of the bargaining outcome, thus increasing her return from investment and allowing the bank to forward more credit.

Another way of understanding these results is to note that lenders complement each other in providing external finance for low debt capacities, while acting as substitutes when the moneylender is wealthier.[30] This provides an explanation for when and why the informal sector competes with and/or channels the formal sector's funds.

The previous discussion also offers intuition as to why entrepreneurs employ multiple lenders. As the wealth of the moneylender increases, he gradually attracts proportionally more formal capital into the venture. This result follows directly from the twofold effect associated with the increase in ω_M, leading to a larger $\bar{L}_E$. With a larger stake in the project—in terms of internal funds—the moneylender reduces the risk of opportunistic behavior of the entire venture since, by assumption, his wealth is always invested. An interpretation of this finding is that moneylenders in equilibrium serve as an implicit commitment device for entrepreneurs versus banks by increasing the return to investment; wealthier moneylenders induce stronger entrepreneurial commitment.

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[29] The assets are not complements in a strict sense, however, since an increase in the entrepreneur's wealth, ω_E, reduces $\bar{L}_M$ by strengthening the entrepreneur's bargaining position, making diversion more tempting for the moneylender.

[30] The findings supplement Burkart and Ellingsen (2004), who find that bank and trade credit are complements for credit-constrained firms, while substitutes for firms with sufficient debt capacity. However, whereas their result relates to the supply of funds in response to entrepreneurs' assets, my concern is the dual role of informal assets (as wealth and external funds) in relation to the entrepreneurial venture.

The value of commitment is maximized at the point where the informal lender refrains from bank borrowing altogether. Beyond that, incremental increases in ω_M will not be invested in the project, and hence not affect the extension of bank funds.

Taken together, formal lenders offer entrepreneurs a stronger bargaining position vis-à-vis the informal lender. Meanwhile, informal lenders provide entrepreneurs with a commitment device that improves their relationship with the formal sector—unless informal lenders themselves are credit rationed.

4 Institutions and Informal Finance

The equilibrium outcomes established in the preceding section were derived under the assumption that legal protection of creditors is less than perfect. As argued in the Introduction, the reason for informal finance in the first place is the inability of the formal sector to prevent misuse of its funds. I now show that informal finance is redundant for sufficiently low levels of creditor vulnerability.

Proposition 2: *There is a creditor vulnerability threshold $\phi^*(r, \omega_E) > 0$ such that:*
(i) If $\phi \leq \phi^*$ and $\omega_E < I^*(r)$ then entrepreneurs borrow from banks exclusively.
(ii) If $\phi > \phi^*$ and $\omega_E \in [\hat{\omega}_E, I^*(r))$ then entrepreneurs borrow from banks exclusively.
(iii) If $\phi > \phi^*$ and $\omega_E < \hat{\omega}_E$ then entrepreneurs borrow from banks and moneylenders.

Proof: See Appendix.

If $\phi \leq \phi^*$, entrepreneurs borrow exclusively from banks, regardless of their debt capacity (below first-best investment). In other words, as credit markets become more developed, informal finance looses its edge. The intuition is straightforward. The threshold ϕ^* defines the level of creditor vulnerability for which a penniless entrepreneur can attain first-best by resorting exclusively to bank funds. As the entrepreneur prefers bank to moneylender funds, she will borrow from the formal sector alone when given the opportunity.[31]

A related issue concerns how the ratio of informal to total intermediation varies in response to institutional change. Define the share of informal intermediation in total intermediation as

$$i = \frac{B}{B + \bar{L}_E}. \tag{11}$$

[31] Parts (ii) to (iii) of Proposition 2 are simply restatements of Proposition 1. Namely, that bank lending is preferable when this achieves first-best (part (ii)), but the entrepreneur resorts to both lenders if borrowing from the bank attains less than first-best (part (iii)).

An increase in (11) corresponds to a larger relative share of moneylender funds.[32]

Proposition 3: *If moneylenders are not credit rationed, the share of moneylender funds in total intermediation, i, increases in creditor vulnerability, ϕ.*

According to Table 1, right panel, the entrepreneur substitutes $\bar{L}_E$ for L_M when creditor vulnerability increases. Intuitively, the informal sector becomes the lender of choice if it has the financial means *and* the formal sector's ability to prevent opportunistic behavior deteriorates. When the moneylender's debt capacity declines (Table 1, left panel), two other effects come into play. A higher ϕ raises the utility of opportunistic behavior relative to lending money, leading to less bank credit extended to the moneylender (*diversion effect*). Meanwhile, an increase in ϕ lowers $\bar{L}_E$, which strengthens the moneylender's bargaining position, raising $\bar{L}_M$ (*bargaining effect*). If the latter effect dominates—that is, when $\omega_E + \bar{L}_E$ accounts for a substantial part of total investment—deteriorating institutions in fact induce more credit forwarded to the moneylender, even if he is credit rationed. When this is true, Proposition 3 holds globally.

Propositions 2 and 3 are novel predictions of the model that offer a striking yet simple explanation for why informal lending is prominent in developing markets but virtually non-existent in developed credit markets with well functioning legal protection of creditors.

5 Distribution of Wealth

Until now, the distribution of assets has been assumed given. It is interesting to ask how a reallocation of wealth across lenders and entrepreneurs would affect investment. As a preliminary analysis, I first consider a reallocation of wealth between the entrepreneur and the moneylender using the model outlined in Section 2. The theory is then extended to capture the difference in technology endowment that distinguishes the moneylender from the entrepreneur. Specifically, I assume that while entrepreneurs' production technology applies to one project, lenders' monitoring technology is applicable to more than one entrepreneur. This assumption is explored by considering a moneylender that interacts with two entrepreneurs in a multi-period setting. Besides providing additional insight into the relationship between inequality and investment, the modification allows

[32] B may include bank loans and the moneylender's own wealth. Consistent with the empirical evidence referred to in the Introduction, I define the origin of intermediated funds to mean the final source of money lent to the entrepreneur.

for a comparison with related work (see, for example, Banerjee and Newman, 1993; Galor and Zeira, 1993).

Let me first consider the effects of a wealth reallocation between the entrepreneur and the moneylender within the model's present set-up. The comparative static exercise in Section 3 showed that the bargaining power of the entrepreneur, α, had no effect on bank credit at low levels of wealth. This suggests that a reallocation between the moneylender and the entrepreneur will be irrelevant for subsequent investment, which can be stated formally.

Proposition 4: *A reallocation of wealth from entrepreneurs to moneylenders has no effect on investment.*

Proof: See Appendix.

Intuitively, for low debt capacities an asset reallocation between the entrepreneur and the moneylender will not improve investment since they both invest or lend their entire wealth. When the moneylender becomes sufficiently wealthy such that first-best is realized, the outcome is the same but for a different reason; investment will not increase any further and the assets of the entrepreneur and moneylender are perfect substitutes. If credit market transactions were to be characterized as one-shot interactions, the distribution of wealth would have no effect on productive efficiency when comparing informal and entrepreneurial assets.

As noted above, however, the moneylender may lend to more than one entrepreneur, while the entrepreneur is engaged in one project only. Implications of this assumption are illustrated in the following three examples.

Example 1: Consider a sequence of two periods, with one entrepreneur in need of external finance in each period. First note that a reallocation of wealth from the period 2 entrepreneur to the moneylender leaves investment unchanged (similar to Proposition 4).

A wealth reallocation does, however, raise aggregate investment if reallocating wealth from the period 1 entrepreneur to the moneylender increases investment in period 2. Indeed, such an operation is possible as it leaves period 1 investment unchanged (Proposition 4), increases the lending capacity of the moneylender in period 2, thereby raising investment in period 2 *if* the moneylender and the period 2 entrepreneur are credit rationed. Hence, as the moneylender becomes richer on account of the period 1 entrepreneur, more is invested in the following period. When first-best is attained, redistribution ceases to have an effect.

Example 2: Using the set-up of *Example 1*, I turn to the frequency with which borrowers interact with the bank. So far, the interaction between the bank and its borrowers has been modeled as identical. Suppose, however, that the moneylender returns to the bank in the second period—if wealth constrained—while the period 1 entrepreneur only borrows once. If so, it is reasonable to assume that the moneylender has more to lose from a default, allowing the bank to extend funds more liberally to the moneylender than to the period 1 entrepreneur. In this instance, an additional dollar of wealth with the moneylender generates more bank credit on the margin. Again, this only holds for low levels of wealth. As soon as first-best investment is attained, investment will not increase any further.[33]

Example 3: Finally, consider a one period set-up with two possibly heterogeneous entrepreneurs, $\omega_E^i \lesseqqgtr \omega_E^j$, $i \neq j \in (1,2)$, where $\omega_M \lesseqqgtr \omega_E^i, \omega_E^j$. For simplicity, assume that the incentive constraint binds for all involved. As it is optimal for the moneylender to lend to the point where marginal returns to his loans are equalized, $R'(B^i) = R'(B^j)$. Because repayment is a function of amount invested, B will be set such that investment across entrepreneurs is equalized and productive efficiency maximized (see Lemma A7 in the Appendix for details). However, this assumes that the moneylender is sufficiently wealthy. Suppose, for example, that there are three asset levels (with corresponding credit lines), $\omega_E^i + \bar{L}_E^i = 5$, $\omega_E^j + \bar{L}_E^j = 3$, and $B = \omega_M + \bar{L}_M = 1$.[34] Here, the lender is unable to equalize assets to be invested, leading to lower overall production. It turns out that with two entrepreneurs and one moneylender, productive efficiency is maximized when the debt capacity of the moneylender exceeds the differential value of the entrepreneurs asset holdings and credit lines, that is, $\left|(\omega_E^i + \bar{L}_E^i) - (\omega_E^j + \bar{L}_E^j)\right| \leq B$ (see Lemma A8 in the Appendix for details). In terms of the example provided, B must equal 5 in order for the moneylender to equally satisfy the financing needs of the entrepreneurs.

Intuitively, because a wealthy moneylender is capable of smoothing lending and subsequent investment across entrepreneurs (unlike a wealthy entrepreneur), increased asset inequality in favor of the moneylender improves productive efficiency. Notably, an equalized distribution of wealth across all three agents serves the same purpose. A situation with a wealthy moneylender is therefore preferable to one with a more affluent entrepreneur, but just as efficient as one with a perfectly equal income distribution. However, as a wealthier moneylender reaps a higher repayment (by increasing the outside option in the bargaining), this leaves him with additional resources to be lent to future projects (similar to *Example 1*). More wealth also allows him to draw upon

[33] Similar conclusions are obtained if more frequent interaction with the bank implies a lower ϕ on the part of the moneylender.

[34] Since $\bar{L}$ increases in ω, higher wealth induces more bank credit.

extra bank capital by considering future bank interaction (similar to *Example 2*).[35]

The examples demonstrate that wealth concentration must be accompanied by an ability to put money to work, which is exactly what moneylenders' monitoring technology achieves. Money must also be put to work where it is needed, i.e. when less than first-best is invested. Hence, asset inequality will not raise investment when firms and lenders are more affluent.[36] These ideas are reminiscent of the work of Lewis (1954), Kuznets (1955), and Kaldor (1956). However, while Kuznets and Lewis saw inequality as inevitable in the development process, I merely claim that it may improve investment.[37] According to Kaldor, the marginal propensity to save was higher among the rich than the poor. As the gross domestic product was assumed to be directly related to the proportion of national income saved, the economy was presumed to grow faster for a less equal distribution of income. Kaldor's capitalists resemble somewhat my moneylenders, but I do not assume that the propensity to save is higher for richer individuals, nor that mobilization of domestic savings necessarily translates into more projects being undertaken.

Finally, I determine how an increase in the capital of the moneylender as opposed to the bank affects investment.

Proposition 5: *When entrepreneurs and moneylenders are credit rationed, investment increases in the share of moneylender funds in total intermediation, i (expression (11)).*

The result is straightforward once you take into account that neither the entrepreneur nor the moneylender's assets affect the other borrower's credit limit for low debt capacities (Table 1, left panel). From expression (11), it follows that an increase in the moneylender's wealth, ω_M, improves the credit limit, $\bar{L}_M$, the share of moneylender funds in total intermediation, and investment. Meanwhile, the credit limit of the entrepreneur, $\bar{L}_E$, remains unchanged. Extending more bank funds in this case (increasing $\bar{L}_E$) is not possible as it induces opportunistic behavior. The model

[35] A noteworthy feature of the above result is that entrepreneurial income is identical ex-post if the moneylender sets $\bar{L}_M$ such that $R'\left(B^i\right) = R'\left(B^j\right)$. The effect on the overall income distribution is ambiguous as it depends on the initial value of ω_M.

[36] The introduction of a (fixed) monitoring cost incurred by the lender does not alter these insights as a marginal reallocation of wealth still leaves investment unchanged, in parallel to Proposition 4. Similarly, Examples 1 to 3 remain intact. The only difference is that a transfer of the moneylender's full wealth to the entrepreneur (avoiding lending and hence the cost) leads to increased investment, except in Example 2, as the additional funds that the moneylender attracts may outweigh the cost. Note that investment increases both in *relative* and *absolute* inequality in favor of the moneylender.

[37] See Greenwood and Jovanovic (1990) for a more recent contribution along the lines of Kuznets and Lewis.

thus suggests that more liquidity in the financial system is not good per se. If scarce resources of the informal sector act as a bottleneck, a mobilization of domestic savings in the formal sector will not necessarily translate into more funds invested, contradicting Kaldor's claim.[38]

The prediction complements recent empirical findings related to the theory of relationship banking.[39] Let the moneylender represent the small community bank and the bank correspond to its transaction-based counterpart. The model then predicts that a greater share of community bank lending leads to higher gross domestic product growth at low levels of wealth since community banks fill a lending-gap otherwise not met, a result empirically supported by Berger et al. (2004). Using cross-sectional data from 49 developed and developing countries, they conclude that a greater share of small, private, domestically-owned banks is associated with improved economic performance, with the effect being more pronounced in the developing-country context. Hence, in less developed economies with high ϕ and low ω, increasing the assets of the community bank rather than its transaction-based counterpart increases overall investment.

6 Discussion and Concluding Remarks

Let me conclude by discussing implications of the paper's main assumptions and consider some extensions. Proposition 1 rests on the assumption that the moneylender is able to monitor investment ex-ante. An alternative would be to model the informal sector's advantage as one of ensuring repayments ex-post, where the moneylender prevents strategic default.[40] However, in the theory's one-period setup this reasoning excludes bank lending, as the entrepreneur would default on her formal loan and simply repay the moneylender. Introducing a second period potentially alleviates the problem as the bank could threaten to liquidate a successful entrepreneur in the first period to force repayment. This assumes, however, that bankruptcy law actually functions properly so that assets may be seized. Indeed, Claessens et al. (2003) show that creditors in East Asia only resort to bankruptcy as a means of securing debt ex-post if creditor vulnerability is low. By viewing the problem as one of ex-ante moral hazard, I arrive

[38] For higher levels of moneylender wealth such that first-best is obtained, the results are indeterminate. The reason is that a higher level of moneylender assets, ω_M, simultaneously induces a decrease in L_M and an increase in $\bar{L}_E$ (see Table 1, right panel).

[39] Relationship banking implies that a lender develops a close relationship with a borrower over time, acquiring borrower-specific "soft" information facilitated through multiple interactions with the firm, the owner and the local community, as opposed to transaction-based lending based on "hard" information acquired at the time of the loan origination (see Boot, 2000 and Berger and Udell, 2002).

[40] See, for example, Bolton and Scharfstein (1990).

at multiple lending without needing to pay special consideration to the problems of seizing assets.[41]

This argument also distinguishes the moneylender, as outlined in the present paper, from the "extortionary" loanshark, where the latter is often associated with Mafioso-like methods to collect their loans. In situations where the informal sector's advantage is characterized by enforcing repayment through these more violent means, the model predicts that multiple lending should be less prevalent.[42]

A related concern is whether the paper's main insights would be altered if informal monitoring was less efficient. Nonetheless, it can be shown that the equilibrium outcomes remain the same, as do predictions related to the distribution of wealth (allowing for some slight alterations). To see the last point, suppose the entrepreneur fails to invest a fraction $\delta \in (0,1)$ of the moneylender's funds.[43] In the one-period setup, it then matters whether the entrepreneur or the moneylender holds the wealth, since a reallocation that benefits the entrepreneur improves investment. In the context of the extensions discussed in Section 5, however, the results remain basically the same. Specifically, if the informal lender's value of future bank borrowing is much larger than the entrepreneur's (*Example 2*), and the inefficiency δ is sufficiently small, reallocating wealth to the moneylender is still beneficial. Similarly, a wealthier moneylender is preferred to a wealthier entrepreneur for reasons of productive efficiency and value of future bank interactions (*Example 3*) for sufficiently small δ.

Another worthwhile question is why the bank does not merge with the moneylender, rather than extending a loan, making him the local branch manager of the bank? The straightforward answer is that "bringing the market inside the firm" at best replicates the market outcome, as the branch manager now has to be incentivized to act responsibly with the bank funds. However, the merger also adds a new dimension, the employer-employee relationship, which opens up opportunistic behavior not only

[41] A way to salvage the ex post set-up would be to assume bank seniority over verifiable project claims. Again, proper enforcement of seniority clauses assumes functioning creditor rights. The problem of dysfunctional bankruptcy law could be avoided by introducing the notion of reputation building to prevent the entrepreneur from defaulting on the bank loan. However, this assumes frequent interaction between the bank and its borrowers. As discussed in Section 5, this may be true of a credit-constrained moneylender as he turns to the bank on a regular basis to lend money to entrepreneurs. However, for a single entrepreneur this is less likely.

[42] Moreover, whereas the typical mafioso is ignorant of a venture's circumstances, collecting repayment regardless of project outcome, my moneylender can be more lenient since he is knowledgeable of the state of affairs. For example, the moneylender would know that a farmer invested her money in new plant seeds, and in the case of a bad harvest, also be able to reschedule the loan without inducing future opportunistic behavior.

[43] The value δ could be a deadweight loss or, alternatively, a benefit accruing directly to the entrepreneur.

on the part of the newly hired moneylender, but also on the part of the bank itself.[44] Hence, the overall effect is likely to be efficiency reducing, confirming why this kind of organizational design is uncommon in developing credit markets.[45]

As the model stands, the informal lender's occupational choice is restricted to lending money. In a more general setting he may have additional sources of income, such as holding land or trading. This will not weaken the results. Complementary sources of income make it less tempting to behave opportunistically, enabling the bank to extend more funds.[46] The case examined thus provides the lower limit of bank funds flowing to the moneylender and the model's predictions therefore applies to a broader class of phenomena characterized as informal finance, including credit extended by traders, landlords, and distant family.[47]

Finally, a common feature of developing credit markets is segmentation of the financial sector in such a way that borrowers are restricted to the informal lender despite the existence of banks. To explore this topic in the current set-up, I suppose here that bank borrowing is associated with a fixed cost $k > 0$ while access to the informal sector is costless.[48] For expositional purposes I focus on the situation in which the bank credit limit binds for both the entrepreneur and the moneylender.[49] For sufficiently low values of k, the market outcome remains the same as described in Proposition 1, where the entrepreneur and the moneylender both acquire formal funds. However, as k increases relative to the utility of borrowing from the bank, formal funds become less attractive. Indeed, when the cost k rises over and above the entrepreneur's utility of obtaining a bank loan, she resorts to the moneylender alone to raise capital for her project. Meanwhile the moneylender takes bank credit. The asymmetry in formal access is explained by dispersion in the asset distribution between the entrepreneur and the moneylender, where segmentation occurs when the entrepreneur is relatively poor while the moneylender is relatively wealthy (see Lemma A9 in the Appendix for details).[50] Hence, transaction costs introduce a wedge for the least wealthy in their

[44] The reasoning resembles Williamson's arguments of why "selective interventions" are hard to implement (Williamson, 1985, chapter 6).

[45] See Varghese (2004) for a survey of the issue.

[46] The inclusion of collateral in the model has a similar effect.

[47] Additional reasons why a landlord, for example, engages in lending include the practice of linking credit and land transactions to increase the tenant's work effort, as in Braverman and Stiglitz (1982).

[48] The difference in transaction cost is meant to capture the fact that the moneylender is a local resource, whereas bank borrowing often entails traveling some distance and setting up an account.

[49] The analysis readily extends to the remaining cases.

[50] Similarly, the moneylender refrains from bank borrowing when he is relatively poor and the entrepreneur relatively rich. A complete segmentation (where the entrepreneur borrows from the moneylender who only lends his own funds) will not occur as the entrepreneur and the moneylender

access to formal sector finance.

The current model may also be modified. In a companion paper (Madestam, 2005b), I explore the implications of a monopolistic formal sector, demonstrating that market power in banking leads to distortions that are especially large for less capitalized entrepreneurs. A related extension (Madestam, 2005a) further illustrates that banks' market power explains both the prevalence of moneylenders and the high effective interest rates in many developing credit markets. The paper shows that a monopoly bank extracts more rent by channeling funds through moneylenders than by lending directly to entrepreneurs. When moneylenders are sufficiently rich relative to entrepreneurs, they are less prone to divert bank funds. Therefore, a monopoly bank need not share rents when it lends through the moneylender. Bank market structure thus provides an explanation, in addition to transaction costs, for why formal-informal credit markets are segmented.

together never prefers full isolation to bank lending.

Appendix

The following result will be helpful in the subsequent analysis.

Lemma A1: *(i)* $Q'\left(\omega_E+\bar{L}_E\right)-(1+r+\phi)<0$*; and (ii)* $Q'\left(\omega_E+\bar{L}_E+\omega_M+\bar{L}_M\right)-(1+r+\phi)<0$.

Proof. Part (i): When the entrepreneur borrows exclusively from the bank and the credit limit binds,

$$Q\left(\omega_E+\bar{L}_E\right)-(1+r)\,\bar{L}_E-\phi\left(\omega_E+\bar{L}_E\right)=0.$$

This constraint is only binding if $Q'\left(\omega_E+\bar{L}_E\right)-(1+r+\phi)<0$. Otherwise, $\bar{L}_E$ could be increased without violating the constraint. Part (ii): When the credit limits for the entrepreneur and the moneylender bind,

$$\begin{aligned}\alpha Q\,(I)+(1-\alpha)\,Q\left(\omega_E+\bar{L}_E\right)-(1+r)\,\bar{L}_E-\alpha\,(1+r)\,\bar{L}_M\\ -\alpha\phi\left(\omega_M+\bar{L}_M\right)-\phi\left(\omega_E+\bar{L}_E\right)=0\end{aligned} \tag{A1}$$

and

$$(1-\alpha)\left(Q\,(I)-Q\left(\omega_E+\bar{L}_E\right)-(1+r)\,\bar{L}_M-\phi\left(\omega_M+\bar{L}_M\right)\right)=0, \tag{A2}$$

with $I=\omega_E+\bar{L}_E+\omega_M+\bar{L}_M$. Adding the two expressions yields the maximum incentive-compatible investment level:

$$Q\,(I)-(1+r)\,(I-\omega_E-\omega_M)-\phi I=0. \tag{A3}$$

Given that it is maximal, the term must have a negative derivative, i.e. $Q'\,(I)-(1+r+\phi)<0$. ∎

Proof of Proposition 1

I first show the existence and uniqueness of $\hat{\omega}_E\,(r,\phi)$, $\hat{\omega}_M^2\,(r,\phi)$, and $\hat{\omega}_M^1\,(r,\phi)$, proceed with the lender constellations that arise, and finally derive the properties of the thresholds depicted in Figure 1.

Lemma A2: *There exist unique thresholds* $\hat{\omega}_E(r,\phi)>0$*,* $\hat{\omega}_M^2(r,\phi)$*, and* $\hat{\omega}_M^1(r,\phi)$ *such that:*

(i) $Q\left(\omega_E+\bar{L}_E\right)-(1+r)\,\bar{L}_E-\phi\left(\omega_E+\bar{L}_E\right)=0$*, for* $\omega_E=\hat{\omega}_E\,(r,\phi)$ *and* $\omega_E+\bar{L}_E=I^*\,(r)$*;*

(ii) $\alpha Q\left(\omega_E+\bar{L}_E+\omega_M+\bar{L}_M\right)+(1-\alpha) Q\left(\omega_E+\bar{L}_E\right)-(1+r) \bar{L}_E-\alpha(1+r) \bar{L}_M-\alpha \phi\left(\omega_M+\bar{L}_M\right)-\phi\left(\omega_E+\bar{L}_E\right)=0$ *and* $Q\left(\omega_E+\bar{L}_E+\omega_M+\bar{L}_M\right)-Q\left(\omega_E+\bar{L}_E\right)-(1+r) \bar{L}_M-\phi\left(\omega_M+\bar{L}_M\right)=0$, *for* $\omega_M=\hat{\omega}_M(r, \phi)$ *and* $\omega_E+\bar{L}_E+\omega_M+\bar{L}_M=I^*(r)$;

(iii) $(1-\alpha)(Q(\omega_E+\bar{L}_E+\omega_M+L_M)-Q(\omega_E+\bar{L}_E+\omega_M)-(1+r)\bar{L}_M)+\alpha\phi(\omega_M+\bar{L}_M)-\alpha(1+r)\omega_M>0$, *for* $\omega_M=\hat{\omega}_M^2(r, \phi)$ *and* $\omega_E+\bar{L}_E+\omega_M=I^*(r)$; *and*

(iv) $\hat{\omega}_M^2(r,\phi)>\hat{\omega}_M^1(r,\phi)>0$.

