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Bank competition and financing efficiency under asymmetric information

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Abstract

We consider a setting in which an entrepreneur seeks bank financing, and the project type is her private information. Different from existing theories featuring information asymmetry, and consistent with empirical findings, our model predicts: greater bank competition leads to increased bank lending as interest rates fall, leading to lower quality loans. The relationship between market power and financing efficiency is hill-shaped. An intermediate level of market power is desirable, as it can mitigate inefficiencies arising due to cross-subsidization among borrowers in a pooling equilibrium. Interest rate controls may achieve efficiency, but the specific policy depends on the bank market structure.

JEL codes: G21, G28, D40

Keywords: Bank market power, Deregulations, Loan quality, Asymmetric Information, Interest rate controls.

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1 Introduction

Deregulations in the banking sector, which fosters competition, has been widely documented to have real effects on firm financing; the effect has been especially strong for small firms, which are characterized by asymmetric information (e.g., Rice and Strahan (2010), Jayaratne and Strahan (1996)). What has received less attention is how efficient this expansion of credit supply is. As Rice and Strahan (2010) point out, increased competition lowers the borrowing cost, which in theory, should reduce the risk of borrowers (e.g., Boyd and DeNicolo (2005) and Stiglitz and Weiss (1981)). However, Kerr and Nanda (2009) find that the deregulation-induced growth in entrepreneurship is accompanied by an increase in business closures, and the closures are concentrated in the new ventures; this is inconsistent with the prediction of lower risk of borrowers. While these findings are puzzling from the view of existing bank competition models featuring asymmetric information, our model delivers this prediction.

We examine the relationship between firm financing efficiency and the bank market structure (different degrees of competition), and derive some novel empirical and policy implications. First, greater competition in banking leads to a lending boom which is characterized by lower interest rates, and lower average quality of loans. In terms of policy, there is a hill-shaped relationship between firm financing efficiency and market power. That is, the optimal intervention policy depends crucially on the market structure of the banking sector.

Specifically, we consider a model in which an entrepreneur (she) seeks external financing for her project from a bank. Projects differ on their probability of success, which is private information of the entrepreneur, and entrepreneurs cannot signal their type. As a result, there is a unique pooling equilibrium where all projects are evaluated according

to the average quality of the pool. Efficiency requires that a project be financed only if it generates a positive net present value (NPV).

We compare three different competition settings: perfect competition, monopoly and imperfect competition (oligopoly). The unregulated competitive pooling equilibrium is always inefficient and is characterized by an inefficiently high level of firm financing. Because bank loans are priced as a pool, some intermediate quality projects are subsidized by higher quality ones. Due to the subsidy, it is individually profitable for the intermediate quality borrowers to demand bank loans, even though they possess negative NPV projects (inefficiency).

In the monopolistic banking sector, the outcome is an inefficiently low level of firm financing, but with high average quality of bank loans. The banker maximizes total profits by charging high interest rates on loans, which allows only high profitability projects to be financed. Unlike the case of competition, a monopolist may set a high interest rate, without being undercut by competitors.

Therefore, in the extreme cases of perfect competition and monopoly, firm financing is inefficiently high and (weakly) low, respectively. An intermediate level of (non-zero) market power in banking achieves the efficient outcome. Thus, our model delivers a new benefit from market power in banking: some market power is desirable as it can mitigate inefficiencies arising due to cross-subsidisation among borrowers in a pooling equilibrium.

In modelling imperfect competition, we use the Salop (1979) circular city model. The interest rate on loans increases if banks have higher levels of market power. As a consequence of higher interest rates, the size of the banking sector shrinks and the average quality of bank loans improves as the lower quality projects are driven out. That is, greater market power in banking monotonically reduces the level of firm financing as in-

terest rates rise, leading to a higher quality of bank loans. In contrast, the relationship between the market power of banks and financing efficiency is hill-shaped. If competition among banks is sufficiently tough, an increase in bank market power leads to an increase in financing efficiency. Above a threshold, a further increase in bank market power reduces efficiency as it results in an inefficiently low level of firm financing (some firms are financially constrained).

The key empirical prediction of the model is that greater competition in the banking sector leads to lower interest rates and a higher volume of firm financing (lending boom). This prediction is consistent with the empirical findings of Rice and Strahan (2010), who show that bank branching deregulations in the US lead to cheaper credit, and more credit, for small firms. Existing theories predict that cheaper credit should reduce borrower risk-taking, due to reduced risk-shifting incentives (e.g., Boyd and DeNicolo (2005) and Stiglitz and Weiss (1981)). However, opposite to these predictions, Kerr and Nanda (2009) find that the deregulation-induced higher competition fuels growth in entrepreneurship, but also leads to more closures. And these closures are concentrated in the new ventures. Consistent with these findings, our model predicts that marginal borrowers, which receive financing due to increased competition, but did not before, are of lower quality. Finally, the model predicts that at a macroeconomic level, a larger banking sector leads to more growth only when the banking sector is sufficiently small, and beyond a threshold, the relation may turn negative (consistent with findings in Law and Singh (2014)).

