Credit, Bankruptcy, and Intermediary Market Structure

Andrea Buraschi

London Business School and CEPR

Li, Hao

University of Toronto

June, 2004

Abstract: We use a model of costly monitoring to study the determinants of savings mobilization, capital allocation and entrepreneur bankruptcy rates under different market structures of financial intermediation. Borrowers have access to the same investment project but differ in the value of their collateralizable assets. The main finding is that monopolistic intermediation induces less lending and higher bankruptcy rates than competitive intermediation. These two types of monopoly distortions are due to the monopoly power with lenders and with borrowers respectively. Under both market structures, an increase in available credit or a reduction in monitoring costs implies that more borrowers obtain funds. Bankruptcy rates, however, are reduced only under competitive intermediation.

JEL classification: G2, D3, D4, P26, P50

Keywords: Credit market structure, banking, bankruptcy, default, collateral

Acknowledgements: Andrea Buraschi is an Assistant Professor from London Business School, Institute of Finance, Sussex Place, Regent's Park, London NW1 4SA, United Kingdom; Li, Hao is a Professor of Economics at the University of Toronto. We gratefully acknowledge the suggestions of In-Koo Cho, Bruce Greenwald, Lars Hansen, Robert Lucas, George Pennacchi, Robert Townsend, and Michael Woodford. The Editor and an anonymous referee made detailed comments that have helped us improve on an earlier draft.

Credit, Bankruptcy, and Intermediary Market Structure

ABSTRACT: We use a model of costly monitoring to study the determinants of savings mobilization, capital allocation and entrepreneur bankruptcy rates under different market structures of financial intermediation. Borrowers have access to the same investment project but differ in the value of their collateralizable assets. The main finding is that monopolistic intermediation induces less lending and higher bankruptcy rates than competitive intermediation. These two types of monopoly distortions are due to the monopoly power with lenders and with borrowers respectively. Under both market structures, an increase in available credit or a reduction in monitoring costs implies that more borrowers obtain funds. Bankruptcy rates, however, are reduced only under competitive intermediation.

JEL CLASSIFICATION: G2, D3, D4, P26, P50

KEYWORDS: Credit market structure, banking, bankruptcy, default, collateral

1. Introduction

In an economy with a well-developed financial intermediary sector, lenders rarely lend to borrowers directly. Instead, as financial intermediaries between lenders and borrowers, banks perform the important function of insuring lenders against the risks of default by borrowers. This function is achieved by screening the investment projects of borrowers, by assessing their credit worthiness and by monitoring the investment outcomes. How is the function affected by the market structure of the intermediary sector?

A recent line of literature on financial intermediation has stressed the effect of banking competition on project screening and found that competition in the intermediary sector increases default risks. For example, in Broeker's (1990) model, banks announce interest rates at which they will provide credit to borrowers that pass a credit test. When the credit tests are independent across banks and give noisy signals of the credit worthiness of the borrowers, the proportion of borrowers that pass at least one test increases with the number of banks. Thus, when there is a greater number of competing banks, the average credit quality decreases, and hence the default risks increase. Riordan (1993) considers a similar setting and shows that in the absence of collateral or other self-selection devices, banks have the incentive to cut interest rates to improve the credit quality of the pool of their borrowers. The intuition is that borrowers that accept the least favorable interest rate are the ones that have been rejected by other banks. In this setting, more competition makes each individual bank more conservative about marginal loans. This "winner's curse" becomes worse with more competing banks, and the aggregate result is less bank lending (see also Shaffer, 1998 and Marquez, 2002).

In this paper we present a contrasting view on the effect of competition on the banks' function of insuring lenders against risks of default by borrowers. Our paper differs from the existing literature by focusing on the role of collateral in credit assessment and project monitoring, while abstracting from project screening by assuming that borrowers have identical investment projects. We build on the costly monitoring framework introduced by Townsend (1979).[1] In Townsend's (1979) original contribution, borrower-entrepreneurs

[1] Williamson (1987b) uses a similar costly monitoring framework in a real business cycle setup to show

have *ex post* private information about the outcome of their projects, and monitoring (auditing) is costly for lenders. Diamond (1984) show that intermediaries arise as "delegated" monitors to economize on the monitoring cost and solve the free-rider problem among lenders; we use this result to compare alternative market structures of the intermediary sector. To the costly monitoring framework, we introduce the feature that entrepreneurs differ in the amount of non-liquid wealth that they can lodge as collateral in loan contracts. In our model, entrepreneurs are endowed with fixed assets that are needed for production and therefore cannot be liquidated to finance the project, but they can use their fixed assets as collateral to reduce the cost of the *ex post* moral hazard problem to the intermediary in monitoring the project output.