Proof. Part (i) is analogous to Lemma A1 in Burkart and Ellingsen (2004) and hence omitted. Part (ii): The threshold $\hat{\omega}_M^1(r, \phi)$ is the smallest wealth level that satisfies $I=I^*(r)$ when the entrepreneur and the moneylender utilize bank funds. As (A3) yields the maximum incentive compatible investment level for a given level of entrepreneurial wealth, ω_E, $\hat{\omega}_M^1(r, \phi)$ must satisfy

$$Q\left(I^*(r)\right)-(1+r)\left(I^*(r)-\omega_E-\hat{\omega}_M^1\right)-\phi I^*(r)=0. \tag{A4}$$

The threshold is unique if $\bar{L}_M$ is increasing in ω_M. Define $\Delta=(Q'(\omega_E+\bar{L}_E)-(1+r+\phi))^2$. Totally differentiating (A1) and (A2) using Cramer's rule yields

$$\frac{d\bar{L}_M}{d\omega_M}=\frac{\left(\phi-Q'\left(\omega_E+\bar{L}_E+\omega_M+\bar{L}_M\right)\right)\left(Q'\left(\omega_E+\bar{L}_E\right)-(1+r+\phi)\right)}{\Delta}>0,$$

where the determinant, Δ, is positive by Lemma A1 and the inequality follows from Lemma A1, $Q'(I) \geq (1+r)$, and $\phi<1$. Finally, $\hat{\omega}_M^1(r, \phi)>0$ is a result of the assumption $\phi>\underline{\phi}$. Part (iii): The threshold $\hat{\omega}_M^2(r, \phi)$ is the smallest wealth level that satisfies $I=I^*(r)$ when the moneylender services the entrepreneur with his own capital, i.e. when the utility of self-financing the entrepreneur, U^s, is greater than the utility of obtaining a bank loan, U^b, where $U^s=(1-\alpha)\left(Q\left(\omega_E+\bar{L}_E+\omega_M\right)-Q\left(\omega_E+\bar{L}_E\right)\right)+\alpha(1+r)\omega_M$ and $U^b=(1-\alpha)\left(Q\left(\omega_E+\bar{L}_E+\omega_M+\bar{L}_M\right)-Q\left(\omega_E+\bar{L}_E\right)-(1+r)\bar{L}_M\right)+\alpha\phi\left(\omega_M+\bar{L}_M\right)$. Define $f(\omega_M)=U^b-U^s=(1-\alpha) Q\left(\omega_E+\bar{L}_E+\omega_M+\bar{L}_M\right)-(1-\alpha)\left(Q\left(\omega_E+\bar{L}_E+\omega_M\right)+(1+r)\bar{L}_M\right)+\alpha\left(\phi\left(\omega_M+\bar{L}_M\right)-(1+r)\omega_M\right)$. Let $\omega_M=\hat{\omega}_M^2(r, \phi)$ be the threshold where $\omega_E+\bar{L}_E+\omega_M+L_M=I^*(r)$, for $L_M=0$ and a given level of entrepreneurial wealth, ω_E. When $\omega_M \in\left[\hat{\omega}_M^1(r, \phi), \hat{\omega}_M^2(r, \phi)\right)$, $f(\omega_M)>0$ by concavity, $Q'(I) \geq(1+r)$, and the fact that $\phi\left(\omega_M+\bar{L}_M\right)-(1+r)\omega_M>0$ (shown below). In addition, when $\omega_E<\hat{\omega}_E(r, \phi)$ and $\omega_M \in\left[\hat{\omega}_M^1(r, \phi), \hat{\omega}_M^2(r, \phi)\right)$, the relevant constraints are given by

$$\alpha Q\left(\omega_E+\bar{L}_E+\omega_M+L_M\right)+(1-\alpha)\,Q\left(\omega_E+\bar{L}_E\right)-(1+r)\,\bar{L}_E-\alpha\,(1+r)\,L_M \\ -\alpha\phi\left(\omega_M+\bar{L}_M\right)-\phi\left(\omega_E+\bar{L}_E\right)=0, \tag{A5}$$

$$Q'\left(\omega_E+\bar{L}_E+\omega_M+L_M\right)-(1+r)=0, \tag{A6}$$

and

$$I-\omega_E-\bar{L}_E-\omega_M-L_M=0. \tag{A7}$$

Define $\Theta = Q''\left(\omega_E+\bar{L}_E+\omega_M+L_M\right)\left((1-\alpha)\left(Q'\left(\omega_E+\bar{L}_E\right)-(1+r)\right)-\phi\right)$. Differentiating equations (A5) to (A7) with respect to I, $\bar{L}_E$, L_M, and ω_M using Cramer's rule I obtain

$$\begin{aligned}\frac{dI}{d\omega_M} &= \frac{0}{\Theta}=0,\\ \frac{d\bar{L}_E}{d\omega_M} &= \frac{-(1+r)\,Q''\left(\omega_E+\bar{L}_E+\omega_M+L_M\right)}{\Theta}>0,\end{aligned}$$

and

$$\frac{dL_M}{d\omega_M}=\frac{Q''\left(\omega_E+\bar{L}_E+\omega_M+L_M\right)\left((1-\alpha)\left(\phi-Q'\left(\omega_E+\bar{L}_E\right)\right)+1+r\right)}{\Theta}<0,$$

where the determinant, Θ, is positive by concavity and Lemma A1 and the two inequalities follow from concavity, Lemma A1, and $\phi<1$. As $\bar{L}_E$ (L_M) increases (decreases) in ω_M, there exists a $\omega_M=\hat{\omega}_M^2(r,\phi)$, at which $\omega_E+\bar{L}_E+\omega_M=I^*(r)$, where $L_M=\bar{L}_M=0$ by the assumption that bank borrowing ceases when an agent's debt capacity exceeds the first-best investment level, and $f\left(\hat{\omega}_M^2(r,\phi)\right)=\hat{\omega}_M^2(r,\phi)\left(\phi-(1+r)\right)<0$, as $\phi<1$. The threshold is unique as $\bar{L}_E$ is increasing in ω_M. Part (iv): $\hat{\omega}_M^2(r,\phi)>\hat{\omega}_M^1(r,\phi)$ follows from continuity and $d\bar{L}_E/d\omega_M>0$, showed in Part (iii) above. Finally, $\hat{\omega}_M^1(r,\phi)>0$ is a result of the assumption $\phi>\underline{\phi}$. ■

Lemma A3: *If (i) $\omega_E<\hat{\omega}_E(r,\phi)$ and $\omega_M<\hat{\omega}_M^1(r,\phi)$; or (ii) $\omega_E<\hat{\omega}_E(r,\phi)$ and $\omega_M\in\left[\hat{\omega}_M^1(r,\phi),\hat{\omega}_M^2(r,\phi)\right)$ then the entrepreneur borrows from both a bank and a moneylender and this moneylender borrows from a bank. If (iii) $\omega_E<\hat{\omega}_E(r,\phi)$ and (a) $\omega_M\in\left[\hat{\omega}_M^2(r,\phi),I^*(r)-\omega_E\right)$ or (b) $\omega_E+\omega_M\geq I^*(r)$ then the entrepreneur borrows from both a bank and a moneylender and this moneylender does not borrow from a bank. Finally, if (iv) $\omega_E\geq\hat{\omega}_E(r,\phi)$ then the entrepreneur borrows from a bank exclusively.*

Proof. The entrepreneur may borrow from: (1) the bank exclusively; (2) both lenders with the moneylender lending bank funds; (3) the moneylender exclusively with the moneylender lending bank funds; (4) the moneylender exclusively with the moneylender lending his own funds; (5) both lenders with the moneylender lending his own funds (let U_E^i and U_M^i denote the entrepreneur's and the moneylender's utility respectively).

Part (i): Case (1) renders $U_E^1 = Q\left(\omega_E + \bar{L}_E\right) - (1+r)\bar{L}_E$; $U_M^1 = 0$. Case (2) renders $U_E^2 = \alpha Q\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) + (1-\alpha)Q\left(\omega_E + \bar{L}_E\right) - (1+r)\bar{L}_E - \alpha(1+r)\bar{L}_M - \alpha\phi\left(\omega_M + \bar{L}_M\right)$; $U_M^2 = (1-\alpha)Q\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) - (1-\alpha)Q\left(\omega_E + \bar{L}_E\right) - (1-\alpha)(1+r)\bar{L}_M + \alpha\phi\left(\omega_M + \bar{L}_M\right)$. Case (3) renders $U_E^3 = \alpha Q\left(\omega_E + \omega_M + \bar{L}_M\right) + (1-\alpha)Q(\omega_E) - \alpha(1+r)\bar{L}_M - \alpha\phi\left(\omega_M + \bar{L}_M\right)$; $U_M^3 = (1-\alpha)Q\left(\omega_E + \omega_M + \bar{L}_M\right) - (1-\alpha)\left(Q(\omega_E) + (1+r)\bar{L}_M\right) + \alpha\phi\left(\omega_M + \bar{L}_M\right)$. Case (4) renders $U_E^4 = \alpha Q(\omega_E + \omega_M) + (1-\alpha)Q(\omega_E) - \alpha(1+r)\omega_M$; $U_M^4 = (1-\alpha)(Q(\omega_E + \omega_M) - Q(\omega_E)) + \alpha(1+r)\omega_M$. Case (5) renders $U_E^5 = \alpha Q\left(\omega_E + \bar{L}_E + \omega_M\right) + (1-\alpha)Q\left(\omega_E + \bar{L}_E\right) - \alpha(1+r)\omega_M - (1+r)\bar{L}_E$; $U_M^5 = (1-\alpha)\left(Q\left(\omega_E + \bar{L}_E + \omega_M\right) - Q\left(\omega_E + \bar{L}_E\right)\right) + \alpha(1+r)\omega_M$.

Starting with the entrepreneur, $U_E^1 = U_E^2$ (using equation (8) in the main text). However, she prefers U_E^2 by the assumption that for the same level of utility, the agent chooses the outcome with the higher investment. Also, $U_E^3 = Q(\omega_E)$ (using the moneylender's incentive constraint in Case (3)). Hence, $U_E^2 - U_E^3 = U_E^1 - U_E^3 = Q\left(\omega_E + \bar{L}_E\right) - Q(\omega_E) - (1+r)\bar{L}_E > 0$, by concavity and $Q'(I) \geq (1+r)$. However, $U_E^2 \gtreqless U_E^4$. Finally, $U_E^4 - U_E^3 = Q(\omega_E + \omega_M) - Q(\omega_E) - (1+r)\omega_M > 0$, $U_E^5 - U_E^2 = Q\left(\omega_E + \bar{L}_E + \omega_M\right) - Q\left(\omega_E + \bar{L}_E\right) - (1+r)\omega_M > 0$, and $U_E^5 - U_E^4 = \alpha\left(Q\left(\omega_E + \bar{L}_E + \omega_M\right) - Q(\omega_E + \omega_M)\right) + (1-\alpha)\left(Q\left(\omega_E + \bar{L}_E\right) - Q(\omega_E)\right) - (1+r)\bar{L}_E > 0$, by concavity and $Q'(I) \geq (1+r)$. This yields the following preference orderings: (i) $U_E^5 > U_E^2 > U_E^1 > U_E^4 > U_E^3$; or (ii) $U_E^5 > U_E^4 > U_E^2 > U_E^1 > U_E^3$.

As for the moneylender, $U_M^3 - U_M^2 = Q\left(\omega_E + \omega_M + \bar{L}_M\right) - Q\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) + Q\left(\omega_E + \bar{L}_E\right) - Q(\omega_E) > 0$, $U_M^3 - U_M^4 = (1-\alpha)\left(Q\left(\omega_E + \omega_M + \bar{L}_M\right) - Q(\omega_E + \omega_M)\right) - (1-\alpha)(1+r)\bar{L}_M + \alpha\left(Q\left(\omega_E + \omega_M + \bar{L}_M\right) - Q(\omega_E) - (1+r)\left(\omega_M + \bar{L}_M\right)\right) > 0$, and $U_M^2 - U_M^5 = (1-\alpha)\left(Q\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) - Q\left(\omega_E + \bar{L}_E + \omega_M\right) - (1+r)\bar{L}_M\right) + \alpha\left(Q\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) - Q\left(\omega_E + \bar{L}_E\right) - (1+r)\left(\omega_M + \bar{L}_M\right)\right) > 0$, by concavity and $Q'(I) \geq (1+r)$ (where $\phi\left(\omega_M + \bar{L}_M\right) - (1+r)\omega_M = Q\left(\omega_E + \omega_M + \bar{L}_M\right) - Q(\omega_E) - (1+r)\left(\omega_M + \bar{L}_M\right)$ and $Q\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) - Q\left(\omega_E + \bar{L}_E\right) - (1+r)\left(\omega_M + \bar{L}_M\right)$ for $U_M^3 - U_M^4$ and $U_M^2 - U_M^5$ respectively). Finally I have, $U_M^4 - U_M^5 = Q(\omega_E + \omega_M) - Q\left(\omega_E + \bar{L}_E + \omega_M\right) + Q\left(\omega_E + \bar{L}_E\right) - Q(\omega_E) > 0$, by concavity, while $U_M^4 \gtreqless U_M^2$. This yields the following preference orderings: (i) $U_M^3 > U_M^2 > U_M^4 > U_M^5 > U_M^1$; or (ii) $U_M^3 > U_M^4 > U_M^2 > U_M^5 > U_M^1$.

Although Case (5) is the entrepreneur's first choice but the moneylender prefers Case (3), Case (2) is the common second-best outcome for the pair of preference orderings $((i),(i))$, $((i),(ii))$, and $((ii),(i))$. When the entrepreneur and the moneylender hold the ordering, $((ii),(ii))$, Case (4) is preferred. However, in this instance, it can be shown that there does not exist any $\alpha \in (0,1)$ that simultaneously satisfies $U_E^4 > U_E^2$ and $U_M^4 > U_M^2$. Hence, Case (2) is the outcome when $\omega_E < \hat{\omega}_E(r,\phi)$ and $\omega_M < \hat{\omega}_M(r,\phi,\omega_E)$.

Part (ii): When $\omega_M \in \left[\hat{\omega}_M^1(r,\phi), \hat{\omega}_M^2(r,\phi)\right)$ then $\omega_E + \omega_M$ accounts for the interval of credit lines such that $\omega_M < I^*(r) - \omega_E - \bar{L}_E$, for a given ω_E and ω_M. Proceeding in a similar manner to Part (i), starting with the entrepreneur, yields $U_E^2 > U_E^1$; $U_E^2 > U_E^3$; $U_E^5 > U_E^4$; and $U_E^5 > U_E^1$, while $U_E^1 \gtreqless U_E^3$; $U_E^1 \gtreqless U_E^4$; $U_E^2 \gtreqless U_E^4$; $U_E^2 \gtreqless U_E^5$; $U_E^3 \gtreqless U_E^4$; and $U_E^3 \gtreqless U_E^5$. This renders 16 possible preference orderings on the part of the entrepreneur. In Part (i), I demonstrated that $\phi\left(\omega_M + \bar{L}_M\right) > (1+r)\,\omega_M$ to prove that $U_M^2 > U_M^5$. As $d\bar{L}_M/d\omega_M > 0$ (Table 1, right panel), this relationship still holds and $U_M^2 > U_M^5$. The moneylender thus holds the same pair of preference orderings as before. Analogous to Part (i), Case (2) is preferred except when $U_E^4 > U_E^2$ and $U_M^4 > U_M^2$. Again there is no $\alpha \in (0,1)$ that jointly satisfies these two preference orderings. Hence, Case (2) is the outcome when $\omega_M \in \left[\hat{\omega}_M^1(r,\phi), \hat{\omega}_M^2(r,\phi)\right)$.

Part (iii): When (a) $\omega_M \in \left[\hat{\omega}_M^2(r,\phi), I^*(r) - \omega_E\right)$; or (b) $\omega_E + \omega_M \geq I^*(r)$, $\omega_E + \omega_M$ accounts for the interval of credit lines such that $\omega_M \geq I^*(r) - \omega_E - \bar{L}_E$, for a given ω_E and ω_M. When the moneylender is wealthy enough to self-finance large parts (or the entire amount) of the first-best investment, he no longer borrows from the bank and Case (2) ceases to exist (Lemma A2). Excluding Case (2), I get the following outcomes for $\omega_M \in \left[\hat{\omega}_M^2(r,\phi), I^*(r) - \omega_E\right)$: $U_E^5 > U_E^1$; $U_E^5 > U_E^3$; $U_E^5 > U_E^4$, while $U_E^1 \gtreqless U_E^3$; $U_E^1 \gtreqless U_E^4$; and $U_E^3 \gtreqless U_E^4$. Also, $U_M^3 > U_M^4 > U_M^5 > U_M^1$. The exclusion of Case (2) and the entrepreneur's preference for Case (5) leaves the moneylender no other option but to concede to Case (5). When $\omega_E + \omega_M \geq I^*(r)$, Case (3) ceases as an option as well. Here I have $U_E^5 > U_E^1$; $U_E^5 > U_E^4$; and $U_M^4 > U_M^5 > U_M^1$, again resulting in Case (5). Hence, Case (5) is the outcome when (a) $\omega_M \in \left[\hat{\omega}_M^2(r,\phi), I^*(r) - \omega_E\right)$; or (b) $\omega_E + \omega_M \geq I^*(r)$.

Part (iv): In this instance I have $U_E^1 > U_E^2$; $U_E^1 > U_E^3$; $U_E^1 > U_E^4$; and $U_E^1 > U_E^5$, regardless of the moneylender's wealth. Hence, Case (1) is the outcome when $\omega_E \geq \hat{\omega}_E(r,\phi)$. ■

The properties of the thresholds as depicted in Figure 1.

Lemma A4: *(i) The threshold* $\hat{\omega}_M^1(r,\phi)$ *is a negative function of* ω_E *with slope* -1.

(ii) The threshold $\hat{\omega}_M^2(r,\phi)$ is a negative and concave function of ω_E.

Proof. Part (i): The threshold $\hat{\omega}_M^1(r,\phi)$ and the corresponding investment level is given by (A4) and

$$Q'(I) - (1+r) = 0. \tag{A8}$$

Differentiating (A4) and (A8) with respect to $\hat{\omega}_M^1(r,\phi)$ and ω_E using Cramer's rule yields

$$\frac{d\hat{\omega}_M^1(r,\phi)}{d\omega_E} = \frac{-Q''(I)(1+r)}{Q''(I)(1+r)} = -1.$$

Part (ii): The threshold $\hat{\omega}_M^2(r,\phi)$ is given by the function $f\left(\hat{\omega}_M^2(r,\phi)\right)$ derived in Lemma A2. Differentiating $f\left(\hat{\omega}_M^2(r,\phi)\right)$ with respect to ω_E yields

$$\frac{df\left(\hat{\omega}_M^2(\cdot)\right)}{d\omega_E} = (1-\alpha)\left(Q'\left(\omega_E + \bar{L}_E + \omega_M + L_M\right) - Q'\left(\omega_E + \bar{L}_E + \omega_M\right)\right) < 0$$

and

$$\frac{df\left(\hat{\omega}_M^2(\cdot)\right)}{d\omega_E d\omega_E} = (1-\alpha)\left(Q''\left(\omega_E + \bar{L}_E + \omega_M + L_M\right) - Q''\left(\omega_E + \bar{L}_E + \omega_M\right)\right) < 0,$$

where the two inequalities follow from concavity. The line $\omega_M = I^*(r) - \omega_E$ has the same properties since $f(\omega_M)$ increases continuously in ω_M. ∎

Proof of Properties in Table 1

I establish the properties of bank credit as reported in Table 1.

Proof. Table 1, right panel: When $\omega_E < \hat{\omega}_E(r,\phi)$ and $\omega_M < \hat{\omega}_M^1(r,\phi)$, the relevant constraints are given by

$$\begin{aligned}\alpha Q\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) + (1-\alpha) Q\left(\omega_E + \bar{L}_E\right) - (1+r)\bar{L}_E - \alpha(1+r)\bar{L}_M \\ -\alpha\phi\left(\omega_M + \bar{L}_M\right) - \phi\left(\omega_E + \bar{L}_E\right) = 0,\end{aligned} \tag{A9}$$

$$Q\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) - Q\left(\omega_E + \bar{L}_E\right) - (1+r)\bar{L}_M - \phi\left(\omega_M + \bar{L}_M\right) = 0, \tag{A10}$$

and

$$I - \omega_E - \bar{L}_E - \omega_M - \bar{L}_M = 0. \tag{A11}$$

Differentiating equations (A9) to (A11) with respect to I, $\bar{L}_E$, $\bar{L}_M$, and ω_E using Cramer's rule I obtain

$$\begin{aligned}\frac{dI}{d\omega_E} &= \frac{(1+r)\left(1+r+\phi - Q'\left(\omega_E + \bar{L}_E\right)\right)}{\Delta} > 0, \\ \frac{d\bar{L}_E}{d\omega_E} &= \frac{\left(Q'\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) - (1+r+\phi)\right)\left(\phi - Q'\left(\omega_E + \bar{L}_E\right)\right)}{\Delta} > 0,\end{aligned}$$

and

$$\frac{d\bar{L}_M}{d\omega_E} = \frac{(1+r)\left(Q'\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) - Q'\left(\omega_E + \bar{L}_E\right)\right)}{\Delta} < 0,$$

where the determinant, Δ, (defined in Lemma A2) is positive by Lemma A1. The inequalities follow from concavity, Lemma A1, and $\phi < 1$. Differentiating the equations with respect to I, $\bar{L}_E$, and ω_M using Cramer's rule I obtain

$$\frac{dI}{d\omega_M} = \frac{(1+r)\left(1+r+\phi - Q'\left(\omega_E + \bar{L}_E\right)\right)}{\Delta} > 0$$

and

$$\frac{d\bar{L}_E}{d\omega_M} = \frac{0}{\Delta} = 0,$$

where the inequalities follow from Lemma A1 and $\phi < 1$ (the proof that $d\bar{L}_M/d\omega_M > 0$ is provided in Lemma A2). Differentiating the equations with respect to I, $\bar{L}_E$, $\bar{L}_M$, and ϕ using Cramer's rule I obtain

$$\begin{aligned}
\frac{dI}{d\phi} &= \frac{\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right)\left(Q'\left(\omega_E + \bar{L}_E\right) - (1+r+\phi)\right)}{\Delta} < 0, \\
\frac{d\bar{L}_E}{d\phi} &= \frac{\left(\omega_E + \bar{L}_E\right)\left(Q'\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) - (1+r+\phi)\right)}{\Delta} < 0,
\end{aligned}$$

and

$$\begin{aligned}
\frac{d\bar{L}_M}{d\phi} &= \frac{\left(\omega_M + \bar{L}_M\right)\left(Q'\left(\omega_E + \bar{L}_E\right) - (1+r+\phi)\right)}{\Delta} \\
&\quad - \frac{\left(\omega_E + \bar{L}_E\right)\left(Q'\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) - Q'\left(\omega_E + \bar{L}_E\right)\right)}{\Delta},
\end{aligned}$$

where the sign of $d\bar{L}_M/d\phi$ is indeterminate. The inequalities follow from concavity and Lemma A1. Differentiating the equations with respect to I, $\bar{L}_E$, $\bar{L}_M$, and r using Cramer's rule I obtain

$$\begin{aligned}
\frac{dI}{dr} &= \frac{\left(\bar{L}_E + \bar{L}_M\right)\left(Q'\left(\omega_E + \bar{L}_E\right) - (1+r+\phi)\right)}{\Delta} < 0, \\
\frac{d\bar{L}_E}{dr} &= \frac{\bar{L}_M\left(Q'\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) - (1+r+\phi)\right)}{\Delta} < 0,
\end{aligned}$$

and

$$\begin{aligned}
\frac{d\bar{L}_M}{dr} &= \frac{\bar{L}_M\left(Q'\left(\omega_E + \bar{L}_E\right) - (1+r+\phi)\right)}{\Delta} \\
&\quad - \frac{\bar{L}_E\left(Q'\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) - Q'\left(\omega_E + \bar{L}_E\right)\right)}{\Delta},
\end{aligned}$$

where the sign of $d\bar{L}_M/dr$ is indeterminate. The inequalities follow from concavity and Lemma A1. Differentiating the equations with respect to I, $\bar{L}_E$, $\bar{L}_M$, and α using Cramer's rule I obtain

$$\begin{aligned}\frac{dI}{d\alpha} &= \frac{0}{\Delta} = 0,\\ \frac{d\bar{L}_E}{d\alpha} &= \frac{0}{\Delta} = 0,\end{aligned}$$

and

$$\frac{d\bar{L}_M}{d\alpha} = \frac{0}{\Delta} = 0.$$

Table 1, right panel: When $\omega_E < \hat{\omega}_E(r,\phi)$ and $\omega_M \in \left[\hat{\omega}_M^1(r,\phi), \hat{\omega}_M^2(r,\phi)\right)$, the relevant constraints are given by

$$\begin{aligned}\alpha Q\left(\omega_E + \bar{L}_E + \omega_M + L_M\right) + (1-\alpha) Q\left(\omega_E + \bar{L}_E\right) - (1+r)\bar{L}_E - \alpha(1+r) L_M \\ -\alpha\phi\left(\omega_M + \bar{L}_M\right) - \phi\left(\omega_E + \bar{L}_E\right) = 0, \quad \text{(A12)}\\ Q'\left(\omega_E + \bar{L}_E + \omega_M + L_M\right) - (1+r) = 0, \quad \text{(A13)}\end{aligned}$$

and

$$I - \omega_E - \bar{L}_E - \omega_M - L_M = 0. \quad \text{(A14)}$$

Differentiating equations (A12) to (A14) with respect to I, $\bar{L}_E$, L_M, and ω_E using Cramer's rule I obtain

$$\begin{aligned}\frac{dI}{d\omega_E} &= \frac{0}{\Theta} = 0,\\ \frac{d\bar{L}_E}{d\omega_E} &= \frac{Q''\left(\omega_E + \bar{L}_E + \omega_M + L_M\right)\left(\phi - (1-\alpha) Q'\left(\omega_E + \bar{L}_E\right) - \alpha(1+r)\right)}{\Theta} > 0,\end{aligned}$$

and

$$\frac{dL_M}{d\omega_E} = \frac{(1+r) Q''\left(\omega_E + \bar{L}_E + \omega_M + L_M\right)}{\Theta} < 0,$$

where the determinant, Θ, (defined in Lemma A2) is positive by concavity and Lemma A1. The inequalities follow from concavity, Lemma A1, and $\phi < 1$. The remaining comparative-static results with respect to ω_M, ϕ, r, and α are derived in a similar manner and hence omitted. ■

Proof of Proposition 2

The first part establishes the existence and uniqueness of $\phi^*(r,\omega_E)$. The second part shows subsequent lender constellations.