The novel policy implication of our model is that the optimal policy intervention which maximizes financing efficiency, crucially depends on the market structure of the banking sector. For sufficiently competitive banking sectors, a regulator may set a minimum requirement on the loan interest rate (e.g. DeMeza and Webb (1987)) to achieve the efficient outcome. However, such policies may reduce efficiency if banks have sufficient

market power. In this case (when banks have market power above a certain threshold), the regulator imposes a cap on the loan rate. This result complements the theories in the market power-stability literature (e.g., Martinez-Miera and Repullo (2010)) who find that stability is maximized at an intermediate level of competition. In contrast to this strand of the literature, we hold bank stability constant as we consider diversified banks (no systematic risk).

2 Related Literature

This paper is related to the literature on the relationship between bank market power and efficiency of the banking sector. Dinc (2000) shows that as market power increases beyond an intermediate level, banks commit less to relationship lending and switch to arms-length lending (the effect on efficiency is not clear). In our model, higher than optimal bank market power results in lower level of lending by banks altogether, leading to unambiguously lower levels of efficiency. Hauswald and Marquez (2006) show that increased competition increases bank's rents and improves their incentives to gather information (see also Dimitrova and Schlee (2003), who show that entry threats may increase or reduce information acquisition, depending on the shape of demand and investment functions), leading to more efficient lending decisions. In terms of social welfare, banks always over-invest in information acquisition. In contrast, in our model, the efficiency of bank investment depends on the market structure.

The paper also relates to another strand of the literature which studies the effects of the entry of lenders into a credit market with asymmetric information: Broecker (1990) also finds that as the number of banks increases, the credit-worthiness of the average borrower falls. However, unlike in our case, in Broecker's model banks monitor firms in order to

acquire information about firm quality and mitigate the adverse selection problem. Since they study a different function of bank financing, most of our predictions and policy implications differ significantly. In Dell’Ariccia et al. (1999) the incumbent banks have superior information about the borrower riskiness than the new entrants in the banking sector. Consequently, the incumbents lend to safe borrowers leaving the new entrants with the ‘lemons’ which prevents them from entering. In Ferraris and Minetti (2007) incumbent banks have higher liquidation skills than new entrants. In equilibrium, the safer firms end up with the incumbents and obtain cheaper loans while the riskier firms end up with the new entrants and are charged higher interest rates. Compared to Dell’Ariccia et al. (1999) and Ferraris and Minetti (2007), in our model both incumbents and new entrants are identical with respect to the information they have about the firms they fund. In our case, there is no separation (pooling equilibrium) and all borrowers who receive a bank loan are charged the same interest rate. Closer to our predictions, in Marquez (2002), increased competition leads to more lending, similar to here, but different from us (and empirical findings in Rice and Strahan (2010)), more competition may be characterized by higher interest rates.

The paper complements the literature on the nexus on market structure and stability in banking. The charter value theory of Keeley (1990) posits that increased market power positively affects bank’s charter values which in turn curbs the bank’s risk-shifting incentives (see also Hellmann et al. (2000), Allen and Gale (2000), Repullo (2004) and Wagner (2010)). Another strand of the literature posits that market power may be harmful for stability; banks charge higher interest rates which in turn incites risk-shifting by the borrower (e.g., Boyd and DeNicolò (2005)). Several papers show that lower competition reduces the value of information, which leads to instability at very high levels of market power (see e.g., Hauswald and Marquez (2006), Dell’Ariccia and Marquez (2006))

and Wang (2015)). Closer to ours, some papers find a non-linear effect of market power on stability (Martinez-Miera and Repullo (2010) and Gomez and Ponce (2014)). See Berger et al. (2009) for a more complete discussion of these views. In contrast to these models, we consider a setting in which diversified banks are stable, and the focus is squarely on financing efficiency.

Another related strand of the literature considers how bank size or market power affects cost efficiency in banking. Some argue for scale effects in cost saving (see e.g., Hughes and Mester (2013), Wheelock and Wilson (2012), Wheelock and Wilson (2018)), while others do not find evidence for such benefits (Kumar (2018)). In contrast to this strand of the literature, we study financing efficiency.

Finally, from a theoretical perspective, the paper extends the work of DeMeza and Webb (1987). They show that in markets characterized by asymmetric information where projects differ with respect to their expected returns, the competitive equilibrium outcome is over-investment. In contrast, we show that the equilibrium may be characterized by over- or under-investment and this crucially depends on the bank market structure. If banks have sufficient market power, the equilibrium level of investment is below the efficient level. Therefore, in contrast to the above model, for some parameter values the optimal intervention is subsidy, not tax.