Our main discovery is that monopolistic intermediation results in less lending and higher entrepreneur bankruptcy rates than competitive intermediation. A monopoly intermediary lends less because it has the monopoly power with lenders and perceives a higher marginal cost of credit than competitive intermediaries. In contrast, the monopoly distortion of higher business bankruptcy rates arises from the market power with borrowers. As the monopoly intermediary extracts more surplus from entrepreneurs by raising debt repayments, entrepreneurs are more likely to forfeit collateral and declare default. In other words, the monopoly intermediary has incentives to demand a high debt repayment from a borrower so as to sometimes induce default and seize the collateral, while under competitive intermediation intermediaries compete to lower the debt repayment and thus reduce the default risks. The monopoly distortion of higher bankruptcy rates exists even if the monopoly intermediary faces a competitive credit market and has no market power with lenders. Further, in a market expansion due to either an increase in the credit supply or a decrease in the monitoring cost, the default rate for the pre-existing loans is unaffected under monopolistic intermediation while it falls under competitive intermediation.

Our result that monopolistic intermediation increases bankruptcy risks is related to Rajan (1992). He considers a model in which a bank obtains monopolistic information

that endogenous financial intermediation helps to account for monetary phenomena such as the positive correlation between the price level and real output. Bernake and Gertler (1989) address similar questions with a model of collateral.

on the borrower which can be used to gain control on the borrower's decisions and induce the borrower to terminate negative NPV projects. Unfortunately, this control also allows the bank to extract surplus from the borrower *ex post*. This makes the borrower exert less than optimal effort, thus reducing project returns. Since competition among banks reduces their bargaining power over the borrower, Rajan's model has the implication that competitive intermediation can lead to greater effort in project selection and hence lower bankruptcy rates. In the present paper there is no project selection effort, and the monopoly intermediary's tendency of inducing higher bankruptcy rates does not arise from a holdup problem. Instead, we have a model in which collateral is used to alleviate the *ex post* project monitoring problem, and the monopoly distortion of higher bankruptcy rates comes from the monopoly intermediary's incentives to demand a high debt repayment so as to seize the collateral in the event of default. A further difference between our model and Rajan's is that in our paper the optimal monopoly repayment schedule and the competitive repayment schedule are determined in a general equilibrium framework with both the lenders and the borrowers explicitly modeled.

The model is presented in the next section. Sections 3 and 4 analyze monopolistic intermediation and competitive intermediation respectively. We characterize the loan contracts and deposit interest rate for each intermediary structure. Section 5 compares the two representative structures in terms of aggregate lending and entrepreneur bankruptcy rates, and discusses how changes in available credit and monitoring cost affect credit market performance under the two structures. Two extensions of the main results are briefly discussed. In Section 6 we discuss the related extensive literature on "excessive" competition in the financial intermediary sector, and provide some evidence for our result that competition increases bank lending. We conclude with some remarks on the directions of possible future work.

2. A Costly Monitoring Model with Collateral

Our economy is described by three types of agents (borrowers, intermediaries and lenders), three types of goods (investment good, collateral and consumption good) and three periods (contract period, production period and consumption period). In the contract period, borrowers offer collateral to intermediaries to obtain the investment good, and intermediaries in turn receive the investment good from lenders by promising repayment with interest. In the production period, borrowers who received the investment good implement a risky project and observe the output. In the consumption period, consumption takes place after the contracts are settled between the intermediaries and the borrowers, and between the intermediaries and the lenders. The details of these activities and the parameters of the economy are described next.

There is a continuum of risk-neutral borrower-entrepreneurs, each of whom has access to a risky project. The project takes one unit of the investment good and transforms it into a non-negative random output of w units of the consumption good. The output w is assumed to be i.i.d. across projects. The range of distribution of w is $[w_1, w_2]$, with mean $\overline{w}$. The distribution function is $F(w)$; we assume that the the corresponding density function $f(w)$ is continuous. Each entrepreneur can observe costlessly the outcome of his project, but output verification costs $g > 0$ units of the consumption good for any other agent. To focus on the role of collateral in capital allocation, we assume that this monitoring cost is the same for all projects. The monitoring cost plays an important role in our model, and should be interpreted to include not only the cost of auditing, but also the transaction cost of bankruptcy to the intermediary.[2]

Entrepreneurs rely entirely on outside funding to provide one unit of the investment good that is needed to carry out the project. However, they are endowed with different units of divisible and non-liquid fixed assets that can be (partially or wholly) used as collateral in the loan contract with lenders. These assets are non-liquid because they are necessary for the production and cannot be sold to finance the project.[3] Examples

[2] Bankruptcy costs can be a substantial portion of the claims. Altman (1984) finds that the average administrative bankruptcy costs are 6% of the claims under Chapter 11 and 6.2% under U.K. Receivership. Franks and Torous (1994) discuss the direct and efficiency bankruptcy costs under alternative bankruptcy codes. They find that U.S. companies spend an average of 27 months in Chapter 11 and 17 months in workouts outside the bankruptcy process, while the U.K. Insolvency Code generally results in a speedier settlement of claims.