Lemma A5: *There exists a unique threshold, $\phi^*(r, \omega_E)$, such that: $Q(I) - (1+r)\bar{L}_E - \phi\bar{L}_E = 0$, for $\phi = \phi^*(r, \omega_E)$ and $I = I^*(r)$.*

Proof. The threshold $\phi^*(r, \omega_E)$ is the highest level of creditor vulnerability that yields $I = I^*(r)$, when the entrepreneur utilizes bank funds and attains first-best with zero wealth. Hence, $\phi^*(r, \omega_E)$ must satisfy

$$\frac{Q(I^*(r)) - (1+r) I^*(r)}{I^*(r)} = \phi^*(\omega_E). \tag{A15}$$

The threshold is unique if $\bar{L}_E$ is decreasing in ϕ. Totally differentiating (A15) yields

$$\frac{d\bar{L}_E}{d\phi} = \frac{\bar{L}_E}{Q'(\bar{L}_E) - (1 + r + \phi)} < 0,$$

where the inequality is a result of Lemma A1, $Q'(I) \geq (1+r)$, and $\phi < 1$. Finally, $\phi^*(r, \omega_E) > 0$ follows from concavity and $Q'(I) \geq (1+r)$. ■

Lemma A6: *If (i) $\phi \leq \phi^*(r, \omega_E)$ and $\omega_E < I^*(r)$ then entrepreneurs borrow from banks exclusively. If (ii) $\phi > \phi^*(r, \omega_E)$ and $\omega_E < \hat{\omega}_E(r, \phi)$ then entrepreneurs borrow from both banks and moneylenders. Finally, if $\phi > \phi^*(r, \omega_E)$ and $\omega_E \in [\hat{\omega}_E(r, \phi), I^*(r))$ then entrepreneurs borrow from banks exclusively.*

Proof. Part (i): Follows from Lemma A4 and the result of Proposition 1, i.e. that the entrepreneur prefers bank lending to moneylender funds. Parts (ii) to (iii) follow from Proposition 1. ■

Proof of Proposition 4

Proof. There are three relevant cases: (i) $\omega_E < \hat{\omega}_E(r, \phi)$ and $\omega_M < \hat{\omega}_M^1(r, \phi)$; (ii) $\omega_E < \hat{\omega}_E(r, \phi)$ and $\omega_M \in [\hat{\omega}_M^1(r, \phi), \hat{\omega}_M^2(r, \phi))$; and (iii) $\omega_E < \hat{\omega}_E(r, \phi)$ and (a) $\omega_M \in [\hat{\omega}_M^2(r, \phi), I^*(r) - \omega_E)$; or (b) $\omega_E + \omega_M \geq I^*(r)$. Part (i): The equilibrium is given by equations (A9) to (A11). Differentiation with respect to I, ω_M, and ω_E using Cramer's rule while setting $d\omega_M = -d\omega_E$ yields

$$\frac{dI}{d\omega_M} = \frac{0}{\Delta} = 0,$$

where the determinant, Δ, (defined in Lemma A2) is positive by Lemma A1. Part (ii): The equilibrium is given by equations (A12) to (A14). Differentiating these equations with respect to I, ω_M, and ω_E using Cramer's rule while setting $d\omega_M = -d\omega_E$ yields

$$\frac{dI}{d\omega_M} = \frac{0}{\Theta} = 0,$$

where the determinant, Θ, (defined in Lemma A2) is positive by concavity and Lemma A1. Part (iii): The equilibrium is given by

$$\alpha Q\left(\omega_E + \bar{L}_E + B\right) + (1-\alpha) Q\left(\omega_E + \bar{L}_E\right) - (1+r)\bar{L}_E$$
$$-\alpha(1+r)B - \phi\left(\omega_E + \bar{L}_E\right) = 0, \tag{A16}$$
$$Q'(I) - (1+r) = 0, \tag{A17}$$

and

$$I - \omega_E - \bar{L}_E - B = 0. \tag{A18}$$

Define $\Lambda = Q''\left(\omega_E + \bar{L}_E + B\right)\left((1-\alpha)\left(Q'\left(\omega_E + \bar{L}_E\right) - (1+r)\right) - \phi\right)$. Differentiating these equations with respect to I, ω_M, and ω_E using Cramer's rule while setting $d\omega_M = -d\omega_E$ yields

$$\frac{dI}{d\omega_M} = \frac{0}{\Lambda} = 0,$$

where the determinant, Λ, is positive by concavity and Lemma A1. ■

Wealth Reallocation With Heterogeneous Entrepreneurs

I first demonstrate the equality and optimality of investment across the entrepreneurs, given a sufficiently wealthy moneylender (Lemma A7). I then show the conditions for which this holds (Lemma A8).

Lemma A7: *Suppose there are two entrepreneurs and one moneylender with respective wealth $\omega_E^i < \hat{\omega}_E(r,\phi), \omega_E^j < \hat{\omega}_E(r,\phi)$, and $\omega_M < \hat{\omega}_M^1(r,\phi)$ $i \neq j \in (1,2)$. Then investment is (i) equalized and (ii) productive efficiency optimal when the moneylender is sufficiently wealthy to equally satisfy the entrepreneurs' financing needs.*

Proof. Part (i): If the moneylender lends to both entrepreneurs, the repayment obligation is given by $R^i = (1-\alpha)\left(Q\left(I^i\right) - Q\left(\omega_E^i + \bar{L}_E^i\right)\right) + \alpha\left((1+r)\bar{L}_M^i + \phi\left(B^i\right)\right)$ (similarly with respect to R^j). Optimality on part of the moneylender yields $R'\left(B^i\right) = R'\left(B^j\right) \Rightarrow Q'\left(I^i\right) = Q'\left(I^j\right)$ or $I^i = I^j$ by concavity.

Part (ii): Suppose not. The moneylender sets B such that $I^i : I - \epsilon$, $I^j : I + \epsilon$. But then total production decreases, as $Q(I-\epsilon) + Q(I+\epsilon) < 2Q(I)$ by concavity. Hence $I^i = I^j$ maximizes total production. ■

Lemma A8: *Investment is (i) equalized and (ii) production maximized when $\left|\left(\omega_E^i + \bar{L}_E^i\right) - \left(\omega_E^j + \bar{L}_E^j\right)\right| \leq B$, $i \neq j \in (1,2)$.*

Proof. Part (i): Suppose not. If $\left|(\omega_E^i + \bar{L}_E^i) - (\omega_E^j + \bar{L}_E^j)\right| > B$, then B is insufficient to satisfy $\omega_E^i + \bar{L}_E^i + \delta B = I^i = I^j = \omega_E^j + \bar{L}_E^j + (1-\delta) B$, where $\delta \in (0,1)$. Hence, when $\left|(\omega_E^i + \bar{L}_E^i) - (\omega_E^j + \bar{L}_E^j)\right| \leq B$, $I^i = I^j$.

Part (ii): Follows from Lemma A7. ■

Lender Constellations with a Transaction Cost k

Lemma A9: *Suppose $\omega_E < \hat{\omega}_E(r,\phi)$ and $\omega_M < \hat{\omega}_M^1(r,\phi)$ and bank borrowing entails a transaction cost $k > 0$. If (i) $k < Q(\omega_E + \bar{L}_E) - Q(\omega_E) - (1+r)\bar{L}_E \equiv k_E$ and $k < Q(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M) - \alpha Q(\omega_E + \bar{L}_E) - (1-\alpha) Q(\omega_E + \bar{L}_E + \omega_M) - \alpha(1+r)\omega_M - (1+r)\bar{L}_E \equiv k_M$ then the entrepreneur borrows from both a bank and a moneylender and this moneylender borrows from a bank. If (ii) $k < k_E$ and $k > k_M$ then the entrepreneur borrows from both a bank and a moneylender and this moneylender does not borrow from a bank. Finally, if (iii) $k > k_E$ and $k < k_M$ then the entrepreneur borrows from a moneylender and this moneylender borrows from a bank.*

Proof. Adding a cost $k > 0$ associated with bank borrowing then proceeding in a manner similar to the proof of Lemma A3 yields the following cases (the definitions and simplifications of Cases (1) to (5) follow the proof of Lemma A3). Case (1): $U_E^1 = Q(\omega_E + \bar{L}_E) - (1+r)\bar{L}_E - k$; $U_M^1 = 0$. Case (2): $U_E^2 = Q(\omega_E + \bar{L}_E) - (1+r)\bar{L}_E - k$; $U_M^2 = Q(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M) - Q(\omega_E + \bar{L}_E) - (1+r)\bar{L}_M - k$. Case (3): $U_E^3 = Q(\omega_E)$; $U_M^3 = Q(\omega_E + \omega_M + \bar{L}_M) - Q(\omega_E) - (1+r)\bar{L}_M - k$. Case (4): $U_E^4 = \alpha Q(\omega_E + \omega_M) + (1-\alpha) Q(\omega_E) - \alpha(1+r)\omega_M$; $U_M^4 = (1-\alpha)(Q(\omega_E + \omega_M) - Q(\omega_E)) + \alpha(1+r)\omega_M$. Case (5): $U_E^5 = \alpha Q(\omega_E + \bar{L}_E + \omega_M) + (1-\alpha) Q(\omega_E + \bar{L}_E) - \alpha(1+r)\omega_M - (1+r)\bar{L}_E - k$; $U_M^5 = (1-\alpha)\left(Q(\omega_E + \bar{L}_E + \omega_M) - Q(\omega_E + \bar{L}_E)\right) + \alpha(1+r)\omega_M$.

The entrepreneur's preference orderings are given by: (i) $U_E^5 > U_E^2 > U_E^1 > U_E^4 > U_E^3$; (ii) $U_E^5 > U_E^4 > U_E^2 > U_E^1 > U_E^3$; (iii) $U_E^4 > U_E^3 > U_E^5 > U_E^2 > U_E^1$; (iv) $U_E^4 > U_E^5 > U_E^3 > U_E^2 > U_E^1$; or (v) $U_E^4 > U_E^5 > U_E^2 > U_E^1 > U_E^3$. Similarly, the moneylender's preference orderings: (i) $U_M^3 > U_M^2 > U_M^4 > U_M^5 > U_M^1$; (ii) $U_M^3 > U_M^4 > U_M^2 > U_M^5 > U_M^1$; (iii) $U_M^3 > U_M^4 > U_M^5 > U_M^2 > U_M^1$; (iv) $U_M^4 > U_M^5 > U_M^3 > U_M^2 > U_M^1$; or (v) $U_M^4 > U_M^3 > U_M^5 > U_M^2 > U_M^1$. Taken together, this renders 25 possible pairs. However, as in the proof of Lemma A3, there is no $\alpha \in (0,1)$ that simultaneously satisfies $U_E^4 > U_E^2$ and $U_M^4 > U_M^2$, leaving 9 pairs to be analyzed.

Part (i): When k is sufficiently small relative to the entrepreneur's and the moneylender's utility of simultaneously obtaining bank funds, ($k < Q(\omega_E + \bar{L}_E) - Q(\omega_E) - (1+r)\bar{L}_E \equiv k_E$ and $k < Q(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M) - \alpha Q(\omega_E + \bar{L}_E) - (1-\alpha) Q(\omega_E + \bar{L}_E + \omega_M)$

$- \alpha (1+r)\,\omega_M - (1+r)\,\bar{L}_E \equiv k_M)$, Case (2) is the common second-best outcome for the pair of preference orderings: $((i),(i))$, $((i),(ii))$, $((ii),(i))$, and $((v),(i))$.

Part (ii): When k is large relative to the utility of obtaining bank funds for the moneylender, $k > k_M$ (and $k < k_E$) and the moneylender is relatively poor (ω_M is close to zero) while the entrepreneur is relatively rich ($\omega_E \gg 0$), the moneylender and the entrepreneur prefer Case (5) for the following pairs: $((i),(iii))$, $((i),(iv))$, and $((i),(v))$.

Part (iii): Vice versa to Part (ii), when k is large relative to the utility of obtaining bank funds for the entrepreneur, $k > k_E$ (and $k < k_M$) and the entrepreneur is relatively poor (ω_E is close to zero) while the moneylender is relatively rich ($\omega_M \gg 0$), the moneylender and the entrepreneur prefer Case (3) for the following pairs: $((iii),(i))$ and $((iv),(i))$. ■

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Paper 2

Monopoly Banks, Moneylenders, and Usury*

Abstract

The paper demonstrates that monopoly banking can explain both the prevalence of moneylenders and the high effective interest rates in many developing credit markets. When moneylenders are rich relative to entrepreneurs, a monopoly bank can extract more rent by channeling funds through moneylenders than by lending directly to entrepreneurs. The argument rests on the assumption that moneylenders are better than banks at preventing opportunistic behavior of entrepreneurs. When moneylenders are sufficiently rich relative to entrepreneurs, they are less prone to divert bank funds. Therefore, a monopoly bank need not share rents when it lends through the moneylender. Banking competition is the key to both eliminating usurious interest rates charged by moneylenders and promoting investment.

1 Introduction

Market segmentation is a persistent phenomenon in developing credit markets. Despite the coexistence of banks and informal lenders, entrepreneurs frequently obtain credit in the informal sector alone—credit that informal lenders themselves acquire from banks (Floro and Ray, 1997; Bose, 1998; Hoff and Stiglitz, 1998). In this paper, I provide a theory that helps understand why this kind of credit-market segmentation occurs. My theory suggests that the segmented outcome can be explained by banks' market power, and that the usury rates sometimes observed in the informal sector have the same source. Moreover, monopoly banking contributes to the prevalence of informal lending per se.

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In many developing credit markets, both banks and informal lenders—including moneylenders, traders and landlords—are simultaneously active, with a rich array of lender-borrower constellations arising as a consequence. Specifically, entrepreneurs are observed to take credit from both sectors at the same time, as well as resorting to exclusive contracts (see, for example, Conning, 2001; Giné, 2005). Likewise, informal lenders often obtain bank finance to service their borrowers in turn (see, for example, Ghate et al., 1992; Hoff and Stiglitz, 1993; Irfan et al., 1999). In this setting, two key differences distinguish banks from informal lenders. First, informal lenders possess a monitoring advantage over their formal counterpart, as they offer credit to a group of known clients where social ties and social sanctions prevent opportunistic behavior on the part of the borrowers.[1] Second, informal lenders frequently lack funds while banks do not.

Existing theory has modeled informal lenders either as competitors of the bank sector (Bell et al., 1997; Jain, 1999; Varghese, 2005) or as a channel of formal funds (Floro and Ray, 1997; Bose, 1998; Hoff and Stiglitz, 1998). However, this literature is lacking in two respects. First, is not clear whether informal lenders compete with banks or primarily engage in channeling funds. Second, it neglects the potential agency problem between the informal lender and the bank. Following Madestam (2005*a*), this paper reconciles existing approaches by allowing for both competition and channeling of funds while deriving endogenous constraints on informal lending. The main innovation compared to Madestam (2005*a*) is to allow market power in the formal banking sector rather than assume perfect competition. The introduction of market power pemits a comparison between the two banking regimes and yields fruitful insights.

A monopoly bank contracts exclusively with informal lenders, rather than with entrepreneurs or a combination of the two, when informal lenders are sufficiently rich relative to entrepreneurs. This result can be understood intuitively in the following way. When lending directly to a poor entrepreneur, the bank must share rents with the entrepreneur so as to avoid diversion of bank funds. Lending through informal lenders who are sufficiently wealthy not to be tempted by diversion means that a monopoly bank need not share rents. In contrast, competitive banks have no influence over resulting lender constellations (as long as they break even), so competitive bank credit is extended to both entrepreneurs and informal lenders, as this maximizes the

[1] Informal lenders have also been characterized as having a superior ability to screen borrowers. The present contribution chooses to focus on their monitoring advantage, however Section 2 offers some discusison on this issue. For evidence of the highly personal character of informal lending see, for example, Udry (1993), Steel et al. (1997), and La Ferrara (2003) for the case of Africa and Ghate et al. (1992), Aleem (1993), and Bell (1993) for the case of Asia.

borrowers' aggregate payoff.

The segmented outcome offers a simple explanation for the usury rates sometimes observed in the informal sector. Traditionally, excessively high rates have been rationalized on the grounds of pure exploitation (Bhaduri, 1973, 1977), and more recently as a response to the transaction costs involved in informal lending (see Banerjee, 2003 for an overview). Within the present framework, the price of informal credit is a decreasing function of the entrepreneur's reservation payoff. The fact that the entrepreneur has no real outside option in the segmented equilibrium—other than investing her own wealth—rationalizes why the informal lender is able to charge high rates of interest, providing a rationale for Bhaduri's claim when the bank is a monopoly. Moreover, because segmentation potentially benefits both informal lenders and the monopoly bank, this may explain why many less-developed credit markets are characterized by considerable market power in the bank sector.

When the aggregate debt capacity of the entrepreneur *and* the informal lender constrains investment, the monopoly bank (like its competitive counterpart) lends to both agents. At these low levels of wealth, the entrepreneur and the moneylender need to receive a net surplus relative to their respective outside opportunities. By lending to both, the monopolist minimizes the aggregate incentive rent paid out. In this instance, monopoly banking both reduces total lending and increases the importance of informal finance. Intuitively, by charging a high price the monopolist lowers borrowers' incentive to repay. Hence, high interest rates must be coupled with less lending to be incentive compatible. As noted in Madestam (2005*b*), this has the following implications: high monopoly interest rates reduce lending and investment compared to the competitive outcome, and as the monopolist wants to minimize borrower rents and rents increase in wealth, higher wealth induces a reduction in lending to keep rents low. Informal funds thus become increasingly important as the informal lender's debt capacity improves, since a rise in informal wealth generates an equivalent decrease in bank finance.

As mentioned, there are other theories of the consequences of credit-market segmentation, notably Floro and Ray (1997), Bose (1998), and Hoff and Stiglitz (1998). A unifying theme of these contributions is their focus on understanding the negative effects of a formal credit expansion on the rates offered by informal lenders. Bose (1998) and Hoff and Stiglitz (1998) show that subsidized bank credit may induce informal lenders to enter the market, leading to higher informal enforcement costs, while Floro and Ray (1997) consider how the expansion of formal credit increases informal lenders' ability to collude amongst themselves. The end effect in all three cases is that informal rates increase. Besides failing to address the potential agency problem between the formal and informal lender, none of the theories make clear why segmentation occurs in the first place. Madestam (2005*a*) offers an explanation by assuming that there exists a transaction cost associated with bank borrowing. He shows that for a sufficiently high cost, the entrepreneur will resort to the informal lender alone to raise capital for her project. Meanwhile the informal lender takes bank credit. The asymmetry in formal access is explained by dispersion in the asset distribution, where segmentation occurs when the entrepreneur is relatively poor while the informal lender is relatively wealthy. The present theory explains segmentation without recourse to transaction costs and should thus be seen as complementary to existing work.

Finally, my approach yields some useful policy insights. For example, measures promoting banking competition would improve not only financial access and the aggregate volume of credit granted, but also reduce the rates charged by banks and informal lenders alike. Although such policies run the danger of being opposed by powerful vested interests—backed by informal lenders' and monopoly banks' preference for market segmentation—this paper identifies market power of banks (entry restrictions) as a more important area of concern for policymakers than failed banking regulation (in the form of credit subsidies or anti-usury laws).

The remainder of the paper is structured as follows. The next section introduces the model while Section 3 presents equilibrium outcomes under the different banking regimes and provides a discussion of the findings. Section 4 concludes.

2 Model

Consider a credit market consisting of risk-neutral entrepreneurs, banks, and moneylenders (who provide informal finance). As noted in the Introduction, moneylenders have a monitoring advantage over banks. In particular, I assume that banks are unable to control the way their borrowers use extended funds, whereas moneylenders can ensure that credit granted is fully-invested.[2] The entrepreneur is endowed with observable wealth $\omega_E \geq 0$. She has access to a deterministic production function $Q(I)$, where I is the volume of investment. The production function is assumed to be concave and twice continuously differentiable. To ensure the existence of an interior solution, it is assumed that $Q(0) = 0$ and $Q'(0) = \infty$. In a perfect credit market with interest rate r, the entrepreneur would like to invest enough to attain the first-best level of investment

[2] See Madestam (2005*a*) for a fuller discussion of the assumption that the moneylender is able to monitor entrepreneurial investment ex ante.

given by $Q'(I^*) = 1 + r$.[3] However, the entrepreneur lacks sufficient capital to realize this level, $\omega_E < I^*(r)$, and is thus forced to resort to the bank and/or the moneylender for remaining funds.[4]

The moneylender is endowed with observable wealth $\omega_M \geq 0$. To capture his superior ability in monitoring investment, the lender is assumed to be a monopolist.[5] For simplicity, the moneylender's occupational choice is restricted to lending. A contract between the moneylender and the entrepreneur is given by a pair $(B, R) \in \mathbb{R}_+^2$, where B is the amount borrowed by the entrepreneur and R the repayment obligation. The contract terms are settled in a bilateral bargain, given by the generalized Nash Bargaining Solution. Assume for now that $R(B)$ is a primitive that shares the same properties as the production function.[6] Finally, if the moneylender requires additional funding he turns to the bank.

The bank is competitive, has access to unlimited funds at a constant unit cost ρ, and offers a contract (L_i, D_i), where L_i is the loan and D_i the amount to be repaid, $i = E, M$. As stressed above, however, investment or informal lending of bank funds cannot be taken for granted. Specifically, I assume that entrepreneurs (moneylenders) are unable to commit to invest bank funds (offer credit) and that diversion of assets yields private benefits. Diversion denotes any activity that is less productive than investment (lending), for example, using the assets for consumption or financial saving. The diversion activity yields benefit $\phi < 1$ for every unit diverted. While investment (lending) is unverifiable, the outcome of the entrepreneur's project (moneylender's lending operation) may be verified. Entrepreneurs and moneylenders thus face the following trade off: either the entrepreneur invests, in which case she realizes the net benefit of production after repaying the bank (and possibly the moneylender), or she profits directly from diverting bank funds (the entrepreneur will still have to pay the moneylender if she has borrowed from him). In the case of partial diversion, the remaining amount must be repaid in full. Likewise, the moneylender may either extend a loan to the entrepreneur, realizing the net-lending profit after compensating the bank, or benefit directly from diverting the loan. In the case of partial diversion,

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[3] The output price, p, is normalized to one.

[4] As a tie-breaking rule, I assume that the entrepreneur prefers higher investment for the same level of utility, and one lender over two lenders for the same level of utility and investment. I also assume that bank borrowing ceases when an agent's debt capacity exceeds the first-best investment level.

[5] The assumption of exclusivity is also in line with empirical evidence, see Aleem (1993) and Siamwalla et al. (1993).

[6] Any simple sharing rule would do as long as the payment is increasing (decreasing) in the moneylender's (entrepreneur's) outside option.

the moneylender repays the remaining amount to the bank in full. The bank is assumed not to derive any benefit from resources that are diverted. When ϕ is equal to zero, legal protection of banks is perfect and there is no agency problem. To make the problem interesting, assume that

$$\phi > \underline{\phi} \equiv \frac{Q\left(I^*\left(r\right)\right) - \left(1+r\right)\left(I^*\left(r\right) - \omega_E\right)}{I^*\left(r\right)}. \tag{1}$$

In other words, the marginal benefit of diversion yields higher utility than the average rate of return to a first-best investment. As a bank loan is the entrepreneur's outside option in her bargaining with the moneylender, it is optimal for the entrepreneur to visit the bank before turning to the moneylender.[7] After viewing both contract offers, the entrepreneur decides how much to borrow and from whom. Likewise, if wealth constrained, the moneylender also considers the bank contract before bargaining with the entrepreneur.

The sequence of events is characterized as follows:

1. The bank offers a contract, (L_i, D_i), to the entrepreneur and the moneylender respectively.
2. The entrepreneur decides how much she wants to borrow from the moneylender, B, and they bargain over the repayment, R.
3. The moneylender makes his lending/diversion decision.
4. The entrepreneur makes her investment/diversion decision.
5. Repayments are made.

3 Equilibrium Outcomes and Discussion

I will begin by analyzing the competitive bank market as a benchmark. Without loss of generality, I follow Burkart and Ellingsen (2004) and focus on contracts of the form $\{(L_i, (1+r)\, L_i)\}_{L_i \leq \bar{L}_i}$, where $\bar{L}_i$ specifies the credit limit of funds extended by the bank.[8] The contract implies that a borrower may withdraw any amount of funds until the bank credit limit binds. To keep things simple, borrowers only borrow from one bank at a time. I solve for the subgame perfect equilibrium outcome and begin with the

[7] The timing is also empirically supported by Bell et al. (1997).

[8] In a framework similar to the present paper, Burkart and Ellingsen (2002) show that $\{(L_i, (1+r)\, L_i)\}_{L_i \leq \bar{L}_i}$ constitutes an optimal contract.

entrepreneur's borrowing and investment decisions. If wealth constrained, she chooses the amount of bank funds to invest, I_B, and the amount of credit, L_E, by maximizing

$$U_E = \max\{0, Q(I_B + B) - (1+r)L_E - R(B)\} + \phi(\omega_E + L_E - I_B), \qquad (2)$$

subject to

$$\begin{aligned} \omega_E + L_E &\geq I_B, \\ \bar{L}_E &\geq L_E. \end{aligned}$$

The first part of expression (2) is the profit from investing. The second part denotes the profit from diversion. The full expression is maximized subject to available funds and the credit limit posted by the bank. Note that B, the amount borrowed from the moneylender, is free from the entrepreneur's potential opportunistic behavior. It can be shown that the investment choice is essentially binary; either the entrepreneur chooses to invest all the money or she diverts the maximum possible.[9] The entrepreneur will not be tempted to behave opportunistically if the contract satisfies the incentive constraint

$$Q\left(\omega_E + L_E^u + B\right) - (1+r)L_E^u - R(B) \geq \phi\left(\omega_E + \bar{L}_E\right), \qquad (3)$$

where $L_E^u = \min\left\{I^*(r) - \omega_E - B, \bar{L}_E\right\}$. In other words, either the entrepreneur borrows and invests such that the first-best level of investment is achieved or she exhausts the maximum credit line extended by the bank.

Similarly, the moneylender chooses the amount to lend to the entrepreneur, B, and the amount of credit, L_M, by maximizing

$$U_M = \max\{0, R(B) - (1+r)L_M\} + \phi(\omega_M + L_M - B),$$

subject to

$$\begin{aligned} \omega_M + L_M &\geq B, \\ \bar{L}_M &\geq L_M. \end{aligned}$$

The outcome is analogous to that of the entrepreneur, yielding the critical incentive constraint

$$R(\omega_M + L_M^u) - (1+r)L_M^u \geq \phi\left(\omega_M + \bar{L}_M\right), \qquad (4)$$

[9] Neither partial investment nor diversion are optimal. Investing yields the entrepreneur at least $1+r$ on every dollar invested, while diversion leaves her with only ϕ. If the entrepreneur plans to divert resources, there is no reason to invest either borrowed or internal funds as the bank would claim all of the returns.

where $L_M^u = \min\{I^*(r) - \omega_M - \omega_E - L_E^u, \bar{L}_M\}$. In sum, whereas the entrepreneur contemplates whether or not she should invest the bank funds (expression (3) above), the moneylender's decision problem concerns whether or not he should lend the bank funds to the entrepreneur (expression (4) above).

I now determine the repayment function as shaped by Nash Bargaining. The entrepreneur's inside option is given by the net benefit of investing the funds extended from the bank and the moneylender, while her outside option is the residual return from investing bank funds alone.[10] The moneylender's inside option is the repayment less the cost of borrowing the money from the bank, while the outside option is the utility from diverting all funds. The equilibrium repayment is given by

$$\max_{\{R\}} [Q(I) - (1+r) L_E^u - R - (Q(\omega_E + L_E^u) - (1+r) L_E^u)]^{\alpha} \times \left[R - (1+r) L_M^u - \phi\left(\omega_M + \bar{L}_M\right)\right]^{1-\alpha}, \quad (5)$$

where $\alpha \in (0,1)$ represents the bargaining power of the entrepreneur. The investment level with credit extended by the bank and the moneylender equals $I = \omega_E + L_E^u + B = \omega_E + L_E^u + \omega_M + L_M^u$, while the stand-alone investment level utilizing bank funds is given by $\omega_E + L_E^u$. The bargaining outcome that solves (5) is

$$R^* = (1-\alpha)(Q(I) - Q(\omega_E + L_E^u)) + \alpha\left((1+r) L_M^u + \phi\left(\omega_M + \bar{L}_M\right)\right).^{11} \quad (6)$$

Finally, the perfectly competitive bank market yields the equilibrium zero-profit interest rate of ρ.

For low levels of wealth the entrepreneur and the moneylender will be credit rationed by the bank. Here the temptation to divert for each of them is too strong to permit bank lending supporting a first-best investment. Specifically, the entrepreneur exhausts her credit line with the bank in addition to borrowing the maximum amount made available to her from the moneylender. Likewise, the moneylender utilizes all available bank funds and his own capital to service the entrepreneur. Note that the entrepreneur's first choice would be to borrow from the bank and the moneylender, where the latter only lends his own capital. This increases the entrepreneur's outside option while keeping the outside option of the moneylender to a minimum. In other words, the entrepreneur

[10] The outside option of the entrepreneur is given by borrowing from the bank alone. The reason is that the relationship with the moneylender builds on exclusivity. See Sutton (1986) and Binmore et al. (1989), for work where the outside option implies breaking up the current relationship.

