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The Social Cost of a Credit Monopoly

Andreas Madestam

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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 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 bank competition in developing countries.

*IGIER and Department of Economics, Bocconi University, email: `andreas.madestam@unibocconi.it`.
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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. 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 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 the 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]

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

[2] See also Gelos and Werner (2002), Laeven (2003), 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.

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., 2006).

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 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-scarce 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 liquid competitive banking sector and an illiquid corporate sector is more efficient than vice versa. With a monopoly lender the reverse is true. Intuitively, in the latter case it is more beneficial if entrepreneurs have a sufficient debt capacity since a monopoly bank with access to unlimited funds chooses to lend less at a higher price.

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, 2002; Laeven, 2003).

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

[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 (forthcoming) , 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.

(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, 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 toward 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.

[8]See Besanko and Thakor (1993) and Repullo (2004) for similar conclusions and Boyd and De Nicolò (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.

[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.

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]

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.

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

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

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

and

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

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.

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

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

and

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

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

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

subject to

$$\omega + L \geq I,$$
$$\bar{L} \geq L.$$

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 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

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

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.

[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.

[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.

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:

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

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

$$(8) \qquad U_B=\max\left\{\left(1+\sigma\right)a,\max\left\{0,\left(1+r\right)L_E-\left(1+\rho\right)D\right\}+\phi_B(a+D-L_E)\right\},$$

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

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

where $D^u\left(r\right)=\min\left\{L_E-a,\bar{D}\right\}$. 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

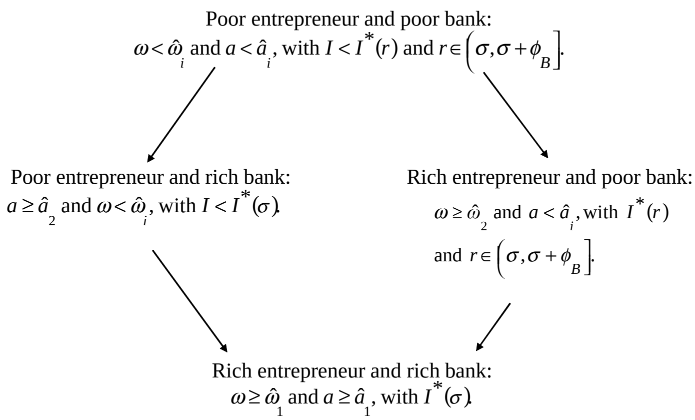


Figure 1. Resource Thresholds and Equilibrium Investment

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 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 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

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

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

[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.

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.

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.

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

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.

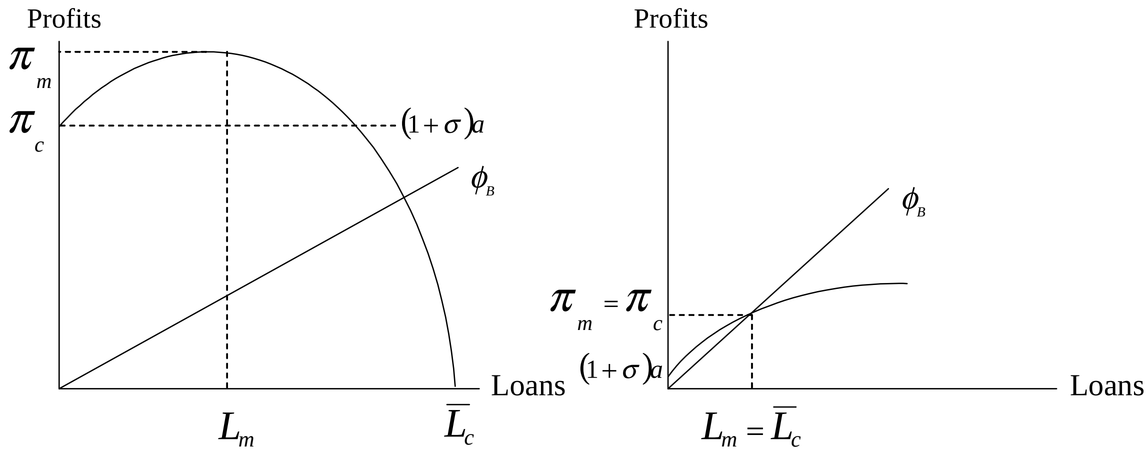
4 Investment and Market Power

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 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 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 across 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" in the sense that entrepreneurs would prefer to invest more, while the banking

[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.