3 Model

3.1 Set-up

We consider a one-period ($t = 0, 1$) economy in which all agents are risk-neutral. All returns are consumed at the end of the period. The risk-free rate is normalized to 0, so

there is no discounting. There are three types of agents: the borrower/entrepreneur, the banks and depositors.

The entrepreneur (she) has access to a project. She has a wealth, W , which is either entirely invested in her project or a safe asset (as in DeMeza and Webb (1987)). We normalize the return on the safe asset to 0. The risky project requires an investment, $I = 1 + W$ units. If investing in the risky project, the entrepreneur borrows 1 unit from the bank. The investment is undertaken at $t = 0$ and returns are realized at $t = 1$. Any project returns X (success) or 0 (failure). Projects differ on their success probability. A project i succeeds with probability, p_i , and fails with probability, $(1 - p_i)$. p_i is private information of the entrepreneur.

There is a continuum of measure 1 of projects distributed uniformly in the interval, $p_i \in (0, 1)$.¹ Bank financing entails a transaction cost, $C \geq 0$, for the bank at date 0. $C > 0$ ensures that there is a positive spread between loan and deposit rates, which reflects reality. Setting $C = 0$ does not affect any results. The NPV of a project of type i is $p_i X - (1 + W) - C$. There exists a project, $p_e < 1$, whose NPV is equal to 0.

A1: There exists a project, $p_i = p_e$, which is marginally profitable: $p_e X - (1 + W) - C = 0$ for some $p_e \in (0, 1)$.

For all $p_i > p_e$, a project is positive NPV, so it is efficient to undertake. Conversely, for $p_i < p_e$ a project is negative NPV, and it is inefficient.

We summarize the timing of the model below:

Date 0: Depending of the market structure, there is either a single bank (monopoly case) or multiple banks (oligopoly or perfect information cases) which provide finance for projects by offering debt contracts, while the entrepreneur provides equity capital,

¹The assumption of uniform distribution is for algebraic simplicity and does not carry qualitative implications for the results.

W .² The debt contract determines the amount of funds given from the bank to the entrepreneur, 1, and the promised repayment, R_L , (and so implicitly the interest rate). In the symmetric equilibrium, all banks post the same interest rate. The borrower chooses one of the contracts offered and investment occurs.

Date 1: Project returns are realized, they are distributed to the entrepreneur and the bank according to the debt contract signed at Date 0, and consumption takes place.

Definition of Efficiency: An allocation is efficient if all projects with $p_i \geq p_e$ obtains bank financing and all project with $p_i < p_e$ are not financed.

3.2 Bank Financing

The debt (loan) contracts offered by banks specify the amount given by the bank to an entrepreneur of type i , 1 unit, and the repayment, R_L , given limited liability.

The Full-information Benchmark

Under full information, the banks observe the project type and so they know the success probability, p_i , of each project they finance. Therefore, they can charge a different repayment, R_L^i , to each type of project.

Asymmetric Information

Under asymmetric information, the project type is private information of the entrepreneur. Because we focus on smaller firms, we do not consider collateral as a screening or signalling device. Moreover, a collateral requirement is similar in its economic effects to a rise in W , and does not affect our results (similar argument as in Stiglitz and Weiss (1981) and DeMeza and Webb (1987)). Additionally, the investment, I , is fixed and hence, cannot be used for separating purposes either. Thus, banks have only one instrument to induce the

²The assumption that only debt contracts are offered is without loss of generality as, given the structure of returns in our model, all contracts (sharing rules) are equivalent.

entrepreneurs to truthfully reveal information which is the repayment when the project succeeds, R_L . However, for any two repayments designed for types i and j respectively with $R_L^i > R_L^j$, the expected return of type i of entrepreneur is:

$$p_i(X - R_L^i) < p_i(X - R_L^j) \quad (1)$$

That is, the incentive compatibility constraint of type i is violated and truthful information revelation is impossible. This argument applies to all types of entrepreneurs (projects) who choose to borrow and invest. Therefore, among the types which are undertaken, and regardless of the bank market structure, the only possible equilibrium is pooling where all types of projects are charged the same repayment, R_L . Lemma 1 below summarizes this general result.

***Lemma 1:** Among the types of projects which choose to receive financing and are undertaken, and regardless of the bank market structure, the only candidate equilibrium is pooling. All types of participating projects are offered the same contract and charged the same repayment.*

Proof. See Appendix. ■

Notice, however, that the characteristics of this pooling equilibrium (the amount of the repayment, R_L , and the types of projects which receive financing and are undertaken) depend on the bank market structure, as we will see below.