[11] R^* satisfies the incentive constraints of the entrepreneur and the moneylender. R^* also captures the empirical regularity that wealthier entrepreneurs pay lower rates of informal interest (see Banerjee, 2003 and references therein). To see this, note that $d[(R^* - B)/B]d\omega_E < 0$.

prefers to borrow less at a more favorable rate. Similar logic yields the result that the moneylender favors being the exclusive borrower of the bank, thus reducing the value of the entrepreneur's threat point. Nonetheless, as each agent has access to bank funding, the common second-best option is for both to borrow from the bank. Finally, the competitive bank has no influence over resulting lender constellations, as long as it breaks even.

Hence, the credit limits will be given by the following binding constraints of the entrepreneur and the moneylender, depending on the bargaining outcome:

$$\alpha Q(I) + (1-\alpha) Q\left(\omega_E + \bar{L}_E\right) - (1+r)\bar{L}_E - \alpha(1+r)\bar{L}_M \\ -\alpha\phi\left(\omega_M + \bar{L}_M\right) - \phi\left(\omega_E + \bar{L}_E\right) = 0 \tag{7}$$

and

$$Q(I) - Q\left(\omega_E + \bar{L}_E\right) - (1+r)\bar{L}_M - \phi\left(\omega_M + \bar{L}_M\right) = 0, \tag{8}$$

with $I = \omega_E + \bar{L}_E + \omega_M + \bar{L}_M$.

As the moneylender becomes wealthier, his bank credit limit no longer binds and he is able to borrow and lend enough to satisfy the first-best level of investment. Although preferences diverge in similar spirit to the previous equilibrium, the same outcome is obtained when the entrepreneur borrows from both a bank and a moneylender (who lends his own and bank funds). Hence, the entrepreneur's credit limit is still given by equation (7), while the moneylender's credit line is determined by

$$Q'(I) - (1+r) = 0. \tag{9}$$

That is, the equation $I^*(r) = \omega_E + \bar{L}_E + \omega_M + L_M$ determines L_M.

When the moneylender is wealthy enough to self-finance larger parts (or the entire amount) of a first-best investment, he no longer acquires bank funds. In this case, the entrepreneur borrows from both a bank and a moneylender, where the latter services the entrepreneur with his own capital. In this instance, the entrepreneur's incentive constraint yields

$$\alpha Q(I^*(r)) + (1-\alpha) Q\left(\omega_E + \bar{L}_E\right) - (1+r)\bar{L}_E - \alpha(1+r)B - \phi\left(\omega_E + \bar{L}_E\right) = 0, \tag{10}$$

with $I^*(r) = \omega_E + \bar{L}_E + B$, and $B \leq \omega_M$. As the informal lender has no bank loan, his outside option changes from $\phi\left(\omega_M + \bar{L}_M\right)$ to $(1+r)B$.[12] Finally, a sufficiently

[12] The moneylender's outside option is now given by the equivalent of depositing the funds in the bank instead of lending them to the entrepreneur. The deposit and lending rates will equal the alternative cost of funds in the economy, ρ, if deposits and bank funds are in excess supply.

wealthy entrepreneur will realize the first-best level by borrowing exclusively from the bank. Equilibrium outcomes are summarized in Proposition 1.[13]

Proposition 1: *There are wealth thresholds* $\hat{\omega}_E(r,\phi) > 0$ *and* $\hat{\omega}_M^2(r,\phi) > \hat{\omega}_M^1(r,\phi) > 0$ *such that:*

(i) If $\omega_E < \hat{\omega}_E$ *and* $\omega_M < \hat{\omega}_M^1$ *then investment is credit constrained* $(I < I^*(r))$*. The entrepreneur borrows from both a bank and a moneylender and this moneylender borrows from a bank.*

(ii) If $\omega_E < \hat{\omega}_E$ *and* $\omega_M \in [\hat{\omega}_M^1, \hat{\omega}_M^2)$ *then the first-best level is invested* $(I = I^*(r))$*. The entrepreneur borrows from both a bank and a moneylender and this moneylender borrows from a bank.*

(iii) If $\omega_E < \hat{\omega}_E$ *and (a)* $\omega_M \in [\hat{\omega}_M^2, I^*(r) - \omega_E)$ *or (b)* $\omega_E + \omega_M \geq I^*(r)$ *then the first-best level is invested* $(I = I^*(r))$*. The entrepreneur borrows from both a bank and a moneylender and this moneylender does not borrow from a bank.*

(iv) If $\omega_E \geq \hat{\omega}_E$ *then the first-best level is invested* $(I = I^*(r))$ *and the entrepreneur borrows exclusively from a bank.*

Proof: See Appendix.

The entrepreneur's threshold $\hat{\omega}_E$ refers to the debt capacity at which a first-best investment is realized without informal funds, whereas $\hat{\omega}_M^1$ denotes the level of moneylender wealth where first-best is attained given a bank-rationed entrepreneur. The moneylender's upper threshold $\hat{\omega}_M^2$ shows the amount of informal wealth that satisfies the first-best level when the rationed entrepreneur alone takes bank credit. (Part (b) states that the same outcome is obtained when the moneylender is able to self-finance larger parts of the needed investment.)

Enter the monopolist lender. Contrary to a competitive bank, the monopolist sets the price of lending *and* the loan size simultaneously, making borrowers a take-it-or-leave-it offer (L_i, D_i). Finally, first-best is given by $Q'(I^*) = (1+\rho)$, which is identical to the competitive bank market (as $r = \rho$ due to competition). The monopolist sets L_i and D_i by maximizing

$$U_B = D_E + D_M - (1+\rho)(L_E + L_M), \tag{11}$$

[13] Madestam (2005*a*) shows that the equilibrium outcomes are collusion-proof.

subject to

$$
\begin{aligned}
Q(\omega_E+L_E+B) - D_E - R(B) &\geq \alpha Q(\omega_E+B) + (1-\alpha)Q(\omega_E) - \alpha(1+\rho)B, \\
R(B) - D_M &\geq (1-\alpha)(Q(\omega_E+L_E+B) - Q(\omega_E+L_E)) + \alpha(1+\rho)B, \\
D_E &\geq (1+\rho)L_E, \\
D_M &\geq (1+\rho)L_M,
\end{aligned}
$$

and the incentive compatibility constraints (3) and (4). The first and second inequalities denote the entrepreneur's and moneylender's participation constraint showing the utility of investing (lending) internal funds,[14] while the last two expressions ensure non-negative bank profits. Note that D_i replaces $(1+r)L_i$, with the borrower choosing whether or not to accept the offer, and consequently the amount to invest (lend). It follows immediately that the relevant incentive or participation constraint must bind, otherwise the bank could increase D_i and earn a strictly positive profit. Optimal loan sizes and resulting equilibrium constellations remain to be determined.

With a poor entrepreneur and a poor moneylender, the bank lends to both agents with the moneylender forwarding funds to the entrepreneur. Here both incentive constraints hold with equality and the bank's profit may be written as $Q(I) - \phi I - (1+\rho)(L_E + L_M)$, with $I = \omega_E + L_E + \omega_M + L_M$. The first-order condition of the bank's profit expression determines the optimal loan size, whereas D_i is defined as the solution to each respective incentive constraint. The profit expression indicates that there is a unique aggregate loan size, L $(= L_E + L_M)$, although the division of the loan is arbitrary within a given range. Let $L_E = \beta L$ and $L_M = (1-\beta)L$, $\beta \in (\beta_1, \beta_2)$ for $0 < \beta_1 < \beta_2 \leq 1$ (defined below). Hence, L is the unique loan size that solves

$$Q'(I) - (1+\rho+\phi) = 0, \tag{12}$$

while D_E and D_M are determined by

$$
\begin{aligned}
\alpha Q(I) + (1-\alpha) Q(\omega_E + L) - D_E - \alpha D_M - \alpha\phi(\omega_M + (1-\beta)L) \\
-\phi(\omega_E + \beta L) = 0
\end{aligned} \tag{13}
$$

and

$$Q(I) - Q(\omega_E + L) - D_M - \phi(\omega_M + (1-\beta)L) = 0, \tag{14}$$

[14] A borrower receives the utility-equivalent without bank funding when the inequality binds. Meanwhile the other borrower's constraint may still be slack, explaining why $L_E \geq 0$ appears on the right-hand side of the moneylender's participation constraint.

with $I = \omega_E + \omega_M + L$. While the competitive outcome minimizes banks' aggregate payoff, the monopoly outcome maximizes this payoff allowing the monopolist to optimally adjust the loan size and consequent investment (as expressed in (12)). At this level of investment, lending to both the entrepreneur and the moneylender limits the use of bank funds compared to lending to the entrepreneur alone when she is restricted to bank capital. It also dominates exclusive contracts with the moneylender or entrepreneur when she obtains informal funds.

To understand this outcome, note that the bank's main objective is to minimize the rent shared with its borrowers, or equivalently, to charge the highest incentive compatible price for a given level of investment. In particular, if the bank contracts exclusively with the entrepreneur it would forgo substantial rents to prevent opportunistic behavior. However, for the same level of investment (given by (12)), the bank can decrease the entrepreneur's net surplus by shifting part of the loan (decreasing β) to the moneylender. The reallocation increases the rent kept by the bank as the moneylender's participation constraint initially binds for values above β_2, enabling the bank to charge the lender a higher price without having to worry about diversion. The process continues until the poor moneylender *and* the poor entrepreneur both experience binding incentive constraints when $\beta \in (\beta_1, \beta_2)$. Conversely, if the bank was to lend the full amount to the moneylender, it could increase its own rent by moving part of the loan to the entrepreneur whose participation constraint initially binds for values below β_1, with the same end result. Finally, and similar to the competitive case, the entrepreneur and the moneylender opt for the same outcome as the bank.

As the moneylender's debt capacity increases, the bank lends exclusively to the informal lender who in turn supplies the entrepreneur. Here the moneylender's repayment obligation D_M solves the binding participation constraint

$$\begin{aligned}(1-\alpha)\left(Q\left(I\right)-Q\left(\omega_E\right)-D_M\right)+\alpha\left(1+\rho\right)\omega_M-(1-\alpha)\left(Q\left(\omega_E+\omega_M\right)-Q\left(\omega_E\right)\right)\\ -\alpha\left(1+\rho\right)\omega_M=0 \qquad (15)\end{aligned}$$

and the bank loan is determined by the first-order condition

$$Q'\left(I\right)-\left(1+\rho\right)=0, \qquad (16)$$

with $I^*\left(\rho\right)=\omega_E+\omega_M+L_M$. Strikingly, this outcome indicates that the entrepreneur no longer has direct access to bank funds. As before, the bank's main concern is to charge the highest price possible. The difference from above, however, is that the moneylender is sufficiently wealthy not to be tempted by diversion, implying that the bank no longer needs to share rents with him. Meanwhile, the poor entrepreneur's outside option remains diverting the bank's funds. Hence, the way to keep this option as low as possible is to *not* lend to the entrepreneur at all.

Moreover, a more detailed argument shows that by dealing with the moneylender alone, the bank reduces his outside option because the entrepreneur's lack of bank credit implies that she in turn requires a lower payoff from the informal lender. A contract with the moneylender (rather than both agents) thus saves the bank rent otherwise accrued by the moneylender. Likewise, the moneylender prefers the segmented outcome as it maximizes his net return. Although the exclusive contract leaves the moneylender with less bank rent, he is able to charge the entrepreneur a larger amount (compared to the co-lending regime), as the entrepreneur's threat point is reduced given her lack of bank funds.

Interestingly, bank debt is strategic in the sense that the bank favors lending to the moneylender even when he is sufficiently wealthy to self-finance larger parts of a first-best investment. By comparison, in the competitive scenario the entrepreneur becomes the exclusive customer of the bank as soon as her debt capacity together with the moneylender's wealth satisfies first-best (Proposition 1: (iii), part (a)). The difference is that the competitive bank cannot refuse the entrepreneur a loan, implying that she fully exhausts her credit line. The monopoly bank, however, prefers to extend credit to the moneylender until $\omega_E + \omega_M = I^*(\rho)$, as this yields the bank a higher profit.

The segmented outcome offers an explanation for the usury rates sometimes observed in developing credit markets. To see this, suppose the informal lender holds all of the bargaining power ($\alpha \to 0$). The utility of the entrepreneur becomes

$$\lim_{\alpha \to 0} \alpha Q(\omega_E + \omega_M) + (1-\alpha) Q(\omega_E) - \alpha (1+\rho) \omega_M = Q(\omega_E), \tag{17}$$

while the moneylender obtains

$$\lim_{\alpha \to 0} (1-\alpha)(Q(\omega_E + \omega_M) - Q(\omega_E)) + \alpha(1+\rho)\omega_M = Q(\omega_E + \omega_M) - Q(\omega_E). \tag{18}$$

Hence, with a monopoly bank and a moneylender keeping the entire surplus, the entrepreneur receives her autarky utility as she faces a "double marginalization" on the price of credit. This can be compared with the equivalent situation in the competitive bank market. Suppose first that we are in the equilibrium where both the entrepreneur and the moneylender obtain bank funds (Proposition 1: (ii)). For α approaching zero, the entrepreneur gains $Q(\omega_E + \bar{L}_E) - (1+r)\bar{L}_E > Q(\omega_E)$ and the moneylender receives $Q(I) - Q(\omega_E + \bar{L}_E) - (1+r)\bar{L}_M \gtreqless Q(\omega_E + \omega_M) - Q(\omega_E)$. It is less clear what happens for $\alpha \in (0,1)$, as the bargaining outcome between the entrepreneur and the moneylender under competitive banking leaves the moneylender compensation equivalent to diversion $\left(\alpha\phi\left(\omega_M + \bar{L}_M\right)\right)$, a payoff not actually realized since the moneylender is sufficiently wealthy not to be tempted by diversion.

However, the model gives clear predictions if monopoly bank credit is strategic in the sense discussed above, while competition renders an outcome where the entrepreneur obtains bank credit and informal funds and the moneylender refrains from bank funding (Proposition 1: (iii), part (a)). Here, the entrepreneur always receives higher utility in the competitive bank market, whereas the opposite is true for the moneylender.[15] In sum, the lack of real outside options other than investing internal funds rationalizes why the entrepreneur fares much worse in the monopoly banking regime.

When $\omega_E + \omega_M \geq I^*(\rho)$, the entrepreneur obtains funding from the bank and the moneylender, who self-finances his lending operation. The bank is forced to lend at zero profit because the break-even rate is the only interest price consistent with the entrepreneur obtaining funds from both lenders and attaining a first-best investment. Bank credit and moneylender funds are given by

$$\alpha Q(I) + (1-\alpha) Q(\omega_E + L_E) - (1+\rho) L_E - \alpha(1+\rho) B - \phi(\omega_E + L_E) = 0 \quad (19)$$

and

$$Q'(I) - (1+\rho) = 0, \quad (20)$$

where $B < \omega_M$ and $I^*(\rho) = \omega_E + L_E + B$. Notice that this equilibrium perfectly resembles the competitive scenario (expressions (9) and (10)). When the two lenders supply their own funds, the monopoly bank loses its pricing power over the entrepreneur despite being the only formal intermediary. Finally, when the entrepreneur is sufficiently wealthy, her participation constraint holds with equality and she takes credit from the bank alone to satisfy a first-best investment. Proposition 2 recapitulates the findings.[16]

[15] To see this, note that the net entrepreneurial surplus associated with competitive banking yields $\alpha\left(Q\left(I^*(r)\right) - Q(\omega_E + \omega_M) - (1+r)\left(\bar{L}_E + L_M\right)\right) + (1-\alpha)\left(Q\left(\omega_E + \bar{L}_E\right) - Q(\omega_E) - (1+r)\bar{L}_E\right) + \alpha(1+r)(\omega_M - B) > 0$, by concavity and $Q'(I) \geq 1+r$, while the moneylender obtains $(1-\alpha)\left(Q\left(I^*(r)\right) + Q(\omega_E) - Q(\omega_E + \omega_M) - Q\left(\omega_E + \bar{L}_E\right)\right) - \alpha(1+r)(\omega_M - B) < 0$, by concavity.

[16] Equilibrium outcomes are collusion proof. For example, in Proposition 2: (i) either one of the two agents prefers to be an exclusive bank borrower, opening up the possibility of side-payments. Since assets are used most efficiently in production, a bribe to the bank must occur *after* payments are realized as it otherwise reduces the amount invested. Suppose however that the moneylender credibly commits to leave the bank the net benefit $\phi\beta L$ that is obtained when the bank lends exclusively to him. This amount must exceed the bank's net benefit of lending to the moneylender alone, $Q(\omega_E) - \phi\omega_E$. The best scenario from the moneylender's perspective is when $\omega_E = 0$, as this leaves the bank indifferent. However, here $\phi\beta L$ amounts to what the entrepreneur is willing to give the bank to remain in the co-lending equilibrium. Thus, even under the assumption that the moneylender can credibly commit to pay, a bribe would not change the outcome. Similar reasoning yields that remaining equilibria are also insensitive to collusion.

Proposition 2: *There are wealth thresholds* $\tilde{\omega}_E(\rho,\phi) > 0$ *and* $\tilde{\omega}_M(\rho,\phi) > 0$ *such that:*
(i) If $\omega_E < \tilde{\omega}_E$ *and* $\omega_M < \tilde{\omega}_M$ *then investment is credit constrained* $(I < I^*(\rho))$*. The entrepreneur borrows from both a bank and a moneylender and this moneylender borrows from a bank.*
(ii) If $\omega_E < \tilde{\omega}_E$ *and* $\omega_M \in [\tilde{\omega}_M, I^*(\rho) - \omega_E)$ *then the first-best level is invested* $(I = I^*(\rho))$*. The entrepreneur borrows from a moneylender and this moneylender borrows from a bank.*
(iii) If $\omega_E < \tilde{\omega}_E$ *and* $\omega_E + \omega_M \geq I^*(\rho)$ *then the first-best level is invested* $(I = I^*(\rho))$*. The entrepreneur borrows from both a bank and a moneylender and this moneylender does not borrow from a bank.*
(iv) If $\omega_E \geq \tilde{\omega}_E$ *then the first-best level is invested* $(I = I^*(\rho))$ *and the entrepreneur borrows exclusively from a bank.*

Proof: See Appendix.

Monopoly banking not only affects equilibrium outcomes but also the mechanisms that explain market behavior, the relative importance of the informal lender, and resulting investment levels. To see the first two points, I examine effects of changing the parameters in the model when the aggregate debt capacity of the entrepreneur and the moneylender constrains investment.

Proposition 3: *(i) When* $\omega_E < \hat{\omega}_E$ *and* $\omega_M < \hat{\omega}_M^1$ *then investment, I, and competitive credit,* $\bar{L}_E$ $(\bar{L}_M)$*, are increasing in borrower wealth* ω_E (ω_M)*. (ii) When* $\omega_i < \tilde{\omega}_i$ *then monopoly credit, L, is decreasing in borrower wealth,* ω_i*, while I is independent of* ω_i*.*

Proof: See Appendix.

For low debt capacities, bank credit expands continuously in the competitive environment, while neither borrower reaps the benefits of marginal wealth increases in the monopolistic setting. In fact, an increase in the entrepreneur's or moneylender's assets generates less monopoly bank credit—not more—implying that wealth and monopolistic credit are substitutes, while complements in the competitive bank market. This result hinges crucially on the fixed investment level given by expression (12). Because the monopolist wants to minimize borrower rents and rents increase in wealth, higher wealth induces a reduction in lending to keep rents low.

An additional feature of monopoly banking is the pronounced importance of the informal over the formal sector. Define the share of informal funds in investment as

$$\frac{\omega_M}{\omega_E + L_E + \omega_M + L_M}. \tag{21}$$

Proposition 3 tells us that this fraction increases in ω_M with a monopolistic bank, while it decreases in the competitive bank market. Intuitively, whereas the monopoly bank substitutes credit for the constrained moneylender's wealth, its competitive counterpart raises lending in tandem with increased debt capacity. When the first-best level of investment is realized, bank market structure no longer matters as investment is constant across the two regimes.

Finally, it is worth noting that a monopoly bank reduces aggregate lending and subsequent investment. By charging a high price the monopolist lowers borrowers' incentive to repay. Hence, high interest rates must be coupled with less lending and, as a consequence, lower investment. Specifically, the monopolist extends credit until marginal revenue of an additional dollar lent, $Q'(I)$, equals the opportunity cost of additional funds, together with the increased risk of opportunistic behavior that follows from more liberal lending, $(1 + \rho + \phi)$. A complementary way of understanding this result is to notice that monopoly banking increases the minimum wealth needed to attain a first-best investment as $\hat{\omega}_E < \tilde{\omega}_E$ and $\hat{\omega}_M^1 < \tilde{\omega}_M$. That is, an entrepreneur and moneylender with assets $\omega_E \in [\hat{\omega}_E, \tilde{\omega}_E)$ and $\omega_M \in [\hat{\omega}_M^1, \tilde{\omega}_M)$ will invest or lend strictly less with a monopolistic bank. I summarize this last result in the following proposition.

Proposition 4: *Investment is higher in a competitive banking market if both the entrepreneur and the moneylender experience credit rationing.*

Proof: See Appendix.

4 Concluding Remarks

The model's key insight is that bank market structure fundamentally shapes the way developing credit markets function. The findings shed light on the type of policy measure most conducive to entrepreneurial success. A policy promoting banking competition would improve not only financial access but also the aggregate volume of credit granted. A caveat applies, however. The fact that segmentation potentially benefits both informal lenders and the monopoly bank rationalizes why market power in the bank sector still characterizes many less developed credit markets. It also suggests that pro-competitive policy measures run the danger of being opposed by powerful vested interests. These conclusions complement the traditional view that usurious rates charged by some moneylenders are the main culprit, a view that has led to the establishment of anti-usury laws (see Conning and Udry, 2005 for an overview). Moreover, bank market structure offers a means of explaining both the prevalence of informal finance and the rates charged, and adds to the existing literature's focus on failed credit provision.

Indeed, if the objective is to increase entrepreneurs' access to cheap credit, then a more thorough understanding of market power (entry restrictions) and the political economy of banking will provide policymakers with more powerful tools than concentration on bank market regulation (anti-usury laws) alone.

Appendix

The following results will be helpful in the subsequent analysis.

Lemma A1: *(i)* $\alpha Q'(\omega_E + L_E + \omega_M) + (1-\alpha) Q'(\omega_E + L_E) \geq Q'(\omega_E + L_E + \alpha\omega_M)$; *(ii)* $Q'(\omega_E + \bar{L}_E) - (1 + r + \phi) < 0$; *and (iii)* $Q'(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M) - (1 + r + \phi) < 0$.

Proof. Part (i): By concavity I have that $\alpha Q(\omega_E + L_E + \omega_M) + (1-\alpha) Q(\omega_E + L_E) \leq Q((1-\alpha)(\omega_E + L_E + \omega_M) + \alpha(\omega_E + L_E)) = Q(\omega_E + L_E + \alpha\omega_M)$. Differentiating both sides of the expression with respect to L_E yields the desired result. Part (ii): When the entrepreneur borrows exclusively from the competitive bank and the credit limit binds,

$$Q(\omega_E + \bar{L}_E) - (1+r)\bar{L}_E - \phi(\omega_E + \bar{L}_E) = 0.$$

This constraint is only binding if $Q'(\omega_E + \bar{L}_E) - (1 + r + \phi) < 0$. Otherwise, $\bar{L}_E$ could be increased without violating the constraint. Part (iii): When the competitive bank-credit limits for the entrepreneur and the moneylender bind,

$$\begin{aligned} \alpha Q(I) + (1-\alpha) Q(\omega_E + \bar{L}_E) - (1+r)\bar{L}_E - \alpha(1+r)\bar{L}_M \\ -\alpha\phi(\omega_M + \bar{L}_M) - \phi(\omega_E + \bar{L}_E) = 0, \end{aligned} \tag{A1}$$

and

$$(1-\alpha)\left(Q(I) - Q(\omega_E + \bar{L}_E) - (1+r)\bar{L}_M - \phi(\omega_M + \bar{L}_M)\right) = 0, \tag{A2}$$

with $I = \omega_E + \bar{L}_E + \omega_M + \bar{L}_M$. Adding the two expressions yields the maximum incentive-compatible investment level:

$$Q(I) - (1+r)(I - \omega_E - \omega_M) - \phi I = 0. \tag{A3}$$

Given that it is maximal, the term must have a negative derivative, i.e. $Q'(I) - (1 + r + \phi) < 0$. ■

Proof of Proposition 1

The proof of Proposition 1 is analogous to the proof of Proposition 1 in Madestam (2005*a*) and hence omitted.

Proof of Proposition 2

I show the existence and uniqueness of $\tilde{\omega}_E(\rho,\phi)$ and $\tilde{\omega}_M(\rho,\phi)$ and proceed with the lender constellations that arise.

Lemma A2: *There exist unique thresholds $\tilde{\omega}_E(\rho,\phi)$ and $\tilde{\omega}_M(\rho,\phi)$ such that:*

(i) $Q(\omega_E+L_E)-D_E-\alpha Q(\omega_E+B)-(1-\alpha)Q(\omega_E)+\alpha(1+\rho)\omega_M=0$, *for* $\omega_E=\tilde{\omega}_E(\rho,\phi)$ *and* $\omega_E+L_E=I^*(\rho)$;

(ii) $(1-\alpha)(Q(\omega_E+\omega_M+L_M)-Q(\omega_E)-D_M)+\alpha(1+\rho)\omega_M-(1-\alpha)Q(\omega_E+\omega_M)+(1-\alpha)Q(\omega_E)-\alpha(1+\rho)\omega_M=0$, *for* $\omega_M=\tilde{\omega}_M(\rho,\phi)$ *and* $\omega_E+\omega_M+L_M=I^*(\rho)$.