A Banking Sector Facing no Deposit Limit. A Banking Sector Facing a Deposit Limit.

(a) (b)

Figure 2. Bank Profit and Equilibrium Credit

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, $\bar{L}$, mono-poly 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.

[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, $(1+\rho+\phi_E)$.

This result also holds true if entrepreneurs are rationed while banks are sufficient 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.

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 (2002), Laeven (2003), and Claessens and Laeven (2005). Claessens and Laeven find that industrial sectors using relatively more external financing develop faster in countries with more competitive banking systems. Gelos and Werner and Laeven study the outcome of recent financial liberalization policies. They conclude that liberalization policies, such as the removal

[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.

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 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

[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.

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 bank 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: $V^{2}=\max\left\{0,pQ\left(I^{2}\right)-(1+\sigma)\,L^{2}\right\}+\phi_{E}(\omega^{2}+L^{2}-I^{2})$ 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

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

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

[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}.

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 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 fu-

[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.

ture 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. Allowing for a (collusive) banking oligopoly may be worse than a banking monopoly if individual banks are capacity constrained and profit varies over borrower groups. The reason is that the threat of defection in this environment entails capturing the most profitable borrowers, and so an oligopoly lender may lower profit and thereby lending, to provoke less aggressive behavior by its contenders. Another topic for future research would be to investigate whether bank market competition has distinct effects on capital regulation and banks' solvency ratio.

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

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

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

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

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:

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

This constraint is binding only if $pQ'(\omega+\bar{L})-(1+\sigma+\phi_E+\phi_B)<0$, 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,

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

and

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

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

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

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

Proof of Lemma 1

I first establish the relevant outcomes and then show 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

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

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

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

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

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

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 $pQ(\omega+\bar{L})-(1+r)\bar{L}-\phi_E(\omega+\bar{L})=0$ 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* $\overline{\omega}_1(\sigma,\phi_B,\phi_E,p)$, $\overline{\omega}_2(\sigma,\phi_B,\phi_E,p)$, $\bar{a}_1(\sigma,\phi_B,\phi_E,p)$, *and* $\bar{a}_2(\sigma,\phi_B,\phi_E,p)$ *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* $a=\bar{a}_1$ *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* $a=\bar{a}_2$ *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 $\bar{a}_1$ 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, $\bar{a}_1$ must satisfy

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

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, $\bar{a}_1>0$ 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 ($2 \times a$) 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 $pQ\left(I^*\left(\sigma\right)\right) - pQ\left(\omega\right) - \left(1+\sigma\right)\left(I^*\left(\sigma\right)-\omega\right) + \left(1+\sigma\right)\overline{a}_1 - \phi_B\left(I^*\left(\sigma\right)-\omega\right) = 0$ and $\hat{a}_1$ satisfies $\left(1+r\right)\left(I^*\left(\sigma\right)-\omega\right) - \left(1+\rho\right)\left(I^*\left(\sigma\right)-\omega\right) + \left(1+\sigma\right)\hat{a}_1 - \phi_B\left(I^*\left(\sigma\right)-\omega\right) = 0$. As $pQ\left(I^*\left(\sigma\right)\right) - pQ\left(\omega\right) - \left(1+r\right)\left(I^*\left(\sigma\right)-\omega\right) > 0$ by concavity and $pQ'\left(I\right) \geq \left(1+r\right) = \left(1+\rho\right)$, I have that $\overline{a}_1 < \hat{a}_1$. The existence of a pair $\left(\omega, a\right)$ 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 $I^*\left(\sigma\right)$. 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 $pQ'\left(I\right) - \left(1+\sigma\right) = 0$ and is hence the same. The existence of a pair $\left(\omega, a\right)$ 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 $I^*\left(\sigma\right)$. □

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

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

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

(A17) $$I - \omega - L = 0.$$

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

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

where the determinant, Ω, is negative by Lemma A3 and the inequality a result of $pQ'\left(I\right) \geq \left(1+\sigma\right)$ 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

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

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 $\Psi = pQ'(\omega + \bar{L}) - (1 + \sigma + \phi_E)$. 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

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

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)-(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 $pQ\left(I_c^2\right) - (1+\sigma)\, I_c^2 > -\sigma\phi_E I_c^2$, 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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