The Role of the Participation Constraint

Because the entrepreneurs contribute part of the amount required for the investment, some types of projects may not be undertaken. Specifically, an entrepreneur of type i will choose to borrow and undertake the project if her expected return from doing so exceeds

her outside option, which is to invest in the safe asset (yielding 0 return). Formally, the participation constraint of an entrepreneur of type i is given by:

$$p_i(X - R_L) \geq W \quad (2)$$

Notice that if $R_L > X - W$ all types of entrepreneurs prefer not to invest. In contrast, for any given $R_L < X - \frac{W}{p_i}$, the expected return under bank financing and investment in the project exceeds the outside option for some types of entrepreneurs (with sufficiently high p_i). Also, the entrepreneurs' expected return is strictly increasing in the project quality p_i .

Lemma 2: *For any $R_L < X - W$, there exists a $p_i \equiv p^* \in (0, 1)$ such that an entrepreneur with project quality (type) p^* is indifferent between investment in her project and in the safe asset. Entrepreneurs with $p_i > p^*$ strictly prefer investing in their project to investing in the safe asset and vice versa for entrepreneurs with $p_i < p^*$.*

That is, through their participation constraint, entrepreneurs are separated into two groups those who borrow from a bank and undertake their project and those who choose not to undertake their project and invest their initial wealth in the safe asset. However, as we have argued, the entrepreneurs of the first group cannot truthfully reveal information about their type and they are all offered the same contract (pooling equilibrium).

Corollary 1: *Given Lemma 2 and the assumption of uniform distribution of projects, the average project choosing bank financing is of type $\frac{1+p^*}{2}$, (p^* will be determined in equilibrium).*

Deposits

The banks raise funds in the deposit market. The supply of deposits is infinitely elastic

and the depositors earn a zero expected profit. The zero profit condition of depositors is:

$$\frac{1 + p^*}{2} R_D - 1 = 0 \quad (3)$$

Where R_D is the promised repayment (given limited liability) to a depositor who deposits in a bank a unit of funds. In other words, R_D is the gross interest rate on deposits and can be obtained by solving the depositor zero-profit condition (3):

$$R_D = \frac{2}{1 + p^*} \quad (4)$$

The gross deposit rate, R_D is a function of p^* which is determined in equilibrium. More specifically, R_D falls as the average borrower quality improves (p^* increases).

Given the gross interest rate on loans R_L and the marginal borrower, p^* , (both determined in equilibrium), the banks make an average (per unit) expected profit (denoted by Π) of:

$$\Pi = -C + \frac{1 + p^*}{2} (R_L - R_D) \quad (5)$$

Where C is the transaction cost incurred by the bank. Therefore, total profit of the banking sector is:

$$\int_{p^*}^1 \Pi dp_i = (1 - p^*) \left[-C + \frac{1 + p^*}{2} (R_L - R_D) \right] \quad (6)$$

3.2.1 Perfect Competition

In this section we consider the case of a perfectly competitive banking sector. We denote by p^{*pc} the equilibrium level of p^* for the marginal investor under perfect competition.

The main result is summarized in Proposition 1:

Proposition 1: *Under perfect competition among banks, the equilibrium is inefficient and is characterized by $p^{*pc} < p_e$ (over-investment).*

Proof. See Appendix. Additionally, the expression for p^{*pc} is derived at the end of the Appendix. ■

Intuitively, because the equilibrium is pooling, all types of projects choosing bank financing are charged the same gross interest rate (repayment), R_L , which is determined by the average quality of the pool $\frac{1+p^*}{2}$. If the marginal project is characterized by $p^{*pc} = p_e$ (efficiency) then banks make zero profits in the marginal project and strictly positive profits for all $p_i > p_e$. Thus, if $p^{*pc} = p_e$, banks make strictly positive profits and so it cannot be an equilibrium as perfect competition implies that in equilibrium banks make zero profits. In fact, in the competitive equilibrium, the profits from projects with $p_i > p_e$ are offset by losses from projects with $p_i < p_e$. Therefore, under perfect competition, some negative NPV projects are financed. That is, the marginal project is characterized by $p^{*pc} < p_e$ (see Assumption A1). In this sense, there is over-investment and the banking sector is inefficiently large.

3.2.2 Monopolistic Bank

In this sub-section, we consider the other extreme where the bank has monopoly power. We denote by p^{*M} the equilibrium level of p for the marginal investor in the monopoly case. In the competitive banking sector, the threat of losing business to the competition drives down the loan interest rate. If a bank sets a higher interest rate than the competitively determined rate, the bank will lose all its business to its competitors. This threat does not exist in the monopolistic banking sector. If a bank has monopoly power, the banker

chooses the loan interest rate to maximize the bank's total expected profits only subject to the participating constraint of the borrowers. This changes drastically the efficiency properties of the equilibrium.