Proof. Part (i): The threshold $\tilde{\omega}_E(\rho,\phi)$ is the smallest wealth level that satisfies $I=I^*(\rho)$, where the entrepreneur's incentive constraint equals the participation constraint. Thus, the threshold $\tilde{\omega}_E(\rho,\phi)$ satisfies

$$\phi I^*(\rho)=\alpha Q(\tilde{\omega}_E+B)+(1-\alpha)Q(\tilde{\omega}_E)-\alpha(1+\rho)B. \tag{A4}$$

The threshold is unique if L is decreasing in ω_E when the equilibrium is given by equations (12) to (14) in the main text. Define $\Pi=Q''(\omega_E+\omega_M+L)$. Totally differentiating (12) to (14) using Cramer's rule yields

$$\frac{dL}{d\omega_E}=\frac{-Q''(\omega_E+\omega_M+L)}{\Pi}<0,$$

where the determinant, Π, is negative by concavity and the inequality a result of concavity. Finally, $\tilde{\omega}_E(\rho,\phi)>0$ follows from the assumption $\phi>\underline{\phi}$. Part (ii): The threshold $\tilde{\omega}_M(\rho,\phi)$ is the smallest wealth level that satisfies $I=I^*(\rho)$, where the moneylender's incentive constraint equals the participation constraint. Thus, for a given level of entrepreneurial wealth, ω_E, $\tilde{\omega}_M(\rho,\phi)$ satisfies

$$\phi(I^*(\rho)-\omega_E)=(1-\alpha)(Q(\omega_E+\tilde{\omega}_M)-Q(\omega_E))+\alpha(1+\rho)\tilde{\omega}_M. \tag{A5}$$

The threshold is unique if L is decreasing in ω_M when the equilibrium is given by equations (12) to (14) in the main text. Totally differentiating (12) to (14) using Cramer's rule yields

$$\frac{dL}{d\omega_M}=\frac{-Q''(\omega_E+\omega_M+L)}{\Pi}<0,$$

where the inequality is a result of concavity. Finally, $\tilde{\omega}_M(\rho,\phi)>0$ follows from the assumption $\phi>\underline{\phi}$. ■

Lemma A3: *If (i) $\omega_E < \tilde{\omega}_E(\rho,\phi)$ and $\omega_M < \tilde{\omega}_M(\rho,\phi)$ then the entrepreneur borrows from both a bank and a moneylender and this moneylender borrows from a bank. If (ii) $\omega_E < \tilde{\omega}_E(\rho,\phi)$ and $\omega_M \in [\tilde{\omega}_M(\rho,\phi), I^*(\rho) - \omega_E)$ then the entrepreneur borrows from a moneylender and this moneylender borrows from a bank. If (iii) $\omega_E < \tilde{\omega}_E(\rho,\phi)$ and $\omega_M + \omega_E \geq I^*(\rho)$ then the entrepreneur borrows from both a bank and a moneylender and this moneylender does not borrow from a bank. Finally, if (iv) $\omega_E \geq \tilde{\omega}_E(\rho,\phi)$ then the entrepreneur borrows from a bank exclusively.*

Proof. The entrepreneur may borrow from: (1) the bank exclusively; (2) both lenders with the moneylender lending bank funds; (3) the moneylender exclusively with the moneylender lending bank funds; (4) the moneylender exclusively with the moneylender lending his own funds; (5) both lenders with the moneylender lending his own funds (let U_E^i, U_M^i, and U_B^i denote the entrepreneur's, moneylender's, and bank's respective utility).

Part (i): (1) renders $U_E^1 = Q(\omega_E + L_E) - D_E$ $(= \phi(\omega_E + L_E))$; $U_M^1 = 0$; $U_B^1 = Q(\omega_E + L_E) - \phi(\omega_E + L_E) - (1+\rho)L_E$. (2) renders $U_E^2 = \alpha Q(\omega_E + \omega_M + L) + (1-\alpha)Q(\omega_E + \beta L) - \alpha D_M - \alpha\phi(\omega_M + (1-\beta)L) - D_E$ $(= \phi(\omega_E + \beta L))$; $U_M^2 = (1-\alpha)(Q(\omega_E+\omega_M+L) - Q(\omega_E+\beta L) - D_M) + \alpha(\phi\omega_M + (1-\beta)L)$ $(= (\phi\omega_M + (1-\beta)L))$; $U_B^2 = Q(\omega_E+\omega_M+L) - \phi(\omega_E+\omega_M+L) - (1+\rho)L$. (3) renders $U_E^3 = \alpha Q(\omega_E+\omega_M+L_M) + (1-\alpha)Q(\omega_E) - \alpha D_M - \alpha\phi(\omega_M + L_M)$; $U_M^3 = (1-\alpha)(Q(\omega_E + \omega_M + L_M) - Q(\omega_E)) - (1-\alpha)D_M + \alpha\phi(\omega_M + L_M)$ $(= \phi(\omega_M + L_M))$; $U_B^3 = Q(\omega_E + \omega_M + L_M) - Q(\omega_E) - \phi(\omega_M + L_M) - (1+\rho)L_M$. (4) renders $U_E^4 = \alpha Q(\omega_E + \omega_M) + (1-\alpha)Q(\omega_E) - \alpha(1+\rho)\omega_M$; $U_M^4 = (1-\alpha)(Q(\omega_E + \omega_M) - Q(\omega_E)) + \alpha(1+\rho)\omega_M$; $U_B^4 = 0$. (5) renders $U_E^5 = \alpha Q(\omega_E + L_E + \omega_M) + (1-\alpha)Q(\omega_E + L_E) - \alpha(1+\rho)\omega_M - D_E$ $(= (\omega_E + L_E))$; $U_M^5 = (1-\alpha)(Q(\omega_E + L_E + \omega_M) - Q(\omega_E + L_E)) + \alpha(1+\rho)\omega_M$; $U_B^5 = \alpha Q(\omega_E + L_E + \omega_M) + (1-\alpha)Q(\omega_E + L_E) - \alpha(1+\rho)\omega_M - \phi(\omega_E + L_E) - (1+\rho)L_E$.

I begin by showing that case (2) is obtained. I then establish the existence of β_1 and β_2, where $\beta_1 < \beta_2$ for ω_i sufficiently small. I finally demonstrate that the bank's utility increases when β shifts such that $\beta \in (\beta_1, \beta_2)$ at which the incentive constraint of the entrepreneur and the moneylender holds simultaneously. Starting with the bank, $U_B^2 - U_B^1 = (1+\rho)\omega_M > 0$, $U_B^2 - U_B^3 = Q(\omega_E) - \phi\omega_E > 0$ as $Q'(I) \geq (1+\rho)$ and $\phi < 1$, and $U_B^2 - U_B^5 = \phi(L_E^5 - \omega_M - L^2) + (1+\rho)(L_E^5 + \alpha\omega_M - L^2) \geq \omega_M(1 + \rho - \alpha\phi) > 0$ by Lemma A1 and $\phi < 1$. Hence, the bank always prefers (2). The entrepreneur has $U_E^1 - U_E^2 = \phi(L_E^1 - \beta L^2) > 0$ since $L_E^1 = \omega_M + L^2$ as the investment level is the same in both cases, $U_E^5 - U_E^2 = \phi(L_E^5 - L_E^2) \geq \phi(1-\alpha)\omega_M > 0$ by Lemma A1, and $U_E^4 - U_E^3 = \alpha(Q(\omega_E + \omega_M) - Q(\omega_E) - (1+\rho)\omega_M) > 0$ by concavity and $Q'(I) \geq$

$(1+\rho)$. Meanwhile, $U_E^1 \gtreqless U_E^3$, $U_E^1 \gtreqless U_E^4$, $U_E^1 \gtreqless U_E^5$, $U_E^2 \gtreqless U_E^3$, $U_E^2 \gtreqless U_E^4$, $U_E^3 \gtreqless U_E^5$, and $U_E^4 \gtreqless U_E^5$. Finally, the moneylender has $U_M^3 - U_M^2 = \phi\left(L_M^3 - (1-\beta)L^2\right) > 0$ since $L_M^3 = L^2$ as the investment level is the same in both cases, and $U_M^4 - U_M^5 = (1-\alpha)\left(Q(\omega_E+\omega_M) - Q(\omega_E) + Q(\omega_E+L_E) - Q(\omega_E+L_E+\omega_M)\right) > 0$ by concavity. Meanwhile, $U_M^2 \gtreqless U_M^4$, $U_M^2 \gtreqless U_M^5$, $U_M^3 \gtreqless U_M^4$, and $U_M^3 \gtreqless U_M^5$.

Note that there does not exist any $\alpha \in (0,1)$ that simultaneously satisfies $U_E^4 > U_E^2$ and $U_M^4 > U_M^2$. (Here the bank sets $D_i = (1+\rho)L_i$ to avoid $U_B^4 = 0$.) Eliminating these cases, the only choice of the entrepreneur and the moneylender is to accept the bank's offer, rendering case (2) when $\omega_E < \tilde{\omega}_E(\rho,\phi)$ and $\omega_M < \tilde{\omega}_M(\rho,\phi)$. Also, the same outcome is obtained when $\omega_E = \omega_M = 0$, $\omega_E = 0$ and $\omega_M > 0$ or $\omega_E > 0$ and $\omega_M = 0$.

I now demonstrate the existence of β_1 and β_2, where $\beta_1 < \beta_2$. β_1: There exists a $\beta \in (0,1)$ for $\beta = \beta_1$, where the entrepreneur's incentive constraint equals her participation constraint. That is, $\phi(\omega_E + \beta L) = \alpha\left(Q(\omega_E+\omega_M+(1-\beta)L) - Q(\omega_E+\omega_M+L)\right) + (1-\alpha)Q(\omega_E) + \alpha Q(\omega_E+L)$. Let $f(\beta) = \phi(\omega_E+\beta L) - \alpha Q(\omega_E+\omega_M+(1-\beta)L) + \alpha Q(\omega_E+\omega_M+L) - (1-\alpha)Q(\omega_E) - \alpha Q(\omega_E+L)$. Then $f(0) = \phi\omega_E - (1-\alpha)Q(\omega_E) - \alpha Q(\omega_E+L) < 0$ as $Q'(I) \geq (1+\rho)$ and $\phi < 1$. Further, $f(1) = \phi(\omega_E+L) + \alpha Q(\omega_E+\omega_M+L) - (1-\alpha)Q(\omega_E) - \alpha Q(\omega_E+L) > 0$ by assumption. Hence, since $f(\cdot)$ is continuous in β, there exists a β_1 such that $f(\beta_1) = 0$.

β_2: There exists a $\beta \in (0,1]$ for $\beta{=}\beta_2$, where the moneylender's incentive constraint equals his participation constraint. That is, $\phi(\omega_M + (1-\beta)L) = (1-\alpha)Q(\omega_E+\omega_M+\beta L) - (1-\alpha)Q(\omega_E+L) + \alpha(1+\rho)\omega_M$. Let $h(\beta) = \phi(\omega_M+(1-\beta)L) - (1-\alpha)Q(\omega_E+\omega_M+\beta L) + (1-\alpha)Q(\omega_E+L) - \alpha(1+\rho)\omega_M$. Then $h(0) = \phi(\omega_M+L) - (1-\alpha)Q(\omega_E+\omega_M) + (1-\alpha)Q(\omega_E+L) - \alpha(1+\rho)\omega_M > 0$ by assumption. Further, $h(1) = \phi\omega_M - (1-\alpha)\left(Q(\omega_E+\omega_M+L) - Q(\omega_E+L)\right) + \alpha(1+\rho)\omega_M \leq 0$ by concavity and $\phi < 1$. Hence, $h(\cdot)$ is continuous in β, so there exists a β_2 such that $h(\beta_2) = 0$. For ω_E and ω_M approaching zero, $h(\cdot)$ approaches 0 from above, hence $\beta_1 < \beta_2$.

Finally, I show that the bank's utility increases in β for $\beta < \beta_1$ and decreases in β for $\beta > \beta_2$. When the entrepreneur's participation constraint and the moneylender's incentive constraint binds ($\beta < \beta_1$), the utility of the bank is given by $U_B = (1+\alpha)Q(\omega_E+\omega_M+L) - \alpha Q(\omega_E+\omega_M+(1-\beta)L) - \alpha Q(\omega_E+L) - (1-\alpha)Q(\omega_E) - \phi(\omega_M+(1-\beta)L) - (1+\rho)L$. Differentiating the expression with respect to β yields

$$\frac{dU_B}{d\beta} = L\left(\phi + \alpha Q'(\omega_E+\omega_M+(1-\beta)L)\right) > 0.$$

When the entrepreneur's incentive constraint and the moneylender's participation constraint binds ($\beta > \beta_2$), the utility of the bank is given by $U_B = Q(\omega_E+\omega_M+L) -$

$(1-\alpha)\left(Q\left(\omega_E+\omega_M+\beta L\right)-Q\left(\omega_E+L\right)\right)-\alpha\left(1+\rho\right)\omega_M-\phi\left(\omega_E+\beta L\right)-\left(1+\rho\right)L$. Differentiating the expression with respect to β yields

$$\frac{dU_B}{d\beta}=-L\left(\phi+(1-\alpha)\,Q'\left(\omega_E+\omega_M+\beta L\right)\right)<0.$$

Part (ii): Two things simplify the analysis in this situation. First, note that the bank has to set $D_E=(1+\rho)\,L_E$ (whereas $D_M>(1+\rho)\,L_M$) if case (2) is to be realized. To see this, suppose the bank were to set D_E and D_M such that the incentive constraint of the entrepreneur and the participation constraint of the moneylender held with equality. Maximizing L_E and L_M results in two different investment levels which is inconsistent. Similarly, if the bank imposed $D_M=(1+\rho)\,L_M$ and $D_E>(1+\rho)\,L_E$, the moneylender borrows such that the first-best level is realized. Meanwhile, the bank would maximize its profit equation with respect to L_E, yielding an investment level different from the first-best outcome.

Second, in addition to case (2), case (3) is the only feasible outcome consistent with $\omega_E<\tilde{\omega}_E\left(\rho,\phi\right)$ and $\omega_M\in\left[\tilde{\omega}_M\left(\rho,\phi\right),I^*\left(\rho\right)-\omega_E\right)$. Suppose that case (1) was a candidate, then there has to exist an $\omega_M>0$ where the incentive constraint $\left(\phi\left(\omega_M+(1-\beta)\,L\right)\right)$ of the moneylender equals his participation constraint. However, here his participation utility equals zero (and $(1-\beta)\,L=L_M=0$), yielding $\phi\omega_M=0$ which is unfeasible. Suppose instead that case (5) was a candidate. Again there is no $\omega_M>0$ where the incentive constraint of the moneylender equals his participation constraint. Here $\phi(\omega_M+(1-\beta)L)=(1-\alpha)(Q(\omega_E+L_E+\omega_M)-Q(\omega_E+L_E))+\alpha\,(1+\rho)\,\omega_M$. As $(1-\beta)\,L=L_M=0$, I get $\phi\omega_M$ on the left-hand side of the expression, which is less than the right-hand side since $\phi<1$.

Cases (2), (3), and (4) remain to be considered. Here the bank has $U_B^3-U_B^2=Q\left(\omega_E+L_E^2+\omega_M\right)-Q\left(\omega_E+\omega_M\right)-(1+\rho)\,L_E^2>0$ by concavity and $Q'\left(I\right)\geq(1+\rho)$. The entrepreneur has $U_E^2-U_E^3=\alpha\left(Q\left(\omega_E+L_E^2+\omega_M\right)-Q\left(\omega_E+\omega_M\right)\right)+(1-\alpha)\,Q\left(\omega_E+L_E^2\right)-(1-\alpha)\,Q\left(\omega_E\right)-(1+\rho)\,L_E^2>0$ by concavity and $Q'\left(I\right)\geq(1+\rho)$, and $U_E^2-U_E^4>0$ as $U_E^3=U_E^4$. Finally, the moneylender has $U_M^3-U_M^2=(1-\alpha)\left(Q\left(\omega_E+L_E^2\right)-Q\left(\omega_E\right)\right)-(1-\alpha)\left(Q\left(\omega_E+L_E^2+\omega_M\right)-Q\left(\omega_E+\omega_M\right)\right)>0$ by concavity, and $U_M^4-U_M^2>0$ as $U_M^3=U_M^4$. As the preferences of the bank and moneylender coincide, Case (3) is the only possible outcome when $\omega_E<\tilde{\omega}_E\left(\rho,\phi\right)$ and $\omega_M\in\left[\tilde{\omega}_M\left(\rho,\phi\right),I^*\left(\rho\right)-\omega_E\right)$.

Part (iii): When $\omega_E<\tilde{\omega}_E\left(\rho,\phi\right)$ and $\omega_M+\omega_E\geq I^*\left(\rho\right)$, the moneylender is wealthy enough to self-finance large parts (or the entire amount) of the first-best investment. Here cases (2) and (3) cease as viable options, leaving cases (1), (4), and

(5). In case (5), the bank is forced to set $D_E = (1+\rho) L_E$ as this is the only interest price consistent with a first-best investment. Here the bank has $U_B^1 - U_B^5 = Q(\omega_E + L_E^1) - \phi(\omega_E + L_E^1) - (1+\rho) L_E^1 > 0$. The entrepreneur has $U_E^5 - U_E^1 =$ {to make a comparison possible, let U_E^1 be at its highest. That is, $D_E^1 = (1+\rho)L_E^1$} $= \alpha(Q(\omega_E + L_E^5 + B) - Q(\omega_E + L_E^5) - (1+\rho) B) > 0$, and $U_E^5 - U_E^4 = (1-\alpha)Q(\omega_E + L_E^5) - (1-\alpha)(Q(\omega_E) - (1+\rho)L_E^5) > 0$, where both inequalities follow from concavity and $Q'(I) \geq (1+\rho)$. Meanwhile, $U_E^4 \gtreqless U_E^1$. Finally, the moneylender has $U_M^4 - U_M^5 = (1-\alpha)(Q(\omega_E + L_E^5) - Q(\omega_E)) + \alpha(1+\rho) L_E^5 > 0$ by concavity. As the entrepreneur can threaten to borrow from the moneylender alone, the bank will always concede to (5). Hence, when $\omega_E < \tilde{\omega}_E(\rho, \phi)$ and $\omega_M + \omega_E \geq I^*(\rho)$, case (5) is the only possible outcome.

Part (iv): When $\omega_E \geq \tilde{\omega}_E(\rho, \phi)$ and $\omega_M < \tilde{\omega}_M(\rho, \phi)$, I first note (reasoning in similar fashion to Part (ii)) that the only possible pricing policy for case (2) is to have $D_E > (1+\rho) L_E$ and $D_M = (1+\rho) L_M$. Second, case (3) can be eliminated as there is no $\omega_E > 0$ where the entrepreneur's incentive constraint equals her participation constraint, since this requires that $\phi(\omega_E + \beta L) = Q(\omega_E)$. Here $\beta L = L_E = 0$, and I get $\phi\omega_E$ on the left-hand side of the expression, which is less than the right-hand side as $\phi < 1$ and $Q'(I) \geq (1+\rho)$. Left are cases (1), (2), (4), and (5). The bank has $U_B^1 - U_B^2 = \alpha(Q(\omega_E + \omega_M + L_M^2) - Q(\omega_E + \omega_M)) + (1+\rho)(L_E^2 + \alpha\omega_M - L_E^1) \geq \alpha(Q(\omega_E + \omega_M + L_M^2) - Q(\omega_E + \omega_M) - (1+\rho) L_M^2) > 0$ by concavity, $Q'(I) \geq (1+\rho)$, and Lemma A1 and $U_B^1 - U_B^5 = (1+\rho)(L_E^5 + \alpha\omega_M - L_E^1) \geq 0$ by Lemma A1. Hence, the bank weakly prefers (1). The entrepreneur has $U_E^1 = U_E^4 = U_E^5 \gtreqless U_E^2$, while the moneylender has $U_M^4 - U_M^5 = (1-\alpha)(Q(\omega_E + \omega_M) - Q(\omega_E)) + (1-\alpha) Q(\omega_E + L_E) - (1-\alpha) Q(\omega_E + L_E + \omega_M) > 0$ by concavity. Meanwhile, $U_M^2 \gtreqless U_M^4$ and $U_M^2 \gtreqless U_M^5$. Analogous to Part (ii), there does not exist any $\alpha \in (0,1)$ simultaneously satisfying $U_E^4 > U_E^2$ and $U_M^4 > U_M^2$. Eliminating these cases, the only choice of the entrepreneur and the moneylender is to accept the bank's offer, rendering case (1) when $\omega_E \geq \tilde{\omega}_E(\rho, \phi)$ and $\omega_M < \tilde{\omega}_M(\rho, \phi)$.

Second, when $\omega_E \geq \tilde{\omega}_E(\rho, \phi)$ and $\omega_M \in [\tilde{\omega}_M(\rho, \phi), I^*(\rho) - \omega_E)$, the only consistent pricing policy in case (2) is $D_E = (1+\rho) L_E$ and $D_M > (1+\rho) L_M$. As the entrepreneur is free to borrow any amount needed at marginal cost, she will discard the moneylender's funds altogether in this situation, making case (2) obsolete (together with (3) as described above). As the entrepreneur is indifferent to (1), (4), and (5) and the bank weakly prefers (1) to (5), I thus have case (1) as the only possible outcome when $\omega_E \geq \tilde{\omega}_E(\rho, \phi)$ and $\omega_M \in [\tilde{\omega}_M(\rho, \phi), I^*(\rho) - \omega_E)$. Finally, when $\omega_E \geq \tilde{\omega}_E(\rho, \phi)$ and $\omega_M + \omega_E \geq I^*(\rho)$, the only viable alternatives are (1), (4), and (5). Similar to

$\omega_E \geq \tilde{\omega}_E(\rho, \phi)$ and $\omega_M \in [\tilde{\omega}_M(\rho, \phi), I^*(\rho) - \omega_E)$, I again have case (1) as the only possible outcome. ■

Proof of Proposition 3

I establish the properties of bank credit as reported in Proposition 3 (i) to (ii).

Proof. Part (i): When $\omega_E < \hat{\omega}_E(r, \phi)$ and $\omega_M < \hat{\omega}_M^1(r, \phi, \omega_E)$, the relevant constraints are given by

$$\alpha Q\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) + (1-\alpha) Q\left(\omega_E + \bar{L}_E\right) - (1+r)\bar{L}_E - \alpha(1+r)\bar{L}_M$$
$$-\alpha\phi\left(\omega_M + \bar{L}_M\right) - \phi\left(\omega_E + \bar{L}_E\right) = 0, \quad \text{(A6)}$$

$$Q\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) - Q\left(\omega_E + \bar{L}_E\right) - (1+r)\bar{L}_M - \phi\left(\omega_M + \bar{L}_M\right) = 0, \quad \text{(A7)}$$

and

$$I - \omega_E - \bar{L}_E - \omega_M - \bar{L}_M = 0. \quad \text{(A8)}$$

Define $\Delta = \left(Q'\left(\omega_E + \bar{L}_E\right) - (1+r+\phi)\right)^2$. Differentiating equations (A6) to (A8) with respect to I, $\bar{L}_E$, and ω_E using Cramer's rule I obtain

$$\frac{dI}{d\omega_E} = \frac{(1+r)\left(1+r+\phi - Q'\left(\omega_E + \bar{L}_E\right)\right)}{\Delta} > 0$$

and

$$\frac{d\bar{L}_E}{d\omega_E} = \frac{\left(Q'\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right) - (1+r+\phi)\right)\left(\phi - Q'\left(\omega_E + \bar{L}_E\right)\right)}{\Delta} > 0,$$

where the determinant, Δ, is positive by Lemma A1. The inequalities follow from Lemma A1 and $\phi < 1$. Differentiating the equations with respect to I, $\bar{L}_M$, and ω_M using Cramer's rule I obtain

$$\frac{dI}{d\omega_M} = \frac{(1+r)\left(1+r+\phi - Q'\left(\omega_E + \bar{L}_E\right)\right)}{\Delta} > 0$$

and

$$\frac{d\bar{L}_M}{d\omega_M} = \frac{\left(\phi - Q'\left(\omega_E + \bar{L}_E + \omega_M + \bar{L}_M\right)\right)\left(Q'\left(\omega_E + \bar{L}_E\right) - (1+r+\phi)\right)}{\Delta} > 0,$$

where the inequalities follow from Lemma A1 and $\phi < 1$. Part (ii): When $\omega_i < \tilde{\omega}_i$, the relevant constraints are given by

$$\alpha Q(\omega_E + \omega_M + L) + (1-\alpha) Q(\omega_E + L) - D_E - \alpha D_M$$
$$-\alpha\phi(\omega_M + (1-\beta)L) - \phi(\omega_E + \beta L) = 0, \quad \text{(A9)}$$

$$Q(\omega_E + \omega_M + L) - Q(\omega_E + L) - D_M - \phi(\omega_M + (1-\beta)L) = 0, \quad \text{(A10)}$$

$$Q'(\omega_E + \omega_M + L) - (1+\rho+\phi) = 0, \quad \text{(A11)}$$

and

$$I - \omega_E - \omega_M - L = 0. \tag{A12}$$

Differentiating equations (A9) to (A12) with respect to I, L, and ω_E using Cramer's rule I obtain

$$\frac{dI}{d\omega_E} = \frac{0}{\Pi} = 0,$$

where the determinant, Π, (defined in Lemma A2) is negative by concavity (the proof that $dL/d\omega_E < 0$ is provided in Lemma A2). Differentiating the equations with respect to I, L, and ω_M using Cramer's rule I obtain

$$\frac{dI}{d\omega_M} = \frac{0}{\Pi} = 0.$$

The proof that $dL/d\omega_M < 0$ is provided in Lemma A2. ■

Proof of Proposition 4

I first establish that a lower wealth is needed to attain first-best under competition. That is, $\tilde{\omega}_E > \hat{\omega}_E$ and $\tilde{\omega}_M > \hat{\omega}_M^1$. I then proceed by demonstrating that investment is higher under competition.

Lemma A4: *(i)The minimum wealth needed to attain the first-best investment level under monopoly banking, $\tilde{\omega}_i$, exceeds the minimum wealth needed to realize first-best with a competitive bank, $\hat{\omega}_E$ and $\hat{\omega}_M^1$; (ii) Investment is lower in a monopoly for $\omega_i < \tilde{\omega}_i$.*

Proof. Part (i): I start with the entrepreneur. In a competitive bank market, $\hat{\omega}_E$ is the smallest wealth level such that the entrepreneur can fund $I = I^*(r)$ using only bank credit. Thus, $\hat{\omega}_E$ satisfies $Q(I^*(r)) - (1+r)(I^*(r) - \hat{\omega}_E) - \phi I^*(r) = 0$. Setting $\hat{\omega}_E = 0$ and solving for ϕ gives the creditor vulnerability threshold for which a penniless entrepreneur can realize $I^*(r)$, $\phi_C = (Q(I^*(r)) - (1+r)I^*(r))/I^*(r)$. Similarly, under monopoly banking, $\tilde{\omega}_E$ is the smallest wealth level that allows the entrepreneur to invest $I = I^*(\rho)$, using bank credit alone. Thus, $\tilde{\omega}_E$ satisfies $\phi I^*(\rho) = \alpha Q(\tilde{\omega}_E + B) + (1-\alpha)Q(\tilde{\omega}_E) - \alpha(1+\rho)B$, where $B \leq \omega_M$. Setting $\tilde{\omega}_E = 0$ and solving for ϕ gives the creditor vulnerability threshold for which a penniless entrepreneur can fund $I^*(\rho)$, $\phi_M = \alpha(Q(B) - (1+\rho)B)/I^*(\rho)$. Since a lower threshold implies a higher minimum wealth needed to attain first-best, $\tilde{\omega}_E > \hat{\omega}_E$ follows from $\phi_M < \phi_C$. Proceeding in analogous fashion with the moneylender yields $\phi_C = (Q(I^*(r)) - (1+r)(I^*(r) - \omega_E))/I^*(r)$ and $\phi_M = 0$, implying that $\tilde{\omega}_M > \hat{\omega}_M^1$, as $\phi_M < \phi_C$. Part (ii): When $\omega_E < \hat{\omega}_E$ and $\omega_M < \hat{\omega}_M^1$, investment with a competitive bank, I_C, satisfies $Q'(I_C) < 1 + \rho + \phi$ by

Lemma A1. When $\omega_E \in [\hat{\omega}_E, \tilde{\omega}_E)$ and $\omega_M \in \left[\hat{\omega}_M^1, \tilde{\omega}_M\right)$, I_C satisfies $Q'(I_C) = 1 + \rho$. When $\omega_i < \tilde{\omega}_i$, investment with a monopoly bank, I_M, is provided by expression (12) in the main text. Comparing the two levels, $I_M < I_C$, by concavity. ∎

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Paper 3

The Social Costs of a Credit Monopoly*

Abstract

Banks provide credit and take deposits. Whereas a high price in the credit market increases banks' retained earnings and attracts more deposits, it reduces lending if borrowers are sufficiently poor to be tempted by diversion. Thus optimal bank market structure trades off the benefits of monopoly banking in attracting deposits against losses due to tighter credit. The model shows that market structure is irrelevant if both banks and borrowers lack resources. Monopoly banking induces tighter credit rationing if borrowers are poor and banks are wealthy, and increases lending if borrowers are wealthy and banks lack resources. The results indicate that improved legal protection of creditors is a more efficient policy choice than improved legal protection of depositors, and that subsidies to firms lead to better outcomes than subsidies to banks. There are also likely to be sizable gains from promoting banking competition in developing countries.