[3] Since all entrepreneurs have access to the same investment project, the role of collateral in our model is different from that in Besanko and Thakor (1987), where borrowers with private information regarding the prospects of their investment projects use collateral as a signal of credit-worthiness. Our

of such assets are patents or lab equipment of a biotech firm, or airplanes of an airline company. For analytical convenience, we assume that the non-liquid assets are liquidated after completion of the project, and the consumption value of the liquidated collateral can be costlessly verified by lenders.[4] Collateral represents the lender's claim on the return of the borrower's project, when the latter is unable to honor the repayment obligation specified in the loan contract. The range of the liquidation value of collateralizable assets is $[k_1, k_2]$, in units of the consumption good. The measure of entrepreneurs with non-liquid wealth greater than k, denoted as $U(k)$, is a decreasing continuous function of k. As we will see, putting up more non-liquid assets as collateral helps alleviate the *ex post* monitoring problem and lowers the cost of capital to entrepreneurs.

Motivated by the delegated monitoring result of Diamond (1984), we assume that there is no direct contact between lenders and entrepreneurs; instead, the supply of credit meets with the demand for loans indirectly through intermediaries, who offer contracts to both borrowers and lenders. As they deal with a continuum of borrowers with independent projects, the intermediaries in our model can perfectly diversify and offer lenders a risk-free return.[5] The contracts between intermediaries and lenders are therefore characterized by a risk-free deposit arrangement. We represent lenders by a non-decreasing and differentiable aggregate savings function $S(r)$, where r is the risk-free deposit rate. The savings $S(r)$ are measured in the investment good. Since each entrepreneur needs one unit of the investment good, the supply of credit represented by the function $S(\cdot)$ and the demand for loans represented by the function $U(\cdot)$ are measured in the same unit. The savings function $S(r)$ can be substantiated by specifying endowments and preference for a representative consumer. We simply take $S(r)$ as a primitive, and assume that it is defined for all non-negative deposit rates. We also make the following technical assumption:

---

model also differs from the *ex ante* moral hazard model of Holmstrom and Tirole (1997), who assume that entrepreneurs' own funds are entirely liquid and can be used to finance the project together with outside funds. In their model, the more own funds entrepreneurs have, the more credible their commitment of not misusing the outside fund, and the more likely they can obtain outside funds.

[4] The same assumptions on collateral are made, for example, in Schmidt-Mohr (1997). Adding a disparity in collateral valuation by the entrepreneur and by the lender, as in Barro (1976), will not change the results in the present paper. This will be discussed in Section 5.3.

[5] For results on intermediation when diversification is imperfect, see Winton (1997) and Yosha (1997).

Assumption 2.1: $r + S(r)/S'(r)$ increases with r.

Note that the total cost of obtaining loans from obtaining loans from depositors at deposit rate r is $rS(r)$. Since the aggregation savings function $S(r)$ is non-decreasing, Assumption 2.1 implies that the marginal cost of loans is increasing in the deposit rate. As can be seen in the next section, this is sufficient for the second-order condition of the monopoly's optimization problem. Assumption 2.1 is satisfied as long as the slope of the savings function decreases in the deposit rate, or does not increase too fast.

2.1. Risky debt

The building block for the subsequent sections is the loan contract between an intermediary and an entrepreneur. Regardless of the collateral value k put up by the entrepreneur, any optimal contract that maximizes a weighted sum of the expected profits of the entrepreneur and the intermediary subject to the participation constraints of the two takes the form of "risky debt."[6] A risky debt contract is characterized by a single number x, called the "face value of debt." If the realized output w exceeds $x - k$, the entrepreneur declares "success" and pays x. If $w < x - k$, the entrepreneur "defaults" or declares "bankruptcy." In this case, the intermediary incurs the cost g to verify the output and gets all the output plus collateral k. The logic behind the risky debt contracts is that it is in the interest of the entrepreneur as well as the intermediary to discourage the entrepreneur from falsely declaring bankruptcy. To do so requires making the punishment for default as severe as possible, which is to forfeit all collateral and any output from the project. The proof that any optimal contract takes the form of risky debt is given by, for example, Townsend (1979), Gale and Hellwig (1985), Williamson (1987a, 1987b). The adaptation of the proof to our model of intermediation with collateral is straightforward and omitted.