Proposition 2: *If a bank has monopoly power, the equilibrium is either efficient, $p^{*M} = p_e$ or is characterized by under-investment, $p^{*M} > p_e$. There is never over-investment ($p^{*M} < p_e$ is impossible).*

Proof. See Appendix. ■

The last part of Proposition 2 is straightforward. The monopolistic bank will never charge an interest rate which attracts a project on which the bank makes losses ($p^{*M} < p_e$). If $p^{*M} < p_e$, the bank can increase its profit by increasing the interest rate it charges on its loans. This increase will have two positive effects on the bank profits: a) some marginal projects on which the bank makes losses will choose to invest in the safe asset rather than her risky project, b) the bank will make a higher profit (smaller loss) on all types of projects which still prefer bank financing. Clearly, in order to maximize its profit, the monopolistic bank will set the interest rate such that $p^{*M} \geq p_e$. In the competitive banking sector, the threat of undercutting prevents the banks from following this strategy.

However, depending on the demand elasticity of loans, the monopolistic bank may increase its profits by charging a higher interest rate than that corresponding to $p^{*M} = p_e$. The resulting increase in its profits per project may more than offset the fall in profits due to a smaller customer base. This implies that the monopolistic banking sector may be inefficiently small, $p^{*M} > p_e$, for some parameter values. This inefficiency is also driven by asymmetric information. Asymmetric information does not allow the monopolistic bank to price-discriminate and extract all the surplus generated by bank financing, which would always lead to efficiency.

3.2.3 Imperfect Competition

In this section, we introduce a Salop circle model of imperfect competition and follow the steps in Repullo (2004).

Imperfect Competition in the banking sector is modelled as follows: there are $n > 2$ banks, indexed $j = 1, \dots, n$. The borrowers are distributed uniformly on a circumference of unit length. Location on the circle is independent of project type, p_i . The n banks are located symmetrically on this circumference. It is costly for the borrower to travel to a bank (differentiated products) and the cost is μ times the distance between the borrower and the bank. The degree of differentiation is exogenously given and captured by μ .

The borrower's choice to invest in the project or in the safe asset depends on its distance from the bank, μ (which is observed). Therefore, there is a separate market for each value of μ and within each such market, borrowers differ on their unobservable quality, p . Hence we look at one such market, for a given value of μ . The borrower's participation constraint now includes the cost of travel to the bank.³

Banks compete by offering loan rates. We will focus on symmetric equilibria, in which all banks offer the same loan rate. In equilibrium each bank will lend to a fraction $\frac{1}{n}$ of the loan market (which is all borrowers that lie in the space between 1 and p^*). To obtain the symmetric Nash equilibrium first compute the demand for loans for bank j when it offers a loan rate R_L^j , while the remaining $n - 1$ banks offer the rate R_L . Effectively, Bank j has two competitors, namely banks $j - 1$ and $j + 1$.

A borrower, i , located at distance z_i from bank j and distance $\frac{1}{n} - z_i$ from bank $j + 1$, will be indifferent between going to j or to $j + 1$ if the total cost including the transport

³Lemma 2 now holds separately for each value of μ .

cost is the same, i.e.,

$$-p_i R_L^j - \mu z_i = -p_i R_L - \mu \left(\frac{1}{n} - z_i \right) \quad (7)$$

Solving for z_i yields,

$$z_i(R_L^j, R_L) = \frac{p_i(R_L - R_L^j)}{2\mu} + \frac{1}{2n} \quad (8)$$

Taking into account the symmetric market area between bank j and bank $j - 1$, we can obtain the following demand for loans for bank, j , by borrower:

$$D_i(R_L^j, R_L) = 2z_i(R_L^j, R_L) = \frac{p_i(R_L - R_L^j)}{\mu} + \frac{1}{n} \quad (9)$$

Note that the borrower type, p_i and the distance from the bank, μ are independent of each other. Therefore, we can derive the total demand for loans for a bank, j , by integrating D_i over all types which borrow from the banking sector in equilibrium, i.e., $(p^*, 1)$,

$$D(R_L^j, R_L) = \int_{p^*}^1 D_i(R_L^j, R_L) dp_i = \frac{R_L - R_L^j}{2\mu} (1 - p^{*2}) + \frac{1 - p^*}{n} \quad (10)$$

Given that the equilibrium is always pooling (Lemma 1) and in this pooling equilibrium the average quality is $\frac{1+p^*}{2}$ (Corollary 1), the problem for bank j is:

$$\begin{aligned} \text{Max}_{R_L^j, p^*} \quad & (1 - p^*) \left[-C + \frac{1+p^*}{2} (R_L^j - R_D) \right] D(R_L^j, R_L) \\ \text{s.t.} \quad & p^*(X - R_L) - W - \mu z \geq 0 \end{aligned} \quad (11)$$

A bank's payoff is the overall profit in the banking sector (Equation (6)) times its share of the market (given by the demand function, Equation (9)). The constraint is the

participation constraint of the marginal borrower, p^* (Equation (2)).