1 Introduction

A common belief about the relationship between banking and development is that banks' market power is conducive to the growth of firms: "In the early stage of a country's economic growth..., the availability of finance is most important. It may be least inefficient to restrict interbank competition in order to achieve this" (Petersen and Rajan, 1995, p. 442).[1] Essentially, monopoly banks are best suited to operate the *lending channel* between banks and their borrowers. From a different perspective, Hellman et al. (2000) assert: "competition erodes... franchise values; and lower franchise values lower incentives for...prudential bank behavior" (Hellman et al., 2000, p.

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[1] Similar points are also made by Cetorelli (1997) and Vives (2001) amongst others.

148). That is, banks' market power guarantees the functioning of the *deposit taking channel* between banks and their depositors.

Despite strong theoretical support for monopoly banking, recent empirical findings suggest that market power reduces lending *more* in developing credit markets with weak legal institutions (Beck et al., 2004).[2] In this paper I provide a theoretical foundation for these findings by considering the economy's overall supply of funds. Specifically, I simultaneously explore the costs associated with moral hazard on the part of borrowers in their interaction with creditors, and on the part of creditors in their interaction with depositors. In this way, my approach incorporates the concerns of both Petersen and Rajan (1995) and Hellman et al. (2000).[3] The paper is written in the spirit of recent work that emphasizes the role of well-functioning legal institutions in promoting financial development (La Porta et al., 1997, 1998).[4] It goes further, however, in raising the following questions: Is market power more or less harmful in financial markets characterized by weak legal institutions? How do changes in asset distribution, institutional environment, and length of contracting relationship affect bank credit?

I address these questions by constructing a model in which legal protection of creditors and depositors (in the form of capital requirements) is essential to ensure the availability of funds.[5] In such a framework, a decrease in creditor and depositor vulnerability is synonymous with institutional development. Credit rationing is a result of creditor vulnerability in the bank sector. Specifically, entrepreneurial moral hazard at the investment stage tempers banks' willingness to lend. Similarly, the supply of deposits is restrained by bankers' moral hazard. In line with recent evidence, I assess the role of market power due to entry restrictions rather than market concentration per se (Barth et al., 2004; Beck et al., 2005).

The model predicts that monopoly banking reduces aggregate lending when borrowers' debt capacity is low and the bank itself is unconstrained. Intuitively, by charging a high price the monopolist lowers borrowers' incentive to repay. Hence, high interest rates must be coupled with less lending to be incentive compatible.

On the other hand, if the banking sector's deposit-taking capacity is limited and

[2] See also Gelos and Werner (1999), Laeven (2001), and Claessens and Laeven (2005).

[3] Whereas Hellman et al. focus on risk shifting in banks' portfolios, the present paper takes opportunistic bank behavior to mean any activity that does not maximize the net return of depositors.

[4] Banks have been viewed as pillars in this process, historically in the work of Gerschenkron (1962) and Schumpeter (1934) and more recently by King and Levine (1993) and Levine and Zervos (1998). However, these classic contributions largely neglect the role of market structure in financial markets.

[5] By legal protection I mean more than simply written law, but also functioning law-enforcement bodies and supportive political institutions.

borrowers are constrained, market structure is irrelevant for lending and investment. To understand this result, note that neither competitive nor monopoly banks ever experience rationing in the sense of wanting to raise more deposits at the going market rate. Indeed, the equilibrium interest rate adjusts so as to avoid opportunistic behavior by resource-scare banks. Hence, the only way a competitive banking sector can relax its deposit constraint is to raise lending interest rates toward the monopoly level. The end effect is that investment is the same regardless of the banking regime. Finally, if the banking sector's deposit-taking capacity is limited, while borrowers are sufficiently wealthy not to be tempted by diversion, monopoly banking increases lending and investment. The monopolist is able to extract a larger rent from wealthy borrowers without inducing opportunistic behavior, yielding the monopoly bank higher profits which in turn attract more deposits.

When investment is the same under competitive and monopoly banking, the model demonstrates that it is efficiency enhancing to transfer assets from banks to borrowers *regardless* of market structure. Similarly, improved creditor protection raises investment more than improved depositor protection. The reason is that an increase in entrepreneurial wealth or improved creditor protection reduces the opportunity cost of raising funds in the bank *and* the deposit market, while an increase in bank assets or improved depositor protection only reduces the cost of raising funds in the deposit market. Market structure does matter for efficiency when I consider investment outcomes across *different* asset distributions. In particular, a wealthy competitive banking sector and a penniless entrepreneur is more efficient than vice versa. With a monopoly lender the reverse is true. Intuitively, in the latter case it is more beneficial if the entrepreneur has sufficient debt capacity since a monopoly bank with access to unlimited funds chooses to lend less at a higher price.

If investment is higher under competitive banking than monopoly banking, the adverse investment effects of declining institutional quality are more serious with a monopoly bank. That is, monopoly banking exacerbates the impact of institutional decline on investment.

When lenders and borrowers engage in repeated interaction, I demonstrate that market power reduces investment if banks have access to unlimited funds. Whereas a competitive banking sector extends funds more liberally over time, a monopoly bank lends the same amount every period. The reason is that the competitive outcome minimizes banks' aggregate payoff which allows for a larger incentive-compatible loan size. Since additional wealth permits more lending, this in turn supports wealth accumulation and higher investment the following period. A monopolist, on the other hand, is driven by a desire to charge a high price, or equivalently, share the minimum rent possible with borrowers while avoiding unsound borrower behavior. As higher wealth is associated with higher rent, an increase in wealth induces the bank to reduce the volume of loans to keep rents low, so investment remains the same in every period.

The findings rationalize Beck et al.'s (2004) observation that small firms face higher financing obstacles in banking markets characterized by market power *and* a low level of institutional development. The growth-impeding effects of market power are largest for small firms, while the effect vanishes for larger firms. In the model it is precisely the smaller (constrained) entrepreneurs that are most adversely affected by banks' market power, while larger (unconstrained) entrepreneurs do equally well in either system, or better under monopoly banking if the banking sector faces a deposit limit.[6] To the extent that liberalization increases competition, this reasoning also explains the empirical finding that small firms become less financially constrained as liberalization progresses (Gelos and Werner, 1999; Laeven, 2001).

The model's predictions contrast with the relationship-banking literature pioneered by Petersen and Rajan (1995). In their study of small businesses in the United States, they argue that market power is beneficial for small firms as it enables lenders to subsidize firms when young then reap the benefits by charging higher rates later on.[7] My conclusions also differ from the literature initiated by Keeley (1990), that emphasizes the importance of banks' charter values. In essence, Keeley (1990) and Hellman et al. (2000) among others claim that banks with market power earn higher rents (charter value) which increase the alternative cost of opportunistic behavior and reduce the risk of unsound bank action.[8]

The present paper further distinguishes itself from previous work by considering the effects of bank market structure on the joint decision of deposit taking *and* credit provision. Hence, my model delineates the trade-off between reduced bank opportunism (arising from higher bank rents) and increased borrower opportunism (also due to higher bank rents). In studying the prudent behavior of banks, the paper draws upon and relates to literature that highlights the role of capital requirements (Bhattacharya, 1982; Rochet 1992) and other banking regulations (Dewatripont and Tirole, 1993,

[6] Claessens and Laeven (2005) provide similar support by showing that industrial sectors using relatively more external financing develop faster in countries with more competitive banking systems.

[7] See Cetorelli and Peretto (2000), Dinç (2000), and Marquez (2002) for variations on the same theme and Boot (2000) and Berger and Udell (2002) for a review of the relationship-banking literature.

[8] See Besanko and Thakor (1993) and Repullo (2004) for similar conclusions and Boyd and Nicoló (2005) for a diverging view. Another distinction between the present paper and the charter-value literature is the latter's preoccupation with deposit rate competition, as opposed to lending rate competition.

1994).[9]

The model yields several policy implications. First, although better functioning institutions increase investment, it is more efficient to improve creditor protection than to improve depositor protection. An exception to this is if the banking sector faces a deposit limit while firms are unconstrained. Second, encouraging banking competition promotes the growth of small firms. Finally, during the transition towards a more competitive environment, subsidized bank credit may serve as a useful means of enhancing credit availability. However, if there is a choice between subsidizing firms or banks, the former is more efficient. Again, the exception above also applies to this conclusion.

The model builds on Burkart and Ellingsen's (2004) analysis of trade credit in a perfectly competitive banking and input-supplier market.[10] The bank and the firm in their model are analogous to the competitive bank and the firm in my setting. I extend their framework by introducing monopoly banking, households, and a dynamic structure.

The next section introduces the model. Section 3 discusses equilibrium outcomes under each banking regime. Section 4 analyzes the relation between investment and market power while Section 5 considers the effects of repeated interaction. Section 6 concludes.

2 Model

Consider an economy consisting of a banking sector, a corporate sector, and households. Although households have an excess supply of funds, deposits in the banking sector are limited because banks cannot commit to lend all of their assets to their borrowers. Similarly, credit in the corporate sector will also be limited, as firms cannot commit to invest all available resources into their projects. In order to compare outcomes with a competitive banking sector and a monopoly bank, I examine the behavior of a representative bank and a representative firm for a given level of bank assets, a, and firm wealth, ω. The comparison between the two banking regimes therefore concerns how lending and investment will evolve for a given pair (a, ω).[11]

[9] Capital requirements may also be used to prevent bank runs, see Diamond and Dybvig (1983) and Diamond and Rajan (2000). Some authors stress the negative effects of capital requirements, inducing asset shifting and loss of equity value (Besanko and Kanatas, 1996).

[10] Burkart and Ellingsen's theory is based on the notion that it is less profitable for the borrower to divert inputs than to divert cash. Thus, input suppliers may lend when banks are limited due to potential agency problems.

[11] This restriction is without loss of generality, as a monopoly bank treats its borrowers symmetrically, enabling me to generalize the investment outcome of any particular firm for a given level of

Specifically, consider a representative and risk-neutral entrepreneur endowed with observable wealth $\omega \geq 0$. She has access to a deterministic production function, $Q(I)$, where I is the volume of investment. The production function is assumed to be concave and twice continuously differentiable. To ensure the existence of an interior solution it is assumed that $Q(0) = 0$ and $Q'(0) = \infty$. In a perfect credit market with interest rate r and output price p, the entrepreneur would like to invest enough to attain the efficient level of investment given by $pQ'(I^*) = 1+r$. However, the entrepreneur lacks sufficient capital to realize this level, $\omega < I^*(r)$, and is thus forced to resort to borrowing the remaining funds from a bank.

As stressed above, however, entrepreneurial investment cannot be taken for granted. Specifically, I assume that borrowers are unable to commit to invest bank funds and that diversion of funds yields private benefits. Diversion denotes any activity that is less productive than investment, for example, using the resources for consumption or financial saving. The diversion activity yields benefit $\phi_E < 1$ for every unit diverted. While investment is unverifiable, the outcome of the entrepreneur's project may be verified. Entrepreneurs thus face the following trade-off: either the entrepreneur invests, in which case she realizes the net benefit of production after repaying the bank, or she profits directly from diverting the bank's funds. In the case of partial diversion, the remaining amount must be repaid in full. The bank is assumed not to derive any benefit from resources that are diverted.

When ϕ_E is equal to zero, legal protection of creditors is perfect in the sense that the efficient level of investment is attainable, even for an entrepreneur with no wealth. For the diversion opportunity to constrain investment, I thus assume that $\phi_E > \underline{\phi}_E = \max\left\{\underline{\phi}_{E1}, \underline{\phi}_{E2}\right\}$, where

$$\underline{\phi}_{E1} = (pQ(I^*(\sigma)) - (1+\sigma)I^*(\sigma))/I^*(\sigma) \tag{1}$$

and

$$\underline{\phi}_{E2} = (pQ(I^*(r)) - (1+\sigma+\phi_B)I^*(r) + (1+\sigma)a)/I^*(r). \tag{2}$$

Here the marginal benefit of diversion either yields higher utility than the average rate of return to an investment at an interest rate of σ (defined below) when $\underline{\phi}_E = \underline{\phi}_{E1}$ or it exceeds the average return from investment $I^*(r)$ when $\underline{\phi}_E = \underline{\phi}_{E2}$. Expression (1) denotes the investment level a penniless entrepreneur is unable to fund when the banking sector is unconstrained, while expression (2) is the investment level that remains out of reach when the banking sector is subject to moral hazard and thus restricted in its deposit taking.

assets in the banking system. (For a proof, see Lemma A7 in the Appendix.)

The representative bank is risk-neutral, endowed with observable asset $a \geq 0$, and offers entrepreneurs a contract (L, R), where L is the loan and R the amount to be repaid. If the bank requires additional funds, it raises deposits D from the households at a rate of ρ. Following the same logic as above, I assume that bank lending cannot be taken for granted, that banks are unable to commit to lend their deposits, and that diversion of deposits yields private benefits equivalent of $\phi_B < 1$ for every unit diverted. While lending is unverifiable, the outcome of the bank's lending operation may be verified. Banks thus face the following trade-off: either they lend the depositors' savings to the entrepreneurs, realizing the net-lending profit after compensating the depositors, or they benefit directly from diverting the savings. In the case of partial diversion, the bank repays the remaining amount to the depositors in full. Depositors do not benefit from assets that are diverted.

If ϕ_B is equal to zero, legal protection of depositors is perfect in the sense that a penniless banking sector can raise any amount of funds demanded by the entrepreneurs. To restrict the banking sector's deposit-taking activities, I thus assume that $\phi_B > \underline{\phi}_B = \max\left\{\underline{\phi}_{B1}, \underline{\phi}_{B2}\right\}$, where

$$\underline{\phi}_{B1} = (pQ(I^*(\sigma)) - (1+\sigma)(I^*(\sigma)) - \omega) - pQ(\omega))/(I^*(\sigma) - \omega) \tag{3}$$

and

$$\underline{\phi}_{B2} = (pQ(I(\sigma+\phi_E)) - (1+\sigma+\phi_E)I(\sigma+\phi_E) + (1+\sigma)\omega))/(I(\sigma+\phi_E) - \omega). \tag{4}$$

In other words, either banks' diversion benefit exceeds the average return to an investment $I^*(\sigma)$, or it yields higher value than the average return from investing $I(\sigma + \phi_E)$. In expression (3), a banking sector with no assets is unable to fund unconstrained entrepreneurs, while in expression (4) it is restricted from funding entrepreneurs that are subject to moral hazard and thus face a credit constraint.

Finally, there are a large number of depositors who either store their savings at the international capital-market rate of return σ, or deposit them with the banks (to earn a rate of ρ per unit of deposits D). I assume that loanable funds are in excess supply to ensure that there is no aggregate shortage of capital. In line with Dewatripont and Tirole (1994), individual depositors are assumed to be small and unable to monitor bank activities, hence, there is a need for a regulator to act on their behalf. The regulator imposes a capital requirement that specifies the minimum amount of assets-to-capital (loans) to be held by the banks.

The sequence of events is characterized as follows:

0. The regulator imposes the capital requirements.
1. Banks raise deposits D and make their lending/diversion decision.
2. Banks offer a contract, (L, R), to the entrepreneur.
3. The entrepreneur chooses L and makes her investment/diversion decision.
4. Repayments are made.

3 Equilibrium Outcomes

I will begin by analyzing the competitive banking sector. As outlined above, I restrict attention to the behavior of a representative entrepreneur and a representative bank. The outcome generated in the competitive regime is then compared to that of a banking sector represented by a single monopoly bank and a representative entrepreneur.[12] I solve for the subgame perfect equilibrium outcome and begin with the representative entrepreneur's borrowing and investment decisions. Without loss of generality, I focus on contracts of the form $\{(L, (1+r)\,L)\}_{L\leq\bar{L}}$, where $\bar{L}$ specifies the credit limit of funds extended by the bank. The contract implies that a borrower may withdraw any amount of funds until the bank credit limit binds.[13] To keep things simple, borrowers only borrow from one bank at a time.

If wealth constrained, the entrepreneur chooses the amount of bank funds to invest, I, and the amount of credit, L, by maximizing

$$U_E = \max\{(1+\sigma)\,\omega, \max\{0, pQ(I) - (1+r)\,L\} + \phi_E(\omega + L - I)\}, \tag{5}$$

subject to

$$\begin{aligned} \omega + L &\geq I, \\ \bar{L} &\geq L. \end{aligned}$$

The first part of expression (5) is the alternative market return σ on entrepreneurial wealth, the second part is the profit from investing, and the third part denotes the

[12] As noted in Section 2, the analysis generalizes to the case of multiple borrowers and lenders. (For a proof, see Lemma A7 in the Appendix.)

[13] Burkart and Ellingsen (2002) show that $\{(L, (1+r)\,L)\}_{L\leq\bar{L}}$ constitutes an optimal contract.

profit from diversion. The full expression is maximized subject to available funds and the credit limit posted by the bank. The choice is essentially binary; either the entrepreneur chooses to invest all the money or she diverts the maximum possible.[14] The entrepreneur will not be tempted to behave opportunistically if the contract satisfies the incentive constraint

$$pQ\left(\omega+L^{u}\right)-(1+r)\,L^{u}\geq\phi_{E}\left(\omega+\bar{L}\right), \tag{6}$$

where $L^{u}(r)=\min\left\{I^{*}(r)-\omega,\bar{L}\right\}$. In other words, either the entrepreneur borrows and invests efficiently (where $r\geq\rho$ determined below), or she exhausts the credit line extended by the bank.

For low levels of wealth, the temptation to divert resources becomes too large to permit the bank to lend sufficiently to satisfy the efficient outcome. In this case, the credit limit $\bar{L}$ is given by the following:

$$pQ\left(\omega+\bar{L}\right)-(1+r)\,\bar{L}=\phi\left(\omega+\bar{L}\right). \tag{7}$$

The left-hand side denotes the utility of investing all funds, while the right-hand side of the constraint is the utility from diverting that same amount. When the entrepreneur is sufficiently wealthy, the constraint no longer binds and the efficient outcome is obtained. (Lemma 1 shows that there exists a unique wealth threshold for which (7) holds.)

Similarly, for given interest and deposit rates r and ρ, the representative bank chooses the amount to lend to the entrepreneur, L_E, and the amount of deposits, D, by maximizing

$$U_{B}=\max\left\{(1+\sigma)\,a,\max\left\{0,(1+r)\,L_{E}-(1+\rho)\,D\right\}+\phi_{B}(a+D-L_{E})\right\}, \tag{8}$$

subject to

$$\begin{aligned} a+D &\geq L_{E}, \\ \bar{D} &\geq D. \end{aligned}$$

The maximand's first term guarantees the bank the alternative market rate σ on internal assets, the second is the net-lending profit, and the third term the diversion benefit. The constraints state that lending is limited by available funds and deposit

[14] Neither partial investment nor diversion are optimal. Investing yields the entrepreneur at least $1+r$ on every dollar invested, while diversion leaves her with only ϕ_E. If the entrepreneur plans to divert resources, there is no reason to invest either borrowed or internal funds as the bank would claim all of the returns.

taking by the cap imposed by the regulator. The outcome is analogous to that of the entrepreneur, yielding the critical incentive constraint

$$(1+r)(a+D^u) - (1+\rho) D^u \geq \phi_B(a+\bar{D}), \tag{9}$$

where $D^u(r) = \min\{L_E - a, \bar{D}\}$. The left-hand side of the inequality is the bank's return from intermediation, while the right-hand side is the return from raising the maximum amount of deposits and then diverting all available assets.

If the entire banking sector (represented by the marginal bank) is poor, it needs to raise a substantial amount of deposits to fund the entrepreneur. As the value of diverting all available assets in this instance exceeds the net-profit margin, the bank will be restricted by the following binding incentive constraint:

$$(1+r)\left(a+\bar{D}\right) - (1+\sigma)\bar{D} = \phi_B\left(a+\bar{D}\right). \tag{10}$$

For a wealthy bank, the constraint is slack and the bank is able to raise an unlimited amount of deposits. (In Lemma 1, I show the existence and uniqueness of an asset threshold for which (10) is satisfied.)

Finally, given the regulator's ability to monitor banks by ensuring that expression (9) is satisfied, households' concerns are restricted to receiving at least their alternative rate of return σ. Since the aggregate endowment of depositors exceeds the amount demanded by the banking sector, the depositors earn the rate $\rho = \sigma$ on their deposits.

Having characterized each agent's optimal behavior, I now examine how they interact for a given resource level. As each agent may or may not be constrained for any particular constellation (a_i, ω_i), the index $i = 1$ denotes that both agents are unconstrained while $i = 2$ denotes that one of the two is constrained.

Lemma 1: *For parameters $(\sigma, \phi_B, \phi_E, p)$ there are resource thresholds $\hat{\omega}_i > 0$ and $\hat{a}_i > 0$ for $i \in (1,2)$ such that: (i) For $\omega < \hat{\omega}_i$ and $a < \hat{a}_i$, $I < I^*(r)$ is invested and $r \in (\sigma, \sigma+\phi_B]$; (ii) For $\omega < \hat{\omega}_i$ and $a \geq \hat{a}_2$, $I < I^*(\sigma)$ is invested and $r = \sigma$; (iii) For $\omega \geq \hat{\omega}_2$ and $a < \hat{a}_i$, $I^*(r)$ is invested and $r \in (\sigma, \sigma+\phi_B]$; (iv) For $\omega \geq \hat{\omega}_1$ and $a \geq \hat{a}_1$, $I^*(\sigma)$ is invested and $r = \sigma$.*

Proof: See Appendix.

For low resource levels, $I < I^*(r)$ is invested, the entrepreneur is credit rationed, and the bank faces a deposit limit. Importantly, while the entrepreneur exhausts her credit line and would be willing to borrow more for a given equilibrium interest rate

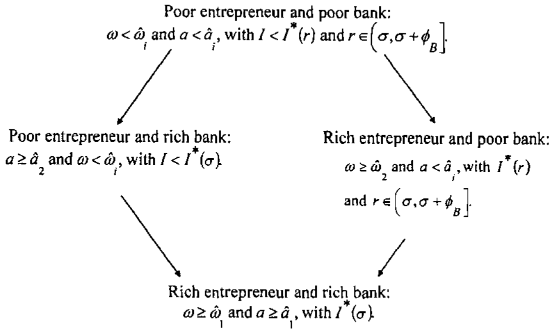

Figure 1: Resource Thresholds and Equilibrium Investment

r, the bank raises exactly the (constrained) amount needed at r. To see this, suppose that r is high. Then the entrepreneur's credit line must shrink to remain incentive compatible. Meanwhile the bank is able to raise more deposits, creating an excess supply of funds. However, if the bank lowers the interest price, both gain since the larger loan size is incentive compatible. Similarly, if r is low, the resulting excess demand is met by an increase in price such that funds demanded equal funds supplied. (For a complete proof, see Lemma A4 in the Appendix)

Since $\bar{L}$ equals $a + \bar{D}$, either $\bar{L}$ or $\bar{D}$ can be taken as the equilibrating variable. As entrepreneurial investment is the main variable of interest, I chose to focus on the final amount lent to the entrepreneur. Hence, the entrepreneur's credit limit and the interest rate are given by the following equations:

$$pQ\left(\omega + \bar{L}\right) - (1 + r)\,\bar{L} - \phi_E\left(\omega + \bar{L}\right) = 0 \tag{11}$$

and

$$(r - \sigma)\bar{L} + (1 + \sigma)a - \phi_B\bar{L} = 0. \tag{12}$$

The outcome is depicted in Figure 1. Interestingly, the deposit limit faced by the banking sector implies that the competitive outcome is "non-competitive" in the sense that the loan price exceeds marginal cost if (12) holds.[15]

When the bank no longer faces a deposit limit, investment increases to $I < I^*(\sigma)$ and competition ensures that the alternative market rate σ determines the interest rate. That is, $r = \rho = \sigma$. Meanwhile, the rationed entrepreneur's credit limit is still

[15] This finding is similar to Kreps and Scheinkman's (1983) result that capacity constraints moderate the effects of Bertrand competition.

given by equation (11). Likewise, if the entrepreneur's debt-capacity improves, the bank faces a deposit limit given by (12) but the entrepreneur invests the efficient level $I^*(r)$ and the credit line is determined by the first-order condition

$$pQ'(\omega + L) - (1 + r) = 0. \tag{13}$$

Finally, with a sufficiently wealthy entrepreneur and affluent bank, the first-best level of investment $I^*(\sigma)$ is realized.

I now turn to the monopoly outcome, where the bank sector is represented by a single monopoly bank. The representative entrepreneur's problem remains unchanged although borrowing costs will differ. Contrary to the competitive bank sector, the monopolist sets the price of lending *and* the quantity lent out simultaneously, making the entrepreneur a take-it-or-leave-it offer. The monopolist sets L, R, and D by maximizing

$$U_B = \max\{(1+\sigma)a, \max\{0, R - (1+\rho)D\} + \phi_B(a + D - L)\}, \tag{14}$$

subject to

$$\begin{aligned} a + D &\geq L, \\ \bar{D} &\geq D, \\ pQ(\omega + L) - R &\geq \phi_E(\omega + L), \\ pQ(\omega + L) - R &\geq pQ(\omega). \end{aligned}$$

The only real modification compared to the bank's previous decision problem (8), is the nonlinear payment R and the entrepreneur's incentive and participation constraint (where the latter denotes the utility of investing internal funds).[16] It follows immediately that either one of the last two inequalities must bind, otherwise the bank could increase R and earn a strictly positive profit. The outcome of the remaining problem resembles that of the competitive banking sector, of either lending all available funds or diverting them. The monopoly bank will resist the temptation of behaving opportunistically if

$$R - (1+\rho)D \geq \phi_B(a + \bar{D}), \tag{15}$$

where R equals either $pQ(\omega + L) - \phi_E(\omega + L)$ or $pQ(\omega + L) - pQ(\omega)$.[17] Resulting equilibrium constellations remain to be determined.