Let $P(x, k)$ be the expected payment from an entrepreneur with collateral value k to the intermediary under a risky debt contract with face value x, before the intermediary

[6] We rule out stochastic monitoring for technical reasons. As Townsend (1979) first pointed out, random monitoring can be more efficient. We note that the focus here is comparison of alternative structures of intermediation, and that any efficiency gain will occur under both monopolistic and competitive intermediation, although the gain may differ.

incurs the monitoring expenses. Then,

$$P(x,k) = \begin{cases} x, \quad \text{for } x \le w_1 + k \\ \int_{w_1}^{x-k} (w+k) f(w) \text{ d}w + \int_{x-k}^{w_2} x f(w) \text{ d}w, \quad \text{for } x \in (w_1 + k, w_2 + k) \\ \overline{w} + k, \quad \text{for } x \ge w_2 + k. \end{cases} \tag{2.1}$$

The probability of default is 0 if $x \le w_1 + k$, strictly between 0 and 1 if $x \in (w_1 + k, w_2 + k)$, and 1 if $x \ge w_2 + k$. A higher face value x leads to a greater probability of default for $x \in (w_1 + k, w_2 + k)$, and a greater expected payment P for $x < w_2 + k$. Denote the expected profits of the entrepreneur with collateral k from the risky debt contract with face value x as $B(x,k)$. Then, $B(x,k)$ is the difference between the expected output $\overline{w}$ and $P(x,k)$:

$$B(x,k) = \overline{w} - P(x,k). \tag{2.2}$$

Since $P(x,k)$ weakly increases with x, $B(x,k)$ weakly decreases with x. Denote the gross return to an intermediary of a risky debt with face value x and collateral k as $L(x,k)$. Then, since the intermediary incurs the cost of auditing the output, $L(x,k)$ is the difference between the expected payment $P(x,k)$ and the expected monitoring expense:

$$L(x,k) = P(x,k) - gF(x-k). \tag{2.3}$$

Finally, let $T(x,k) = B(x,k) + L(x,k)$ be the sum of the entrepreneur's profits and the expected loan return, given by

$$T(x,k) = \overline{w} - gF(x-k). \tag{2.4}$$

Note that the total gross profit T decreases with x for $x \in (w_1 + k, w_2 + k)$ because a higher face value means a greater default probability and hence a greater expected monitoring expense.

For $x \in (w_1 + k, w_2 + k)$, we can rewrite $L(x,k)$ as:

$$L(x,k) = \int_{w_1}^{x-k} (v-g) f(v) \text{ d}v + \int_{x-k}^{w_2} (x-k) f(v) \text{ d}v + k,$$

Note that the first two terms depend on face value x only through $x - k$. Thus, $x \in (w_1 + k, w_2 + k)$ maximizes $L(x,k)$ for a given k if and only if $x - k \in (w_1, w_2)$ maximizes the first two terms above. The following assumption implies that for any collateral value k, the gross return $L(x,k)$ is a concave function of face value x.

ASSUMPTION 2.2: $\int_{w_1}^{w}(v-g)f(v)\,\mathrm{d}v + \int_{w}^{w_2} wf(v)\,\mathrm{d}v$ *is strictly concave in* w *on* $[w_1, w_2]$ *and achieves maximum at a unique interior point* w^*.

In our costly monitoring model, a higher face value of debt increases the probability that the entrepreneur defaults, and can therefore decrease the loan return to the intermediary due to greater monitoring expenses. Assumption 2.2 is a simple way of capturing this idea. Although global concavity of the loan return is a strong assumption, it simplifies the analysis of loan contracts and allows us to focus on the comparison of monopolistic versus competitive intermediation.[7] Note that in our model all entrepreneurs have the same investment project, which explains why Assumption 2.2 is stated independently of the collateral value. The assumption that the loan return function is concave has been a standard one since Stiglitz and Weiss (1981).[8]

By taking derivatives of the expression in Assumption 2.2 with respect to w, we find that w^* satisfies

$$1 - F(w^*) - gf(w^*) = 0. \tag{2.5}$$

Regardless of the intermediary market structure, for any collateral value k, the maximum face value of debt that will occur in a loan contract is $w^* + k$: if the face value of debt exceeds $w^* + k$, then since by Assumption 2.2 L is concave in x with maximum reached at $x = w^* + k$ and since B decreases with x, a reduction in x would increase profits for

[7] Regardless of the cost of monitoring g, concavity is assured as long as the density $f(\cdot)$ is non-decreasing, such as the uniform distribution. If $f(\cdot)$ is decreasing, concavity still obtains if it does not decrease too fast or g is not too great. The function in Assumption 2.2 is always decreasing around w_2. For it to have an interior maximizer on (w_1, w_2), the function has to be increasing around w_1. A sufficient condition is $gf(w_1) < 1$.