Proposition 3: *For each value of μ , both the equilibrium interest rate on loans, R_L , and the quality of the marginal borrower, p^* , are decreasing in the level of competition, n .*

$$\frac{dp^*}{dn} < 0 \tag{12}$$

$$\frac{dR_L}{dn} < 0 \tag{13}$$

Proof. In the symmetric equilibrium $R_L^j = R_L$. The expressions for $\frac{dp^*}{dn}$ and $\frac{dR_L}{dn}$ are derived in Appendix. ■

Proposition 3 represents the key empirical predictions of the model. Tougher competition in banking (higher n) leads to a lending boom (p^*) which is characterized by lower interest rates (R_L), and (marginally) lower loan quality in the banking sector.

3.2.4 Market power and financing efficiency

While the banking sector is inefficiently small in the case of monopoly, it is inefficiently large in the case of perfect competition. Further, we know from Proposition 3 that the equilibrium p^* monotonically reduces in the level of competition, n (and therefore the size of the banking sector increases).

Proposition 4: *There exists a positive level of market power (say \bar{n}), for which the equilibrium outcome is efficient.*

For $n < \bar{n}$, positive market power results in higher quality banking sector and higher social welfare. However, for $n > \bar{n}$, positive market power results in higher quality banking sector but lower social welfare as the banking sector shrinks to an inefficiently small size. Therefore, there exists a monotonically increasing relationship between quality of loans

and market power but a hill-shaped relationship between social welfare and market power.

3.2.5 Example

If a project succeeds, its payoff is $X = 2.5$ and 0, otherwise. Each entrepreneur has wealth, $W = 0.3$. The transaction cost is $C = 0.05$. We derive that the marginally efficient project is $p_e = 0.54$.

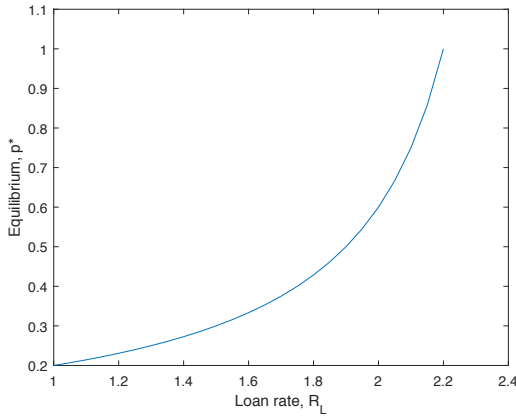


Figure 1: Loan quality

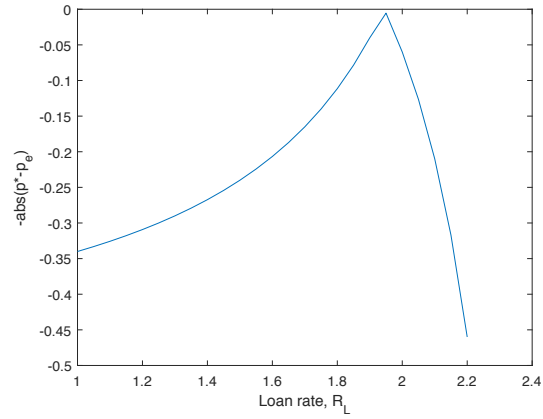


Figure 2: Efficiency

In Figure 1, we plot the equilibrium marginal project, p^* , against the loan interest rate, R_L . We see that p^* monotonically increases in the loan interest rate, R_L (more market power). This indicates the banking sector becomes safer as market power increases.

In Figure 2, we plot a measure of efficiency, $-|p_e - p^*|$, against the loan interest rate, R_L . The absolute distance between p_e and p^* is the degree of inefficiency. We define efficiency as the negative of this measure. In the example used, efficiency increases up to $R_L = 1.95$ at which point $p^* = p_e$ and then falls, giving the appearance of the hill-shape.

4 Implications

4.1 Empirical Predictions

In this section, we list the key empirical implications of the model, and discuss related empirical findings.

1. *Bank competition leads to more, and cheaper, financing of firms which are characterized by asymmetric information, and reduces average loan quality.*

Competition lowers the interest rates that banks charge borrowers and more firms receive financing from banks (which lowers financial constraints and encourages entrepreneurship, as in Paulson and Townsend (2004)). Consistent with our prediction, Rice and Strahan (2010) find that in US states which are more open to branching (more competition), small firms are more likely to borrow from banks, and at cheaper rates (see e.g., Black and Strahan (2002), Jayaratne and Strahan (1996), Huang (2008), Berger et al. (2018) for more real effects of deregulation). In other contexts, Carlson and Mitchener (2009) study the effect of new bank branches in the US in the 1920s and Canales and Nanda (2012) study decentralized banks in Mexico, and find evidence consistent with our predictions.