[16] R replaces $(1+r)L$ with the borrower choosing whether or not to accept the bank's offer and consequently the amount to invest.

[17] As in competition, a monopoly bank optimally adjusts R such that funds demanded equal funds supplied.

With a poor entrepreneur and a poor monopoly bank, $I < I(\sigma + \phi_E)$ is invested and the equilibrium outcome resembles that of the competitive banking sector. Hence, bank credit L and the repayment obligation R, solve the following (substituting L for $a + \bar{D}$):

$$pQ(\omega + L) - R - \phi_E(\omega + L) = 0 \tag{16}$$

and

$$R - (1 + \sigma)(L - a) - \phi_B L = 0. \tag{17}$$

If the bank's deposit capacity improves with the entrepreneur still being rationed, investment increases to $I(\sigma + \phi_E)$ and the lender's profit may be written as $pQ(\omega + L) - \phi_E(\omega + L) - (1 + \sigma)(L - a)$. In this instance, the optimal loan size is determined by the first-order condition of the bank's profit expression, given that R solves the entrepreneur's incentive constraint (16). That is, L is the unique loan size that solves

$$pQ'(\omega + L) - (1 + \sigma + \phi_E) = 0. \tag{18}$$

When the entrepreneur is sufficiently wealthy but the bank faces a deposit limit, $I < I^*(\sigma)$ is invested, R is given by (17), and bank credit L solves

$$pQ(\omega + L) - R - pQ(\omega) = 0. \tag{19}$$

Finally, the first-best level of investment $I^*(\sigma)$ is attained when the entrepreneur and the bank can raise an unlimited amount of funds. Lemma 2 summarizes the resulting outcomes.

Lemma 2: *For parameters $(\sigma, \phi_B, \phi_E, p)$ there are resource thresholds $\overline{\omega}_i > 0$ and $\overline{a}_i > 0$ for $i \in (1, 2)$ such that: (i) For $\omega < \overline{\omega}_i$ and $a < \overline{a}_i$, $I < I(\sigma + \phi_E)$ is invested and R solves expression (17); (ii) For $\omega < \overline{\omega}_i$ and $a \geq \overline{a}_2$, $I(\sigma + \phi_E)$ is invested and R solves expression (16); (iii) For $\omega \geq \overline{\omega}_2$ and $a < \overline{a}_i$, $I < I^*(\sigma)$ is invested and R solves expression (19); (iv) For $\omega \geq \overline{\omega}_1$ and $a \geq \overline{a}_1$, $I^*(\sigma)$ is invested and R solves expression (19).*

Proof: See Appendix.

4 Investment and Market Power

I now explore implications of the equilibria derived in Section 3. Without loss of generality I restrict attention to comparing the investment outcome of a single entrepreneur under each bank system. While the initial analysis is conducted for a given set of

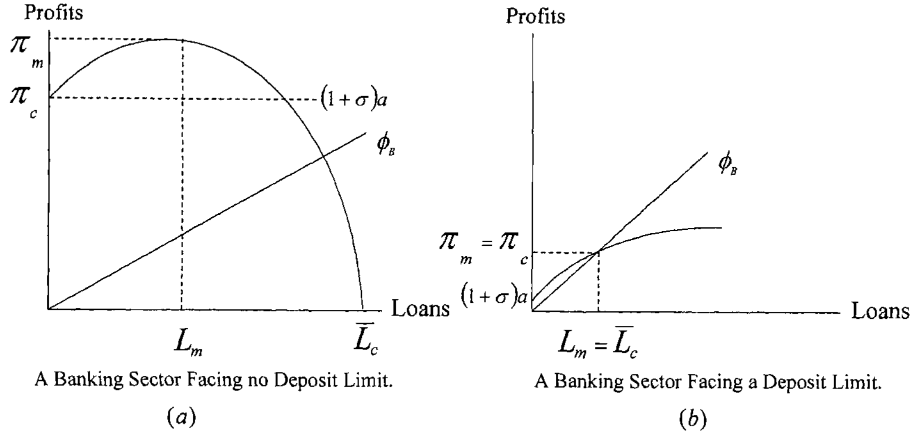

Figure 2: Bank Profit and Equilibrium Credit

parameter constellations, I also consider effects of marginal changes in endowments of entrepreneurs and banks, as well as variations in institutional quality and opportunity cost of lending.

When the banking sector is sufficiently capitalized but entrepreneurs experience credit rationing, my theory predicts that a monopoly bank reduces aggregate lending. Intuitively, whereas the competitive outcome minimizes banks' aggregate payoff, the monopoly outcome maximizes this payoff by allowing a monopolist to charge the highest interest rate possible. When increasing the price, the bank lowers the borrower's incentive to repay. Hence, high interest rates must be coupled with less lending and as a consequence lower investment (see Figure 2 (a)).

As bank assets decrease (with the entrepreneur still being rationed), the banking sector eventually faces a deposit limit in the sense that is unable to attract an unlimited amount of deposits. I now find that lending and investment is the same regardless of market structure.[18] The underlying intuition for this result is that competitive pricing coincides with the rent charged by the monopoly bank when resources are scarce. That is, the only way to relax the competitive banking sector's deposit constraint is to raise the lending interest rate to the monopoly level, with the end effect that bank profit is the same regardless of banking regime. The investment outcome is "constrained efficient"

[18] Competitive prices approach the monopoly rate as the competitive bank approaches a deposit limit. Given that such a bank lends more at lower prices, the deposit limit will be reached for a higher asset level, a.

in the sense that entrepreneurs would prefer to invest more, while the banking sector raises the needed, but constrained, amount (see Figure 2(b) above).

If the bank faces a deposit limit while the entrepreneur is sufficiently wealthy not to be tempted by diversion, I find that monopoly banking increases aggregate lending. This flows from the fact that the monopoly lender's ability to extract a larger rent from the unconstrained entrepreneur yields the bank a larger profit that in turn attracts more deposits. Charging a high rate does not entail less credit, because the entrepreneur's residual return from investment exceeds the diversion payoff. This is in stark contrast to the situation when the entrepreneur is rationed but the bank is sufficiently capitalized. In this case, charging a high price entails less lending to avoid opportunistic borrower behavior.

Finally, when entrepreneurs are unconstrained and banks no longer face a deposit limit, lending and investment are not sensitive to market structure. Proposition 1 recapitulates the findings.

Proposition 1: *Investment is weakly higher with a competitive banking sector, unless entrepreneurs are unconstrained and the banking sector faces a deposit limit.*

Proof: See Appendix.

Examining marginal changes in endowments of banks and entrepreneurs demonstrates that constrained banks *help* entrepreneurs accumulate wealth—regardless of the market regime—while an unconstrained monopoly bank *reduces* entrepreneurs' ability to accumulate wealth. To see this, I first consider the case when banks and entrepreneurs are poor and then turn to the case when banks are unconstrained but entrepreneurs remain rationed.

Proposition 2: *(i) If banks and entrepreneurs are poor, competitive credit, $\bar{L}$, monopoly credit, L, and investment, I, increase in bank assets, a, and entrepreneurial wealth, ω. (ii) If banks are unconstrained and entrepreneurs are poor, $\bar{L}$ (L), increases (decreases) in ω, I increases in ω with a competitive banking sector, and I is independent of ω with a monopoly bank.*

Proof: See Appendix.

Intuitively, in part (i) higher a and ω increase the residual return from the entrepreneur's investment activity *and* the bank's lending operation. This makes it possible to raise more deposits at a given price, which in turn increases lending. This is to be contrasted with part (ii). Whereas credit and investment continue to expand in the competitive environment, the monopoly lender now reaps the entire benefit of marginal wealth increases. In fact, an increase in the entrepreneur's wealth generates less monopoly credit—not more—implying that wealth and monopolistic credit are substitutes here, while complements in the competitive bank market. This result hinges crucially on the fixed investment level given by expression (18). Intuitively, because the monopolist wants to minimize entrepreneurial rents and rents increase in wealth, higher wealth induces a reduction in lending to keep rents low.[19]

Another insight provided by the model concerns the efficiency of the economy's resource allocation and the relative efficiency of its institutions. When banks face a deposit limit while entrepreneurs experience rationing, the theory predicts that it is efficiency enhancing to transfer assets from the banking sector to its borrowers. That is, an extra dollar of entrepreneurial wealth, ω, will expand investment by more than an extra dollar of bank assets, a. The reason for this finding is that an increase in ω reduces the alternative cost of raising funds in the bank market, funds that in turn are raised from the depositors. Meanwhile an increase in a only reduces the cost of raising funds in the deposit market. Likewise, improved creditor protection, ϕ_E, raises investment more than improved depositor protection, ϕ_B. Intuitively, a lower ϕ_E relieves the economy of a double-agency problem, whereas a lower ϕ_B eases a single-agency issue.

This result also holds true if entrepreneurs are rationed while banks are sufficiently wealthy. However, if banks face a deposit limit while entrepreneurs are unconstrained, it is more efficient to transfer wealth from entrepreneurs to banks and to improve depositor rather than creditor protection. The last two findings are explained by the fact that the party experiencing the rationing, or the binding deposit limit, faces a less binding constraint when resources increase (or institutions improve). Market structure is irrelevant in all three instances since the issue at stake concerns the marginal efficiency of a *given* asset distribution.

Proposition 3: *Investment increases if resources are reallocated from banks to entrepreneurs or if creditor vulnerability, ϕ_E, is reduced rather than depositor vulnerability, ϕ_B. An exception is when entrepreneurs are unconstrained and the banking sector faces a deposit limit, in which case investment decreases.*

Proof: See Appendix.

[19] The unique loan size that maximizes the monopoly lender's surplus is given by the point where the marginal revenue of an additional dollar lent, $pQ'(I)$, equals the opportunity cost of additional funds, together with the increased risk of opportunistic behavior that follows from more liberal lending, $(1+\rho+\phi_E)$.

The irrelevance of market structure is not sustained if I compare investment across *different* asset distributions. Consider for simplicity the following two scenarios: either banks are penniless while entrepreneurs are unconstrained, or banks are rich whereas entrepreneurs are penniless. Suppose further that legal protection of creditors is weakly more efficient than the protection of depositors. That is, $\phi_E \leq \phi_B$. In this instance, the second scenario yields higher investment. Intuitively, poor competitive banks are not helped in their deposit-raising activities by the fact that the competitive outcome minimizes banks' aggregate payoff. However, this is indeed beneficial when entrepreneurs hold no wealth and banks are rich, as competitive banks' resources are always available to entrepreneurs (to the extent that lending is incentive compatible). The assumption on ϕ_i ensures that entrepreneurs are not relatively *more* prone to divert than banks for any (a, ω). If this were the case, a higher ω would improve investment more than a higher a. Next consider a monopoly bank under the reverse assumption that $\phi_E \geq \phi_B$. In this instance, it is more beneficial if entrepreneurs have sufficient debt capacity, since an unconstrained monopoly bank will choose to lend less at a higher price. In sum:

Proposition 4: *Investment is higher if entrepreneurs hold no wealth and the competitive banking sector is unconstrained, while the reverse is true for a monopoly bank.*

Proof: See Appendix.

Market structure continues to matter when I consider general rather than relative effects of changes in institutional environment and opportunity cost of bank funds.

Proposition 5: *Changes in creditor vulnerability, ϕ_E, depositor vulnerability, ϕ_B, and opportunity cost of capital, σ, have a weakly higher effect on investment with a monopoly bank, unless entrepreneurs are unconstrained and the banking sector faces a deposit limit.*

Proof: See Appendix.

Entrepreneurs are affected more seriously by declining institutional quality, or increases in opportunity cost of bank funds, at low levels of investment—a result of the decreasing returns-to-scale technology. For instance, if the banking sector is unconstrained while entrepreneurs are rationed, this implies that monopoly banking exacerbates the impact of institutional decay (and increased opportunity cost of funds) on investment.

The theory's predictions rationalize the observation by Beck et al. (2004) that for low levels of institutional development, small firms face higher financing obstacles in more concentrated banking markets and in markets with higher entry restrictions. Their study explores the impact of bank competition on credit access for a cross-section of 74 developed and developing countries. They further find that growth-impeding effects of bank concentration and markets with high entry restrictions are largest for small firms, while the effect vanishes for larger firms.[20]

In my model it is precisely the smaller, constrained entrepreneurs that are most adversely affected by banks' market power. Larger, unconstrained entrepreneurs do equally well in either system, or indeed better under monopoly banking if the banking sector faces a deposit limit. The inefficiencies of monopoly lending on small firm investment behavior is further highlighted by Gelos and Werner (1999), Laeven (2001), and Claessens and Laeven (2005). Claessens and Laeven (2005) find that industrial sectors using relatively more external financing develop faster in countries with more competitive banking systems. Gelos and Werner (1999) and Laeven (2001) study the outcome of recent financial liberalization policies. They conclude that liberalization policies, such as the removal of barriers to entry, particularly relax small firms' external financing constraints, yielding further support for the theoretical results.[21]

In addition, Proposition 5 indicates that there are instances when subsidized credit is welfare enhancing for small firms. While increased competition is more beneficial in terms of investment (if the banking sector is sufficiently wealthy), subsidized credit may be rationalized in a transition period where new banks have yet to establish the necessary enforcement capacity. Although the positive effects of cheap credit provision have been questioned (see, for example, Adams et al., 1984), the finding is consistent with recent empirical evidence provided by Burgess and Pande (2005). In a study of Indian rural banks they show that subsidized credit substantially improved lending and non-agricultural output.[22]

The predictions yield some useful policy insights. First, although better functioning institutions increase investment, it is more efficient to improve creditor protection than

[20] Cetorelli and Gambera (2001) find that industries that depend more on external funding grow faster under a concentrated market structure. However, they do not control for firm size or institutional development.

[21] The work referred to does not control for the level of bank assets in the banking sector. As pointed out in Section 2, an additional way that competitive banking may increase funding is by allowing more banks to enter such that the aggregate volume of assets available for lending increases.

[22] Burgess and Pande do not analyze the effects of credit provision and market structure per se. However, they evaluate the effects of rural branch expansion into locations previously lacking any banks. Hence, the newly established banks in effect became regional monopolists.

to improve depositor protection. An exception is when the banking sector faces a deposit limit while firms are unconstrained. Second, encouraging banking competition promotes the growth of small firms. Finally, in a transition towards a more competitive environment, subsidized bank credit may serve as a useful means of enhancing credit availability. However, if there is a choice between subsidizing firms or banks, the former is more efficient unless the above exception applies.

5 A Two-Period Framework

It has been argued that market power enhances investment when banks and borrowers meet repeatedly (Petersen and Rajan, 1995). To explore the importance of frequent interaction, I reconsider the basic model in a two-period framework to understand how future loan opportunities affect entrepreneurial and bank incentives. To ease the analysis, I assume that banks have access to unlimited funds.

Suppose that entrepreneurs return to a bank twice to obtain funding for their project. Assume further that contracts only last for one period and that entrepreneurs that divert will not secure additional bank funds in the second period. I begin by solving the two-period game with a competitive banking sector. Focusing on the case when the incentive constraint binds across the two periods yields

$$pQ\left(\omega^1 + \bar{L}^1\right) - (1+\sigma)\,\bar{L}^1 + V^2 - V^1 = \phi_E\left(\omega^1 + \bar{L}^1\right)$$

in $t = 1$. This differs from the outcome of the one-period maximization problem in two terms: $V^2 = \max\{0, pQ\,(I^2) - (1+\sigma)\,L^2\} + \phi_E(\omega^2 + L^2 - I^2)$ and $V^1 = \omega^2$. $V^2 - V^1$ is the value of a future loan if the entrepreneur refrains from diversion in $t = 1$ and revisits the bank the following period for an additional loan.[23] The maximization problem in the subsequent period, $t = 2$, produces an outcome similar to the one-period setting as there is no future loan to account for. Before solving the game, I note that $V^1 = \omega^2 = \phi\left(\omega^1 + \bar{L}^1\right)$ when the incentive constraint binds in $t = 1$. I thus have

$$pQ\left(\omega^1 + \bar{L}^1\right) - (1+\sigma)\,\bar{L}^1 + \phi_E\left(\phi_E\left(\omega^1 + \bar{L}^1\right) + \bar{L}^2\right) - \phi_E\left(\omega^1 + \bar{L}^1\right) = \phi_E\left(\omega^1 + \bar{L}^1\right) \tag{20}$$

in $t = 1$ and

$$pQ\left(\phi\left(\omega^1 + \bar{L}^1\right) + \bar{L}^2\right) - (1+\sigma)\,\bar{L}^2 = \phi_E\left(\phi_E\left(\omega^1 + \bar{L}^1\right) + \bar{L}^2\right) \tag{21}$$

[23] V^1 is subtracted to avoid double counting of period 2 wealth, i.e. the entrepreneur is not allowed to both reinvest *and* consume the wealth, ω^2.

in $t = 2$. The left-hand side of expression (20) shows the net profit from investing in $t = 1$ *and* $t = 2$, while the right-hand side denotes the utility from diversion in $t = 1$. It can be shown that the increase in the value of the left-hand side translates into a higher credit line than the one-period outcome. Intuitively, accounting for the future allows the bank to extend funds more liberally. Moreover, the additional net wealth generated in $t = 1$ further boosts investment in $t = 2$ such that it rises above the one-period outcome *and* the first-period investment.

I now turn to the monopoly bank. Note that the last period resembles the one period set-up, with the first-order condition of the bank's profit expression determining the unique loan and investment equilibrium. From this follows that entrepreneurial rent in the last period equals $\phi_E I^2$. In period 1, the bank's concern is to minimize the rent to be shared with the entrepreneur so that she returns the following period. Conversely, the entrepreneur chooses the maximum of $\{\phi_E I^1, \phi_E I^2\}$. Here period 2 investment must be weakly higher than period 1 investment, otherwise the entrepreneur finds it more attractive to divert in the first period. As bank profit is maximized at $I = I^2$, investment will in fact be the same across the two periods. Hence, for $t = 1, 2$, L is the unique loan equilibrium that solves

$$pQ'(\omega + L) - (1 + \sigma + \phi_E) = 0, \tag{22}$$

while R solves

$$pQ(\omega + L) - R - \phi_E(\omega + L) = 0. \tag{23}$$

The intuition for this result resembles the one provided in Proposition 2. That is, an unconstrained monopoly bank prevents the entrepreneurs from accumulating wealth since this minimizes the rent that the bank has to share with the entrepreneurs. Adding a second period does not change this outcome, but provides further evidence of the fact that monopoly banking eliminates any incentives to accrue private resources.[24]

The striking conclusion is that the presence of a monopoly bank with unlimited funds not only tightens credit compared with a competitive banking sector, but that frequent borrower-lender interactions increase this inefficiency because lending remains fixed in a monopoly regime. This finding contrasts sharply with the predictions made by the relationship-banking literature. Indeed, while Petersen and Rajan (1995) and others claim that long-term relationships upheld by monopoly banks are particularly

[24] If consumption was allowed in between periods, we see that entrepreneurs would consume all resources before the next investment took place. In fact, they would consume all of their wealth even before period 1 is initiated.

important for poor entrepreneurs, I find the exact opposite: monopoly banking increases lending when entrepreneurs are rich, *not* poor, and frequent borrower-lender interactions further exacerbates the adverse effects for the least wealthy. It should be stressed that the difference between a competitive banking sector and a monopoly bank would be somewhat softened if bankruptcy was allowed. Allowing for uncertainty in this dimension reduces the value of future transactions since the possibility that entrepreneurs file for bankruptcy inherently makes future investment less valuable. This lowers investment in the competitive banking sector, while the monopoly result remains the same. Finally, these conclusions also hold true in a multi-period environment. If entrepreneurs' incentive constraints continue to bind across all periods, the monopolist would keep lending constant in every period to extract the maximum possible rent. I summarize this last result in the following proposition.

Proposition 6: *(i) Investment is higher with a competitive banking sector if banks interact repeatedly with the same borrower. (ii) Investment increases (remains the same) compared to the static outcome if a competitive (monopoly) banking sector interacts repeatedly with the same borrower.*

Proof: See Appendix.

6 Concluding Remarks

Access to credit is crucial if underdeveloped markets are to expand. In this paper I have argued that in the face of weak legal institutions, investment is the same or higher with a competitive banking sector when borrowers are poor—a finding that is robust to changes in the length of the contracting relationship between borrowers and lenders.

The current model can be extended in several directions. In a framework similar to the current paper, I show that a collusive banking oligopoly may be worse than a banking monopoly if individual banks are capacity constrained and profit varies over borrower groups (Madestam, 2005*a*). Since the threat of defection in this environment entails capturing the most profitable borrowers, an oligopoly lender may lower profit, and thereby lending, to provoke less aggressive behavior by its contenders.

It is also possible to allow for additional sources of external funding. A common phenomenon in underdeveloped credit markets is the coexistence of formal bank-provided finance and informal finance provided by moneylenders for example. In a companion paper, (Madestam, 2005*b*), I establish that monopoly banking can explain both the prevalence of moneylenders and the high effective interest rates in many developing credit markets. The paper demonstrates that a monopoly bank extracts more rent by channeling funds through moneylenders than by lending directly to entrepreneurs. The argument rests on the assumption that moneylenders are better than banks at preventing opportunistic behavior of entrepreneurs. When moneylenders are sufficiently rich relative to entrepreneurs, they are less prone to divert bank funds. Therefore, a monopoly bank need not share rents when it lends through the moneylender.

Appendix

The following results will be helpful in the subsequent analysis.

Lemma A3: *(i)* $pQ'(\omega+\bar{L})-(1+\sigma+\phi_E)<0$;*(ii)* $pQ'(\omega+\bar{L})-(1+\sigma+\phi_E+\phi_B)<0$; *(iii)* $pQ'(\omega+L)-(1+\sigma+\phi_B)<0$.

Proof. Part(i): When the incentive constraint of the entrepreneur and the participation constraint of the competitive bank binds, I have

$$pQ\left(\omega+\bar{L}\right)-(1+\sigma)\,\bar{L}-\phi_E\left(\omega+\bar{L}\right)=0. \tag{A1}$$

This constraint is binding only if $pQ'\left(\omega+\bar{L}\right)-(1+\sigma+\phi_E)<0$, otherwise $\bar{L}$ could be increased without violating the constraint. Part(ii): When the incentive constraint of the entrepreneur and the competitive bank binds,

$$pQ\left(\omega+\bar{L}\right)-(1+r)\,\bar{L}-\phi_E\left(\omega+\bar{L}\right)=0 \tag{A2}$$

and

$$(r-\sigma)\bar{L}+(1+\sigma)a-\phi_B\bar{L}=0. \tag{A3}$$

Solving for r from (A2) and (A3), yields the maximum incentive-compatible investment level:

$$pQ\left(\omega+\bar{L}\right)-(1+\sigma+\phi_B)\bar{L}+(1+\sigma)a-\phi_E\left(\omega+\bar{L}\right)=0. \tag{A4}$$

This constraint is binding only if $pQ'\left(\omega+\bar{L}\right)-(1+\sigma+\phi_E+\phi_B)<0$, otherwise $\bar{L}$ could be increased without violating the constraint. Part (iii): When the participation constraint of the entrepreneur and the incentive constraint of the monopoly bank binds,

$$pQ\left(\omega+L\right)-R-pQ\left(\omega\right)=0 \tag{A5}$$

and

$$R-(1+\sigma)\left(L-a\right)-\phi_BL=0. \tag{A6}$$

Solving for R from (A5) and (A6), yields the maximum incentive-compatible investment level:

$$pQ\left(\omega+L\right)-(1+\sigma)\left(L-a\right)-\phi_BL-pQ\left(\omega\right)=0. \tag{A7}$$

As above, this contraint is binding only if $pQ'\left(\omega+L\right)-(1+\sigma+\phi_B)<0$. ∎

Proof of Lemma 1

I first establish the relevant outcomes and then show the existence and uniqueness of $\hat{\omega}_1(\sigma, \phi_B, \phi_E, p)$, $\hat{\omega}_2(\sigma, \phi_B, \phi_E, p)$, $\hat{a}_1(\sigma, \phi_B, \phi_E, p)$, and $\hat{a}_2(\sigma, \phi_B, \phi_E, p)$.

Lemma A4: *For any $a \geq \hat{a}_i$ for $i = 1, 2$, the demand for bank funds at the lending rate σ is given by $L^u(\sigma) = \min\{I^*(\sigma) - \omega, \bar{L}\}$. When $a < \hat{a}_i$, the demand for bank funds equals the supply of deposits at the lending rate r, with $L^u(r) = \min\{I^*(r) - \omega, \bar{L}\} = \bar{D}(r) + a$.*

Proof. I first show that the demand for bank funds $L(r)$ is continuously increasing in the loan rate r and establish the relevant outcomes for $a \geq \hat{a}_i$, for $i \in (1, 2)$ (derived below). I then demonstrate that the supply of deposits $D(r)$, is continuously decreasing in the loan rate r, which enables me to show that in equilibrium, the demand for bank funds equals the supply of deposits, for $a < \hat{a}_i$.