[8] Stiglitz and Weiss (1981) argue that credit rationing may occur when the market interest rate does not equate the supply of funds to the demand. They discuss two reasons: adverse selection of borrowers, where a higher interest rate attracts borrowers who are on average less likely to repay the loan, and moral hazard of borrowers, where a higher interest motivates borrowers to select riskier projects. In both cases, an increase in the interest rate will decrease the return to the intermediary from loans, and may therefore contradict the zero-profit condition for intermediaries. Here, as in Williamson (1987a, 1987b) and Bernake and Gertler (1989), costly output verification plays a similar role as adverse selection and moral hazard of borrowers.

both the intermediary and the entrepreneur. It follows that the maximum default rate in any loan contract is $F(w^*)$. For this reason, we call the loan contract with the face value $w^* + k$ the "maximum default contract." The maximum default contract plays a special role in our analysis. Define

$$p^* = \int_{w_1}^{w^*} wf(w)\ \mathrm{d}w + \int_{w^*}^{w_2} w^* f(w)\ \mathrm{d}w.$$

Then, under the maximum default contract, we have:

$$P(w^* + k, k) = p^* + k;$$
$$L(w^* + k, k) = p^* + k - gF(w^*);$$
$$B(w^* + k, k) = \overline{w} - (p^* + k).$$

We can verify that p^* lies between w_1 and $\overline{w}$.[9] For future references, we denote

$$k^* = \overline{w} - p^*;$$
$$t^* = \overline{w} - gF(w^*).$$

Then, k^* is the highest collateral value such that the maximum default contract gives the entrepreneur non-negative expected profits, and $t^* = T(w^* + k, k)$ is the sum of the expected profits of the entrepreneur and the loan return to the intermediary under the maximum default contract.[10]

3. Credit Market with Monopolistic Intermediation

A monopoly intermediary maximizes its expected profits by choosing a deposit rate to obtain savings from lenders and by offering a menu of contracts to entrepreneurs through

[9] By taking the derivatives with respect to w^* of the equation that defines p^*, we can show that p^* is an increasing function of w^*. Further, $w^* = w_1$ implies that $p^* = w_1$, and $w^* = w_2$ implies $p^* = \overline{w}$. Since w^* is in (w_1, w_2), p^* is between w_1 and $\overline{w}$.

[10] We can show that $t^* > 0$ so that gains of trade exist between depositors and the entrepreneur (through intermediaries) under the maximum default contract, regardless of the collateral value k of the entrepreneur. Indeed, we have $t^* > k^* + w_1$, because by Assumption 2.2 at $w = w^*$ the function $\int_{w_1}^{w} (v - g)f(v)\ \mathrm{d}v + \int_{w}^{w_2} wf(v)\ \mathrm{d}v$ reaches the maximum of $p^* - gF(w^*)$, which is greater than w_1, the value of the function at $w = w_1$.

which to lend the capital. The monopoly intermediary makes take-it-or-leave-it offers to entrepreneurs according to their collateral value. This assumes that the value of collateralizable assets of each entrepreneur is known to the intermediary.[11] We first characterize the monopoly loan contracts and then the deposit rate.

3.1. Monopoly loan contracts

For an entrepreneur with any collateral k, the monopoly intermediary chooses the face value of debt x to maximize the expected loan return $L(x,k)$ subject to the entrepreneur's participation constraint that his expected profit $B(x,k)$ is non-negative. The loan return L as a function of x is given by (2.3). It is convenient to rewrite the entrepreneur's participation constraint as $L(x,k) \leq T(x,k)$, where T, given by (2.4), is the sum of the loan return L to the intermediary and the expected profits B of the entrepreneur.

Figure 1 plots $L(x,k)$ and $T(x,k)$ for a given k, as functions of face value x, for the case in which the random output w is uniformly distributed on $[w_1, w_2]$. How the two functions intersect with each other depends on k, as we will see in the proof of the following proposition. We can verify that the uniform distribution satisfies Assumption 2.2 if $g < w_2 - w_1$. In this case, from equation (2.5) we have $w^* = w_2 - g$, which is between w_1 and w_2, as desired. Under the uniform assumption, for face value of debt $x \in [w_1 + k, w_2 + k]$, the total gross profit T is linear and the loan return L is quadratic. These properties are special, but for any output distribution F that satisfies Assumption 2.2, T is decreasing and L is concave with the maximum reached at $x = w^* + k$.

Let $x_m(k)$ denote the solution to the problem of $\max_x L(x,k)$ subject to $L(x,k) \leq T(x,k)$, as a function of collateral value k. We now show that $x_m(k)$ is given by

$$x_m(k) \begin{cases} = w^* + k, & \text{for } k < k^* \\ \text{satisfies } B(x_m(k), k) = 0, & \text{for } k \in [k^*, \overline{w} - w_1) \\ = \overline{w}, & \text{for } k \geq \overline{w} - w_1. \end{cases} \tag{3.1}$$

The following proposition gives this result in words.