Existing theories predict that cheaper credit should reduce borrower risk-taking, due to reduced risk-shifting incentives (e.g., Boyd and DeNicolò (2005) and Stiglitz and Weiss (1981)). However, Kerr and Nanda (2009) find that although US banking reforms fuelled extraordinary growth in entrepreneurship, it was also concurrently associated with more closures, and the closures were concentrated in the new ventures. Consistent with these findings, in our model, the marginal borrowers which previously did not receive credit from banks but receive credit when bank competi-

tion increases, are the firms with the higher probability of default (as p^* is lower). Similarly, consistent with our predictions, Braggion et al. (2017) find evidence in the unregulated (so, pure competition effects) banking sector of 1885-1925 Britain that higher bank concentration is associated with less lending, but higher quality loans.

2. *The relationship between the size of the banking sector and economic growth is non-monotonic: it is positive up to a threshold, and then becomes negative.*

When the banking sector is monopolistic (inefficiently small), an increase in competition leads to a higher level of economic growth (since more positive NPV projects are financed). However, beyond a point, an increase in competition and an expansion of the banking sector hurts economic growth. This prediction is consistent with the finding that too much finance may harm economic growth (see Law and Singh (2014)).

4.2 Policy Interventions

In this section, we consider instruments which may be used to improve financing efficiency, given the level of competition in the banking sector.

1. *Interest Rate controls*

The regulator may set a minimum requirement on the loan interest rate (e.g. DeMeza and Webb (1987)) to achieve the efficient outcome for the competitive banking sectors, $n > \bar{n}$. Such a regulation would effectively make bank financing less attractive for the borrower as it becomes more expensive to borrow, and p^* increases. However, for $n < \bar{n}$, there would be a cap on the loan rate. Specifically, set R_L such that $p^* = p_e$.

2. *Tax/Subsidy*

Similar effects are achieved through the use of a direct tax/subsidy on the banking sector. If $n > \bar{n}$, a benevolent regulator will impose a tax on the sufficiently competitive banking sector to push the equilibrium towards the efficient outcome. When a tax is imposed in competitive banking sectors, the increased cost is passed onto the borrowers. This makes bank financing less attractive, and p^* increases. If, however, $n < \bar{n}$, the benevolent regulator will subsidize the banking sector to reduce the cost of borrowing from banks.

5 Conclusion

In a model of asymmetric information, we study the relationship between firm financing efficiency and market power in the banking sector. The equilibrium is always pooling. We show that if the banking sector is perfectly competitive, the equilibrium is always inefficient and is characterized by an inefficiently high level of financing. In contrast, in the monopolistic banking sector, the level of firm financing is never inefficiently large. The average quality of bank loans increases monotonically with market power, but there exists a hill-shaped relationship between efficiency and market power. Intuitively, market power allows the bank to charge a higher interest rate on loans which drives out the lower quality projects.

Optimal policy interventions (e.g., interest rate controls) depend on the market structure of the banking sector. The regulator may set a minimum requirement on the loan interest rate to achieve the efficient outcome for the sufficiently competitive banking sectors. However, when bank competition is low, there would be a cap on the loan rate.

6 Appendix: Proofs

Proof of Lemma 1:

Compare any two borrowers, i and j , such that $p_i \neq p_j$. Suppose that the equilibrium is separating, such that each borrower is charged a different interest rate, $R_L^i \neq R_L^j$.

Borrower of type i truthfully reveals her type if her incentive compatibility constraint is satisfied:

$$p_i(X - R_L^i) \geq p_i(X - R_L^j) \quad (14)$$

$$\implies R_L^j \geq R_L^i \quad (15)$$

Similarly, borrower j 's incentive compatibility constraint is written as follows:

$$p_j(X - R_L^j) \geq p_j(X - R_L^i) \quad (16)$$

$$\implies R_L^i \geq R_L^j \quad (17)$$

To satisfy both incentive compatibility constraints, we set $R_L^i = R_L^j = R_L$. However, a necessary condition for the existence of a separating equilibrium is that there exists $R_L^i \neq R_L^j$ such that constraints (14) and (16) are satisfied. Clearly this condition is violated and the only candidate equilibrium is a pooling one where both types of borrowers are charged the same interest rate $R_L^i = R_L^j$. It should be noted that the above argument is independent of the bank market structure.

Proof of Proposition 1:

In the perfectly competitive banking sector, a bank makes zero profit,

$$-C + \frac{1 + p^{*pc}}{2}(R_L - R_D) = 0 \quad (18)$$

$$\Rightarrow R_L = \frac{2(1 + C)}{1 + p^{*pc}} \quad (19)$$

Substituting R_L in the marginally efficient borrower's ($p_i = p_e$) participation constraint (Equation (2)),

$$p_e \left(X - \frac{2(1 + C)}{1 + p^{*pc}} \right) - W = 0 \quad (20)$$

Note that $p_e X - W = 1 + C$. Substituting and simplifying,

$$1 + p^{*pc} = 2p_e \quad (21)$$

Re-write p^{*pc} as $p^{*pc} = p_e + \epsilon$. Equation (21) simplifies as:

$$p_e = 1 + \epsilon \quad (22)$$

However, $p_e < 1$ which implies that $\epsilon < 0$. It follows that $p^{*pc} < p_e$.