Focusing on the entrepreneur alone, there exists a unique threshold $\hat{\omega}_i$ for $i \in (1, 2)$ (derived below), at which the efficient level of investment is attained for $\omega \geq \hat{\omega}_i$, whereas the entrepreneur is constrained for $\omega < \hat{\omega}_i$. Demand for bank funds $L(r)$ is given by

$$pQ'(\omega + L) - (1 + r) = 0 \tag{A8}$$

for $\omega \geq \hat{\omega}_i$ or

$$pQ\left(\omega + \bar{L}\right) - (1 + r)\bar{L} - \phi_E\left(\omega + \bar{L}\right) = 0 \tag{A9}$$

when $\omega < \hat{\omega}_i$. Differentiating both equations with respect to r, I have that

$$\frac{dL}{dr} = \frac{1}{pQ''(\omega + L)} < 0$$

and

$$\frac{d\bar{L}}{dr} = \frac{\bar{L}}{pQ'\left(\omega + \bar{L}\right) - (1 + r + \phi_E)} < 0.$$

The first inequality follows from concavity and the second from Lemma A3. Hence, the demand for bank funds is decreasing in r. When the bank is sufficiently rich with assets $a \geq \hat{a}_i$, the overall outcome is thus given either by (A8), or by (A9) and $r = \sigma$. Second, for $a < \hat{a}_i$, the supply of deposits is given by

$$(r - \sigma)\bar{D} + (1 + r)a - \phi_B(\bar{D} + a) = 0. \tag{A10}$$

Differentiating (A10) with respect to r, I have

$$\frac{dD}{dr} = \frac{-\left(\bar{D} + a\right)}{r - \sigma - \phi_B} > 0,$$

where the inequality is a result of $r - \sigma - \phi_B < 0$ for all $a > 0$. Hence, the supply of bank deposits is increasing in r and there exists an equilibrium for any $a < \hat{a}_i$, such that the demand for bank funds equals the supply of deposits. That is, $L^u(r) = \min\{I^*(r) - \omega, \bar{L}\} = \bar{D}(r) + a$. ■

Lemma A5: *There exist unique thresholds* $\hat{\omega}_1(\sigma, \phi_B, \phi_E, p)$, $\hat{\omega}_2(\sigma, \phi_B, \phi_E, p)$, $\hat{a}_1(\sigma, \phi_B, \phi_E, p)$, *and* $\hat{a}_2(\sigma, \phi_B, \phi_E, p)$ *such that:*

(i) $pQ(\omega + \bar{L}) - (1 + r)\bar{L} - \phi_E(\omega + \bar{L}) = 0$ *and* $(r - \sigma)\bar{L} + (1 + \sigma)a - (1 + \sigma)a = 0$, *for* $\omega = \hat{\omega}_1$ *and* $\omega + \bar{L} = \omega + a + D = I^*(\sigma)$;

(ii) $pQ(\omega + \bar{L}) - (1 + r)\bar{L} - \phi_E(\omega + \bar{L}) = 0$ *and* $(r - \sigma)\bar{L} + (1 + \sigma)a - \phi_B\bar{L} = 0$, *for* $\omega = \hat{\omega}_2$ *and* $\omega + \bar{L} = \omega + a + \bar{D} = I^*(r)$, *with* $r \in (\sigma, \sigma + \phi_B]$;

(iii) $pQ'(\omega + L) - (1 + r) = 0$ *and* $(r - \sigma)L + (1 + \sigma)a - (1 + \sigma)a = 0$, *for* $a = \hat{a}_1$ *and* $\omega + L = \omega + a + \bar{D} = I^*(\sigma)$;

(iv) $pQ(\omega + \bar{L}) - (1 + r)\bar{L} - \phi_E(\omega + \bar{L}) = 0$ *and* $(r - \sigma)\bar{L} + (1 + \sigma)a - (1 + \sigma)a = 0$, *for* $a = \hat{a}_2$ *and* $\omega + \bar{L} = \omega + a + \bar{D} = I < I^*(\sigma)$.

Proof. Part (i): The threshold $\hat{\omega}_1$ is the smallest wealth level that yields $I^*(\sigma)$. The proof is analogous to the proof of Lemma A1 in Burkart and Ellingsen (2004) and hence omitted. Part (ii): The threshold $\hat{\omega}_2$ is the smallest wealth level that satisfies $I^*(r)$, with $r \in (\sigma, \sigma + \phi_B]$ where the upper bound on r follows from setting $a = 0$ in (A3). As (A4) yields the maximum incentive-compatible investment level for a given level of bank assets, a, $\hat{\omega}_2$ must satisfy

$$pQ(I) - (1 + \sigma + \phi_B)(I - \hat{\omega}_2) + (1 + \sigma)a - \phi_E I = 0. \tag{A11}$$

The threshold is unique if $\bar{L}$ is increasing in ω. Define $\Gamma = \bar{L}pQ'(\omega + \bar{L}) - \bar{L}(1 + \sigma + \phi_E + \phi_B)$. Totally differentiating (A2) and (A3) using Cramer's rule yields

$$\frac{d\bar{L}}{d\omega} = \frac{\bar{L}(\phi_E - pQ'(\omega + \bar{L}))}{\Gamma} > 0,$$

where the determinant, Γ, is negative by Lemma A3 and the inequality a result of $pQ'(I) \geq (1 + r)$ and $\phi_E < 1$. Finally, $\hat{\omega}_2 > 0$ follows from the assumption $\phi_E > \underline{\phi}_E$. Part (iii): The threshold $\hat{a}_1$ is the smallest asset level that satisfies $I^*(\sigma)$, where the competitive bank's incentive constraint equals its participation constraint. Thus, for a given level of entrepreneurial wealth, ω, such that $pQ'(\omega + L) - (1+\sigma) = 0$, the threshold $\hat{a}_1$ satisfies

$$\phi_B (I^* (\sigma) - \omega) = (1+\sigma)\,\hat{a}_1. \tag{A12}$$

The threshold is unique if L is increasing in a when the equilibrium is given by (12) and (13) in the main text and

$$I - \omega - L = 0. \tag{A13}$$

Define $\Theta = LpQ''(L+\omega) + r - \phi_B - \sigma$. Totally differentiating (12), (13), and (A13) using Cramer's rule yields

$$\frac{dL}{da} = \frac{-(1+\sigma)}{\Theta} > 0,$$

where the determinant, Θ, is negative by concavity and the fact that $r - \phi_B - \sigma \leq 0$. Finally, $\hat{a}_1 > 0$ follows from the assumption $\phi_B > \underline{\phi}_B$. Part (iv): The proof is analogous to the proof of Part (iii), except that the level of entrepreneurial wealth, ω, satisfies $pQ\left(\omega + \bar{L}\right) - (1+r)\,\bar{L} - \phi_E\left(\omega + \bar{L}\right) = 0$ and hence $I < I^*(\sigma)$. ■

Proof of Lemma 2

I show the existence and uniqueness of $\overline{\omega}_1(\sigma, \phi_B, \phi_E, p)$, $\overline{\omega}_2(\sigma, \phi_B, \phi_E, p)$, $\overline{a}_1(\sigma, \phi_B, \phi_E, p)$, and $\overline{a}_2(\sigma, \phi_B, \phi_E, p)$. Note that a monopoly bank facing a deposit limit will choose to lend the same "constrained efficient" amount as its competitive counterpart since this maximizes profit (due to concavity). Hence, in equilibrium, funds demanded equal funds supplied.

Lemma A6: *There exist unique thresholds* $\overline{\omega}_1(\sigma, \phi_B, \phi_E, p)$, $\overline{\omega}_2(\sigma, \phi_B, \phi_E, p)$, $\overline{a}_1(\sigma, \phi_B, \phi_E, p)$, *and* $\overline{a}_2(\sigma, \phi_B, \phi_E, p)$ *such that:*

(i) $pQ(\omega + L) - R - pQ(\omega) = 0$ *and* $pQ'(\omega + L) - (1+\sigma) = 0$, *for* $\omega = \overline{\omega}_1$ *and* $\omega + L = \omega + a + D = I^*(\sigma)$;

(ii) $pQ(\omega + L) - R - pQ(\omega) = 0$ *and* $R - (1+\sigma)(L-a) - \phi_B L = 0$, *for* $\omega = \overline{\omega}_2$ *and* $\omega + L = \omega + a + \bar{D} = I < I^*(\sigma)$;

(iii) $pQ(\omega + L) - R - pQ(\omega) = 0$ *and* $R - (1+\sigma)(L-a) - \phi_B L = 0$, *for* $a = \overline{a}_1$ *and* $\omega + L = \omega + a + \bar{D} = I^*(\sigma)$;

(iv) $pQ(\omega + L) - R - \phi_E(\omega + L) = 0$ *and* $R - (1+\sigma)(L-a) - \phi_B L = 0$, *for* $a = \overline{a}_2$ *and* $\omega + L = \omega + a + \bar{D} = I(\sigma + \phi_E)$.

Proof. Part (i): The threshold $\overline{\omega}_1$ is the smallest wealth level that satisfies $I^*(\sigma)$, where the entrepreneur's incentive constraint equals her participation constraint. Thus, for a given level of bank assets, a, such that $pQ'(\omega + L) - (1+\sigma) = 0$, the threshold $\overline{\omega}_1$ satisfies

$$\phi_E I^*(\sigma) = pQ(\overline{\omega}_1). \tag{A14}$$

The threshold is unique if L is decreasing in ω when the equilibrium is given by (16) and (18) in the main text. Define $\Upsilon = pQ''(L+\omega)$. Totally differentiating (16) and (18) using Cramer's rule yields

$$\frac{dL}{d\omega} = \frac{-pQ''(L+\omega)}{\Upsilon} < 0,$$

where the determinant, Υ, and the inequality is a result of concavity. Finally, $\overline{\omega}_1 > 0$ follows from the assumption $\phi_E > \underline{\phi}_E$. Part (ii): The proof is analogous to the proof of Part (i), except that the level of bank assets, a, satisfies $R - (1+\sigma)(L-a) - \phi_B L = 0$ and hence $I < I^*(\sigma)$. Part (iii): The threshold $\overline{a}_1$ is the smallest asset level that satisfies $I^*(\sigma)$. As (A7) yields the maximum incentive compatible investment level for a given level of entrepreneurial wealth, ω, $\overline{a}_1$ must satisfy

$$pQ(I^*(\sigma)) - (1+\sigma)(I^*(\sigma) - \omega - \overline{a}_1) - \phi_B(I^*(\sigma) - \omega) - pQ(\omega) = 0. \tag{A15}$$

The threshold is unique if L is increasing in a. Define $\Lambda = pQ'(\omega + L) - (1 + \sigma + \phi_B)$. Totally differentiating (A5) and (A6) using Cramer's rule yields

$$\frac{dL}{da} = \frac{-(1+\sigma)}{\Lambda} > 0,$$

where the determinant, Λ, is negative by Lemma A3 and the inequality a result of Lemma A3. Finally, $\overline{a}_1 > 0$ follows from the assumption $\phi_B > \underline{\phi}_B$. Part (iv): The proof is analogous to the proof of Part (iii), except that the level of entrepreneurial wealth, ω, satisfies $pQ(\omega + L) - R - \phi_E(\omega + L) = 0$ and hence $I = I(\sigma + \phi_E)$. ■

Proof of Proposition 1

In Lemma A7, I establish that a comparison of outcomes for a single representative entrepreneur under each banking system is without loss of generality. Specifically, suppose that I have a competitive banking sector that includes two identical banks and two identical entrepreneurs, and a monopoly bank and two identical entrepreneurs. Assume that the monopoly lender has the same volume of assets $(2 * a)$ as the sum of the two competitive banks $(a + a)$. It suffices to show that the monopoly bank treats each of its borrowers symmetrically for the comparison to generalize. I then proceed by demonstrating the relevant investment levels in Lemma A8, where investment is given by I_i, with $i \in \{c, m\}$ for competition (c) and monopoly (m) respectively.

Lemma A7: *The monopoly bank treats each of its identical entrepreneurs symmetrically for any pair* (a, ω).

Proof. If the monopoly bank lends to both entrepreneurs, it allocates resources such that the marginal return is equalized across the two. By concavity and symmetry (in terms of ω), this implies that the bank splits its resources equally across both borrowers. It remains to be considered whether the bank prefers to lend all resources to a single entrepreneur, or allocate funds symmetrically to both. If $\omega < \overline{\omega}_i$ and $a < \overline{a}_i$, I have that for the same loan volume L (either split into two parts of $L/2$, or lent to a single entrepreneur as L), the profit of the bank will be: $\pi(L/2, L/2) = 2pQ(\omega + L/2) - 2\phi_E(\omega + L/2) + 2(1+\sigma)a - (1+\sigma)L$ or $\pi(L) = pQ(\omega + L) - \phi_E(\omega + L) + 2(1+\sigma)a - (1+\sigma)L$. By concavity, $\pi(L/2, L/2) > \pi(L)$. If $\omega < \overline{\omega}_i$ and $a \geq \overline{a}_2$, lending and investment is given by the fixed volume defined by equation (18) in the main text. As profit decreases in the amount lent out, lending symmetrically across the two entrepreneurs yields the highest profit. If $\omega \geq \overline{\omega}_2$ and $a < \overline{a}_i$, the bank's profit is: $\pi(L/2, L/2) = 2pQ(\omega + L/2) - 2pQ(\omega) + 2(1+\sigma)a - (1+\sigma)L$ or $\pi(L) = pQ(\omega + L) - pQ(\omega) + 2(1+\sigma)a - (1+\sigma)L$. Again, by concavity $\pi(L/2, L/2) > \pi(L)$. If $\omega \geq \overline{\omega}_1$ and $a \geq \overline{a}_1$, lending and investment is given by the first-order condition $pQ'(I) - (1+\sigma) = 0$. As profit decreases in the amount lent out, lending symmetrically across the two entrepreneurs yields the highest profit. ∎

Lemma A8: *(i)* $I_c = I_m$ *if* $\omega < \hat{\omega}_i$, $\omega < \overline{\omega}_i$, $a < \hat{a}_i$, *and* $a < \overline{a}_i$; *(ii)* $I_c > I_m$ *if* $\omega < \hat{\omega}_i$, $\omega < \overline{\omega}_i$, $a \geq \hat{a}_2$, *and* $a \geq \overline{a}_2$; *(iii)* $I_c < I_m$ *if* $\omega \geq \hat{\omega}_2$, $\omega \geq \overline{\omega}_2$, $a < \hat{a}_i$, *and* $a < \overline{a}_i$; *and (iv)* $I_c = I_m$ *if* $\omega \geq \hat{\omega}_1$, $\omega \geq \overline{\omega}_1$, $a \geq \hat{a}_1$, *and* $a \geq \overline{a}_1$.

Proof. Part (i): When $\omega < \hat{\omega}_i$, $\omega < \overline{\omega}_i$, $a < \hat{a}_i$, and $a < \overline{a}_i$ the maximum incentive-compatible investment level under competition *and* monopoly is given by equation (A4). Hence, investment is the same across market structure. The existence of a pair (ω, a) satisfying $\omega < \hat{\omega}_i$, $\omega < \overline{\omega}_i$, $a < \hat{a}_i$, and $a < \overline{a}_i$ follows from the assumptions $\phi_E > \underline{\phi}_E$ and $\phi_B > \underline{\phi}_B$. Part (ii): When $\omega < \hat{\omega}_i$, $\omega < \overline{\omega}_i$, $a \geq \hat{a}_2$, and $a \geq \overline{a}_2$ investment under competition satisfies $pQ'(I) < 1 + \sigma + \phi_E$ by Lemma A3, whereas investment under monopoly is provided by equation (18) in the main text. Thus $I_c > I_m$ by concavity. The existence of a pair (ω, a) satisfying $\omega < \hat{\omega}_i$, $\omega < \overline{\omega}_i$, $a \geq \hat{a}_2$, and $a \geq \overline{a}_2$ follows from the assumptions $\phi_E > \underline{\phi}_E$, $\phi_B > \underline{\phi}_B$, and the fact that $\hat{a}_2$ and $\overline{a}_2$ are clearly defined (in the proof of Lemmas 1 and 2) by values below $I^*(\sigma)$. Part (iii): To show that $I_c < I_m$ when $\omega \geq \hat{\omega}_2$, $\omega \geq \overline{\omega}_2$, $a < \hat{a}_i$, and $a < \overline{a}_i$ I establish that $\overline{a}_1 < \hat{a}_1$. That is, a lower a is needed to attain $I^*(\sigma)$ under monopoly, implying that $I_c < I_m$ for a given a. Hence, $\overline{a}_1$ satisfies $pQ(I^*(\sigma)) - pQ(\omega) - (1+\sigma)(I^*(\sigma) - \omega) + (1+\sigma)\overline{a}_1 - \phi_B(I^*(\sigma) - \omega) = 0$ and $\hat{a}_1$ satisfies $(1+r)(I^*(\sigma) - \omega) - (1+\rho)(I^*(\sigma) - \omega) + (1+\sigma)\hat{a}_1 - \phi_B(I^*(\sigma) - \omega) = 0$. As $pQ(I^*(\sigma)) - pQ(\omega) - (1+r)(I^*(\sigma) - \omega) > 0$ by concavity and $pQ'(I) \geq (1+r) = (1+\rho)$, I have that $\overline{a}_1 < \hat{a}_1$. The existence of a pair (ω, a) satisfying $\omega \geq \hat{\omega}_2$, $\omega \geq \overline{\omega}_2$, $a < \hat{a}_i$, and $a < \overline{a}_i$ follows from the assumptions $\phi_E > \underline{\phi}_E$, $\phi_B > \underline{\phi}_B$, and the fact that $\hat{\omega}_2$ and $\overline{\omega}_2$ are clearly defined (in the proof of Lemmas 1 and 2) by values below $I^*(\sigma)$. Part (iv): When $\omega \geq \hat{\omega}_1$, $\omega \geq \overline{\omega}_1$, $a \geq \hat{a}_1$, and $a \geq \overline{a}_1$ investment under competition *and* monopoly is given by $pQ'(I) - (1+\sigma) = 0$ and is hence the same. The existence of a pair (ω, a) satisfying $\omega \geq \hat{\omega}_1$, $\omega \geq \overline{\omega}_1$, $a \geq \hat{a}_1$, and $a \geq \overline{a}_1$ follows from the fact that $\hat{\omega}_1$, $\overline{\omega}_1$, $\hat{a}_1$, and $\overline{a}_1$ are clearly defined (in the proof of Lemmas 1 and 2) by values below $I^*(\sigma)$. ■

Proof of Proposition 2

I establish the comparative statics as stated in Proposition 2.

Proof. Part (i): When $\omega < \hat{\omega}_i$ and $a < \hat{a}_i$, the relevant constraints are given by (A2), (A3), and

$$I - \omega - \bar{L} = 0. \tag{A16}$$

Differentiating equations (A2), (A3), and (A16) with respect to I, $\bar{L}$, and a using Cramer's rule I obtain

$$\frac{dI}{da} = \frac{d\bar{L}}{da} = \frac{-\bar{L}(1+\sigma)}{\Gamma} > 0,$$

where the determinant, Γ, (defined in Lemma A5) is negative by Lemma A3. Differentiation with respect to I, $\bar{L}$, and ω using Cramer's rule I obtain

$$\frac{dI}{d\omega} = \frac{-\bar{L}(1+r)}{\Gamma} > 0.$$

The proof that $d\bar{L}/d\omega > 0$ is provided in Lemma A5. When $\omega < \overline{\omega}_i$ and $a < \overline{a}_i$, the relevant constraints are given by (16) and (17), in the main text and

$$I - \omega - L = 0. \tag{A17}$$

Define $\Omega = pQ'\left(\omega + \bar{L}\right) - (1 + \sigma + \phi_E + \phi_B)$. Differentiating equations (16), (17), and (A17) with respect to I, L, and a using Cramer's rule I obtain

$$\frac{dI}{da} = \frac{-(1+\sigma)}{\Omega} > 0,$$

where the determinant, Ω, is negative by Lemma A3 and the inequality a result of $pQ'(I) \geq (1+\sigma)$ and $\phi_E < 1$ (the proof that $dL/da > 0$ is provided in Lemma A6). Differentiation with respect to I, L, and ω using Cramer's rule I obtain

$$\frac{dI}{d\omega} = \frac{-(1+\sigma+\phi_B)}{\Omega} > 0$$

and

$$\frac{dL}{d\omega} = \frac{\phi_E - pQ'(\omega + L)}{\Omega} > 0,$$

where the inequality a result of $pQ'(I) \geq (1+\sigma)$ and $\phi_E < 1$. Part (ii): When $\omega < \hat{\omega}_i$ and $a \geq \hat{a}_2$, the relevant constraints are given by (11) in the main text and

$$I - \omega - \bar{L} = 0. \tag{A18}$$

Define $\Psi = pQ'\left(\omega + \bar{L}\right) - (1+\sigma+\phi_E)$. Differentiating equations (11) and (A18) with respect to I, $\bar{L}$, and ω using Cramer's rule I obtain

$$\frac{dI}{d\omega} = \frac{-(1+\sigma)}{\Psi} > 0$$

and

$$\frac{d\bar{L}}{d\omega} = \frac{\phi_E - pQ'\left(\omega + \bar{L}\right)}{\Psi} > 0,$$

where the determinant, Ψ, is negative by Lemma A3 and the inequality a result of $pQ'(I) \geq (1+\sigma)$ and $\phi_E < 1$. When $\omega < \overline{\omega}_i$ and $a \geq \overline{a}_2$, the relevant constraints are given by (16) and (18) in the main text and

$$I - \omega - L = 0. \tag{A19}$$

Differentiating equations (16), (18), and (A19) with respect to I, L, and ω using Cramer's rule I obtain

$$\frac{dI}{d\omega} = 0$$

and

$$\frac{dL}{d\omega} = \frac{pQ''(\omega + L)}{\Upsilon} > 0,$$

where the determinant, Υ, (defined in Lemma A6) is negative by Lemma A3 and the inequality a result of concavity. ■

Proof of Proposition 3

Proof. Part (i): When $\omega < \hat{\omega}_i$ and $a < \hat{a}_i$, the equilibrium is given by equations (A2), (A3), and (A16). Differentiation with respect to I, a, and ω using Cramer's rule while setting $d\omega = -da$ yields

$$\frac{dI}{d\omega} = \frac{-\phi_B \bar{L}}{\Gamma} > 0,$$

where the determinant, Γ, (defined in Lemma A5) is negative by Lemma A3. Differentiation with respect to I, ϕ_E, and ϕ_B using Cramer's rule while setting $d\phi_E = -d\phi_B$ yields

$$\frac{dI}{d\phi_E} = \frac{\bar{L}\omega}{\Gamma} < 0.$$

When $\omega < \overline{\omega}_i$ and $a < \overline{a}_i$, the equilibrium is given by equations (16) and (17), in the main text and (A17). Differentiation with respect to I, a, and ω using Cramer's rule while setting $d\omega = -da$ yields

$$\frac{dI}{d\omega} = \frac{-\phi_B}{\Omega} > 0,$$

where the determinant, Ω, (defined in the proof of Proposition 2) is negative by Lemma A3. Differentiation with respect to I, ϕ_E, and ϕ_B using Cramer's rule while setting $d\phi_E = -d\phi_B$ yields

$$\frac{dI}{d\phi_E} = \frac{\omega}{\Omega} < 0.$$

The remaining results establishing that $dI/d\omega > 0$ and $dI/d\phi_E < 0$, when $\omega < \hat{\omega}_i$, $\omega < \overline{\omega}_i$, $a \geq \hat{a}_2$, and $a \geq \overline{a}_2$, together with Part (ii) of Proposition 3, are derived in a similar manner and hence omitted. ■

Proof of Proposition 4

In part (i), I demonstrate that the case of a rich competitive bank and an entrepreneur with no wealth leads to higher investment compared to the outcome of a competitive bank with no assets and a wealthy entrepreneur. I then establish the reverse for a monopoly bank in part (ii).

Proof. Note that $\phi_E \leq \phi_B$ in part (i) and $\phi_E \geq \phi_B$ in part (ii) of the claims to follow. Part (i): Let (1) denote the case when bank assets equal zero, $a = 0$ and entrepreneurial wealth is at least $\hat{\omega}_2$, $\omega \geq \hat{\omega}_2$, and let (2) denote the case when $a \geq \hat{a}_2$ and $\omega = 0$. Case (1) is given by equations (12) to (13) and case (2) by equation (11) and $r = \sigma$ in the main text. Solving for the investment level under case (1) yields $pQ'(I_1) = 1 + \sigma + \phi_B$; and case (2) $pQ'(I_2) < 1 + \sigma + \phi_E$, with $I_1 < I_2$ by concavity.

Part (ii): Let (3) denote the case when $a = 0$ and $\omega \geq \overline{\omega}_2$, whereas (4) denotes the case when $a \geq \overline{a}_2$ and $\omega = 0$. Case (3) is given by equations (17) and (19) and case (4) by equation (18) in the main text. Investment under case (3) thus satisfies $pQ'(I_3) < 1+\sigma+\phi_B$; and case (4) $pQ'(I_4) = 1+\sigma+\phi_E$, with $I_3 > I_4$ by concavity. ∎

Proof of Proposition 5

Proof. By concavity, marginal changes in ϕ_E, ϕ_B, and σ will have larger (identical) effects on investment for lower (identical) investment levels. Hence, from Proposition 1 it follows that if (i) $\omega < \hat{\omega}_i$, $\omega < \overline{\omega}_i$, $a < \hat{a}_i$, and $a < \overline{a}_i$ then investment is affected equally across market structure; (ii) if $\omega < \hat{\omega}_i$, $\omega < \overline{\omega}_i$, $a \geq \hat{a}_2$, and $a \geq \overline{a}_2$ then investment is affected proportionally more with a monopoly bank; (iii) if $\omega \geq \hat{\omega}_2$, $\omega \geq \overline{\omega}_2$, $a < \hat{a}_i$, and $a < \overline{a}_i$ then investment is affected proportionally more with a competitive banking sector. ∎

Proof of Proposition 6

Lemma A9: *With a competitive banking sector: (i) Investment in the second period exceeds the first period; (ii) Investment in the one-period framework is lower than the first period in the two-period sequence. With a monopoly bank: (iii) Investment is the same across periods. Finally: (iv) Investment is higher in a competitive banking sector in the two-period sequence.*

Proof. Part (i): Proof by contradiction. Investment in period 1 and period 2 with a competitive banking sector satisfies

$$pQ\left(I_c^1\right) + (1+\sigma)\omega^1 - (1+\sigma+2\phi_E)\, I_c^1 + \phi_E I_c^2 = 0 \tag{A20}$$

in $t = 1$ and

$$pQ\left(I_c^2\right) + (1+\sigma)\phi_E I_c^1 - (1+\sigma+\phi_E)\, I_c^2 = 0 \tag{A21}$$

in $t = 2$. Suppose first that $I_c^1 = I_c^2$. Then (A20) becomes $pQ\left(I_c^1\right) + (1+\sigma)\omega^1 - (1+\sigma+\phi_E)\, I_c^1 = 0$ and (A21) $pQ\left(I_c^1\right) + (1+\sigma)\phi_E I_c^1 - (1+\sigma+\phi_E)\, I_c^1 = 0$, implying that $(1+\sigma)\omega^1 = (1+\sigma)\phi_E I_c^1$. But this cannot be true since (A20) can be rewritten as $pQ\left(I_c^1\right) - (1+\sigma)\, I_c^1 + (1+\sigma)\omega^1 = \phi_E I_c^1$, where $pQ\left(I_c^1\right) - (1+r)\, I_c^1 > 0$ since $pQ'(I) \geq (1+\sigma)$ and thus $(1{+}r)\omega < \phi_E I_c^1$, a contradiction. Suppose then that $I_c^1 > I_c^2$. Then (A21) can be rewritten as $pQ\left(I_c^2\right) + (1+\sigma)\phi_E I_c^1 - (1+\sigma)\, I_c^2 = \phi_E I_c^2 < \phi_E I_c^1$ or $pQ\left(I_c^2\right) - (1+\sigma)\, I_c^2 < -\sigma\phi_E I_c^2$. This cannot be true, as $pQ\left(I_c^2\right) - (1+\sigma)\, I_c^2 > 0$ since

$pQ'(I) \geq (1+\sigma)$ and thus $pQ(I_c^2) - (1+\sigma)I_c^2 > -\sigma\phi_E I_c^2$, a contradiction. Hence, $I_c^1 < I_c^2$. Part (ii): Investment in the one-period framework satisfies $pQ(I_c) + (1+\sigma)\omega - (1+\sigma+\phi_E)I_c = 0$. Comparing with (A20), we see that the left-hand side of (A20) is larger since $I_c^1 < I_c^2$, which translates into a higher investment. Hence, $I_c < I_c^1 < I_c^2$. Part (iii): Follows from the main text. Part (iv): As investment in the one-period monopoly framework is lower than investment in the one-period competitive framework, the conclusion follows. ∎

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