[11] Our comparison results are robust to the alternative assumption that the collateral value is private information and loan contracts must give entrepreneurs incentives to reveal it. See Section 5.3.

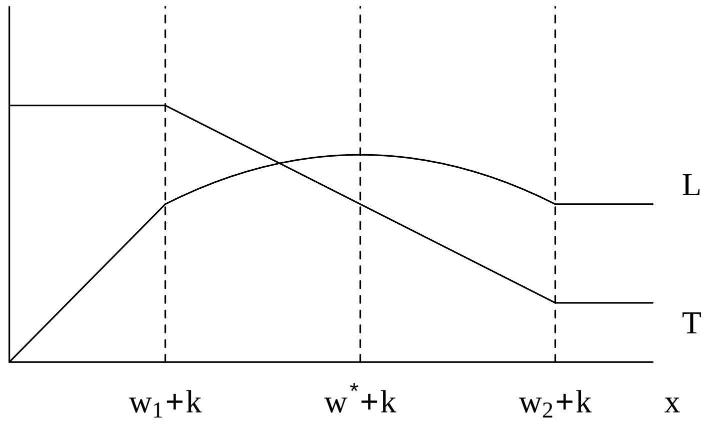

Figure 1. $L(x, k)$ and $T(x, k)$ as functions of x for fixed k.

PROPOSITION 3.1. *Under monopolistic intermediation, among entrepreneurs that obtain loans, (i) maximum default contracts are optimal for low collateral values, (ii) expected profits are zero for intermediate collateral values, and (iii) the probability of default is zero for high collateral values.*

PROOF. Consider the two functions $L(x, k)$ and $T(x, k)$ for any given k, as x varies from 0 to above $w_2 + k$. Since the two functions are continuous, and since $L(0, k) = 0 < \overline{w} = T(0, k)$ and $L(w_2 + k, k) = \overline{w} - g + k > \overline{w} - g = T(w_2 + k, k)$, there is at least one intersection in $(0, w_2 + k)$. There cannot be two or more intersections. To see this, note that since $L(x, k)$ is increasing and $T(x, k)$ is decreasing in $(0, w^* + k]$, there can be at most one intersection in this range. If there is one, then there cannot be another intersection in $(w^* + k, w_2 + k)$, because both $L(x, k)$ and $T(x, k)$ are decreasing in $[w^* + k, w_2 + k)$ but $T(x, k)$ decreases faster (compare (2.3) with (2.4); note that $P(x, k)$ is increasing in x.) For the same reasons, if there is no intersection in $(0, w^* + k]$ (in which case T is entirely above L in this range), then there is exactly one intersection in $(w^* + k, w_2 + k)$.

The two functions $L(x, k)$ and $T(x, k)$ can intersect in $(0, w_1 + k]$, $(w_1 + k, w^* + k)$, or $[w^* + k, w_2 + k)$, depending on the collateral value k. The solution $x_m(k)$ to the problem of $\max_x L(x, k)$ subject to $L(x, k) \leq T(x, k)$ depends on where the intersection is and thus also on k. For $k \geq \overline{w} - w_1$, we have $L(0, k) < T(0, k)$ and $L(w_1 + k, k) = w_1 + k \geq \overline{w} = T(w_1 + k, k)$, so the intersection occurs in $(0, w_1 + k]$. Since $L(x, k) = x$ and $T(x, k) = \overline{w}$ in this range, the intersection is at $x = \overline{w}$. In this case, L increases in x for $x < \overline{w}$ and $L > T$ for $x > \overline{w}$, so we have $x_m(k) = \overline{w}$. For $k \in [k^*, \overline{w} - w_1)$, we have $L(w_1 + k, k) < T(w_1 + k, k)$ and $L(w^* + k, k) = p^* + k - gF(w^*) \geq t^* = T(w^* + k, k)$, so the intersection occurs in $(w_1 + k, w^* + k]$. In this case, L is increasing in x before the intersection and $L > T$ after the intersection, so the intersection gives $x_m(k)$. It satisfies $B(x_m(k), k) = 0$ because $L = T$ at the intersection. Finally, for $k < k^*$, we have $L(w^* + k, k) < T(w^* + k, k)$ and $L(w_2 + k, k) > T(w_2 + k, k)$, so the intersection occurs in $(w^* + k, w_2 + k)$. Since in this range L is decreasing in x, the solution $x_m(k)$ is not given by the intersection. Instead, it is given by $w^* + k$, because this maximizes L while satisfying $L \leq T$. *Q.E.D.*