Proof of Proposition 2:

The interest rate on the loan, R comes from the marginal borrower's participation constraint (Equation (2), with equality) and the deposit rate is set competitively.

The banker's profit from lending to the marginal borrower, who is of type p^{*M} , is:

$$-C + \left[p^{*M} R - \left(\frac{1 + p^{*M}}{2} \right) R_D \right] \quad (23)$$

The banker incurs the cost for the project. The marginal borrower succeeds with probability (p^{*M}) and repays R . Any depositor is repaid with the average probability of the loan portfolio, $\frac{1+p^{*M}}{2}$.

Substituting the marginal borrower's participation constraint (Equation (2), with equality) and the deposit rate (Equation (4)), the banker's expected profit from lending to the marginal borrower is:

$$p^{*M}X - (1 + W) - C \quad (24)$$

Note that the expected profit from lending to the marginal borrower is 0, for $p^{*M} = p_e$. For any project $p_i < p_e$, the banker makes a negative expected profit. Therefore, the banker sets the interest rate, R such that $p^{*M} \geq p_e$.

Derivation of p^{*pc} (competitive banking sector):

The indifference condition between investing in the risky project and the safe asset is written as,

$$p^{*pc}(X - R_L(p^{*pc})) - W = 0 \quad (25)$$

Substituting $R_L(p^{*pc})$,

$$p^{*pc} \left(X - \frac{2(1 + C)}{1 + p^{*pc}} \right) - W = 0 \quad (26)$$

The equation is quadratic in p^{*pc} and is rearranged as,

$$p^{*pc^2}X + p^{*pc}(X - W) - (2(1 + C) + W) = 0 \quad (27)$$

A real solution exists since the determinant $= (X - W)^2 + 4X(2(1 + C) + W) \geq 0$,

We solve for p^{*pc} using the quadratic formula, and keep the positive root:

$$p^{*pc} = \frac{1}{2X}(- (X - W) + \sqrt{(X - W)^2 + 4X(2(1 + C) + W)}) \quad (28)$$

Proposition 3: Derivation of $\frac{dR}{dn}$ and $\frac{dp^*}{dn}$

The problem for bank j is:

$$\begin{aligned} \text{Max}_{R_L^j, p^*} \quad & (1 - p^*) \left[-C + \frac{1 + p^*}{2} (R_L^j - R_D) \right] D(R_L^j, R_L) \\ \text{s.t.} \quad & p^* (X - R_L) - W - \mu z \geq 0 \end{aligned} \quad (29)$$

The associated Lagrangian is,

$$L = (1 - p^*) \left[-C + \frac{1 + p^*}{2} (R_L^j - R_D) \right] D(R_L^j, R_L) + \lambda (p^* (X - R_L^j) - W - \mu z) \quad (30)$$

λ is the Lagrange multiplier. Substituting the demand function into the Lagrangian, we differentiate it with respect to R_L^j and set it equal to 0, for the first order condition.

$$\begin{aligned} & \frac{(1 - p^*)(1 + p^*)}{2} \left[\frac{R_L - R_L^j}{2\mu} (1 - p^{*2}) + \frac{1 - p^*}{n} \right] - \\ & \frac{1}{2\mu} (1 + p^*)(1 - p^*)^2 \left[-C + \frac{1 + p^*}{2} (R_L^j - R_D) \right] - \lambda p^* = 0 \end{aligned} \quad (31)$$

Setting $R_L^j = R_L$ for the symmetric equilibrium, we get:

$$\frac{(1 - p^*)^2(1 + p^*)}{2n} - \frac{(1 - p^*)^2(1 + p^*)}{2\mu} \left[-C + \frac{1 + p^*}{2} (R_L - R_D) \right] - \lambda p^* = 0 \quad (32)$$

Totally differentiating the above with respect to R_L and n ,

$$-\frac{(1-p^*)^2(1+p^*)^2}{4\mu}dR_L - \frac{(1-p^*)^2(1+p^*)}{2n^2}dn = 0 \quad (33)$$

$$\implies \frac{dR_L}{dn} = -\frac{2\mu}{n^2(1+p^*)} < 0 \quad (34)$$

Totally differentiating the constraint with respect to p^* and R_L and using Equation (34),

$$(X - R_L)dp - p^*dR_L = 0 \quad (35)$$

$$\implies (X - R_L)dp + p^*\frac{2\mu}{n^2(1+p^*)}dn = 0 \quad (36)$$

$$\implies \frac{dp^*}{dn} = -\frac{2p^*\mu}{n^2(1+p^*)(X - R_L)} < 0 \quad (37)$$

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