Proposition 3.1 can be explained as follows. In lending to the entrepreneurs, the monopoly intermediary uses the face value of debt in the loan contract to discriminate among different collateral values. Under Assumption 2.2, to maximize the return L on a loan to an entrepreneur with collateral k, the monopolist should choose the maximum default contract with face value $w^* + k$ if it satisfies the entrepreneur's participation constraint. This is precisely the case for entrepreneurs with little collateral ($k < k^*$)—recall that k^* is the highest collateral value such that the maximum default contract yields non-negative expected profits to the entrepreneur. The participation constraint of these entrepreneurs does not bind under the monopoly loan contract. For all entrepreneurs with collateral values higher than k^*, the maximum default contract with $x = w^* + k$ would leave them with negative profits. In this case, the monopolist optimally lowers the face value of debt from $w^* + k$ to the point $x_m(k)$ where the participation constraint just binds, i.e., $B(x_m(k), k) = 0$. For entrepreneurs with intermediate values of collateral ($k^* \leq k < \overline{w} - w_1$), the participation constraint binds at a point where the probability of default is strictly between 0 and 1. (This is the case depicted in Figure 1.) For those entrepreneurs who can provide sufficient collateral ($k \geq \overline{w} - w_1$), the participation constraint binds at a point where "full collateralization" is achieved: the intermediary extracts all output from the entrepreneur by charging $\overline{w}$, and the collateral committed by the entrepreneur is so high that he will never default.

Under the optimal schedule of face value characterized above, the loan return to the monopoly intermediary can be shown to increase with collateral value k. For collateral values below k^*, the intermediary obtains the highest return $k + t^* - k^*$ on the loan to an entrepreneur with collateral k, under the maximum default contract with face value $w^* + k$. For these entrepreneurs, an increase in collateral is matched with an increase in the face value of debt by the same amount. This has no effect on the probability of default, but increases the expected profits for the intermediary because more collateral is forfeited.[12] For collateral levels between k^* and $\overline{w} - w_1$, the probability of default under the optimal contract $x_m(k)$ is strictly between 0 and 1. The intermediary charges a lower face value of debt to entrepreneurs with more collateral for them to break even, since for any given face value of debt these entrepreneurs make greater expected payments to the intermediary. Formally, taking derivatives of $B(x_m(k), k) = 0$ with respect to k, we have:

$$\frac{dx_m(k)}{dk} = -\frac{F(x_m(k) - k)}{1 - F(x_m(k) - k)} < 0.$$

Using the above expression, we have

$$\frac{dL(x_m(k), k)}{dk} = \frac{gf(x_m(k) - k)}{1 - F(x_m(k) - k)} > 0.$$

Thus, even though the monopoly lowers the face value of debt for entrepreneurs with more collateral, the expected loan return $L(x_m(k), k)$ increases with collateral, as the intermediary incurs a smaller monitoring expense due to a lower probability of default. Finally, for collateral levels above $\overline{w} - w_1$, the probability of default is zero and the collateral value does not affect the intermediary's profit.

3.2. Monopoly deposit rate

To attract funds from lenders, the monopoly intermediary sets a deposit rate. Since the loan return L to the monopoly intermediary increases with collateral value k under the loan contracts characterized above, the profit optimization problem of the monopoly

[12] Since $x_m(k) = w^* + k$, we have $B(x_m(k), k) = \overline{w} - (p^* + k)$, so entrepreneurs' expected profits decrease with the collateral value for $k < k^*$. However, the expected amount of consumption goods that the entrepreneurs receive after completion of the projects, including any returned collateral, is equal to $\overline{w} - p^*$, independent of the collateral level. Thus, these entrepreneurs cannot benefit by destroying part of their collateral. The monopoly loan contracts with $x_m(k) = w^* + k$ are no longer incentive compatible when the value of collateralizable assets owned by an entrepreneur is known only to himself, because the entrepreneurs will want to hide part of their assets.

intermediary comes down to choosing the deposit rate r and a "cutoff" collateral value k, such that only the entrepreneurs with collateral higher than k will be financed. This problem can be stated as:

$$\max_{k,r} \int_{k}^{k_2} L(x_m(z), z) \, \mathrm{d}(-U(z)) - S(r)r$$

subject to $U(k) \leq S(r)$. Let r_m and k_m be the solution to the above maximization problem. An interior solution satisfies the following first-order condition

$$L(x_m(k_m), k_m) = r_m + S(r_m)/S'(r_m), \tag{3.2}$$

and the "market-clearing condition" $U(k_m) = S(r_m)$. The second-order condition is satisfied because the loan return increases with the collateral value and by Assumption 2.1 the marginal cost of loan $r + S(r)/S'(r)$ increases with the deposit rate.[13]

The first-order condition (3.2) can be interpreted as the familiar monopoly condition that the marginal revenue equals the marginal cost—the left-hand-side is the marginal revenue from lending to the entrepreneur with the cutoff value, and the right-hand-side is the cost of attracting an additional unit of loan from the lenders. Note that unless the savings function is perfectly elastic, the marginal revenue is strictly greater than the marginal cost, so that the monopoly intermediary makes a positive profit on the loan to the marginal entrepreneur.

Due to the *ex post* monitoring problem not all entrepreneurs get loans; that is, typically we have $k_m > k_1$. Entrepreneurs with low collateral values cannot obtain loans, even though they have access to the same projects as the entrepreneurs who get loans. More interestingly, the nature of the borrowing constraint that the collateral-poor entrepreneurs face depends on whether $k_m > k^*$ or $k_m < k^*$. In the former case, the marginal entrepreneur with collateral k_m earns zero expected profits. The entrepreneurs with lower collateral values do not get loans simply because they cannot offer the monopoly intermediary a loan return that covers the cost of obtaining credit for the monopoly. In contrast,

[13] The second-order condition requires that $(L(x_m(k), k) - r - S(r)/S'(r))U'(k)$ have negative derivatives with respect to k at the solution k_m, where r is a decreasing function of k via the market-clearing condition.

when $k_m < k^*$, the marginal entrepreneur with collateral k_m earns strictly positive profits. For the entrepreneurs with collateral values just below k_m, the monopoly loan contracts given by (3.1), which are all maximum default loan contracts, would give them positive expected profits. These entrepreneurs would be willing to give up part of the profits to avoid being rationed. Due to the *ex post* monitoring problem, however, there is no credible way to transfer the profits to the intermediary. As a result, the entrepreneurs with collateral values just below k_m do not get loans.

4. Credit Market with Competitive Intermediation

Competitive intermediaries engage in price competitions in both the loan market and the deposit market. We will argue that this double-sided competition yields a unique "perfect competitive outcome" where intermediaries earn zero expected profits, with the expected return on each unit of loan equal to the cost of raising the capital. Competitive loan contracts and deposit rate will then be characterized. The results will be used in the next section to compare with monopolistic intermediation.

4.1. Competitive loan contracts

To concentrate on the comparison between monopolistic and competitive intermediation, we assume that the number of competitive intermediaries is fixed and finite; the exact number of intermediaries does not affect our results. We model competition among intermediaries as the following two-stage game. In the first stage, competing intermediaries simultaneously offer loan contracts to entrepreneurs and deposit contracts to lenders.[14] In the second stage, entrepreneurs and lenders simultaneously decide whether to participate in the loan market and the deposit market, respectively, and if they do, choose the best-termed contracts offered by the intermediaries.[15]

[14] In general, intermediaries have incentives to corner one of the two markets in order to secure monopoly power in the other. This is the case when the intermediaries compete in the loan market and in the deposit market sequentially, as in Yanelle (1997).

[15] Recall that in Section 2 we have already replaced the decisions of depositors by the aggregate savings function. Here we describe decisions of depositors for the convenience of the presentation.

We focus on symmetric subgame perfect Nash equilibria of the game, consisting of an identical menu of loan contracts and a common deposit rate offered by each intermediary, and the decisions by the entrepreneurs and the depositors, such that no agent has an incentive to deviate. We impose two additional restrictions on the strategies of intermediaries, entrepreneurs and depositors. First, we adopt the convention that on the equilibrium path when entrepreneurs (depositors) face available contracts that are equally favorable, they divide their loan applications (savings) evenly among them.[16] Each intermediary is dealing with a continuum of entrepreneurs and can therefore offer risk-free returns to depositors, as under monopolistic intermediation. In the equilibrium constructed below, this convention ensures that deposits taken equal loan applications for each intermediary, so that there is no rationing of either depositors or entrepreneurs. Second, we assume that off the equilibrium path, the intermediaries may not ration either depositors or entrepreneurs.[17] Formally, we say that an intermediary is "bankrupt" if either deposits taken exceed loan applications or loan applications exceed deposits. In either case, a bankrupt intermediary receives an arbitrarily large negative payoff.

We claim that a menu of loan contracts and a deposit rate, together with the decisions by entrepreneurs and depositors satisfying the first restriction above, form a symmetric subgame perfect equilibrium if (i) each loan contract maximizes the expected profits of the entrepreneur subject to the intermediary making non-negative profits at the given deposit rate, and (ii) the total demand for loan contracts equals the total supply of deposits. To see this, first note that condition (ii) above ensures that there is no rationing of either depositors or entrepreneurs in equilibrium. Second, for any intermediary to be have a profitable deviation, a different deposit rate must be offered. A lower rate would not attract any deposit and would bankrupt the deviating intermediary if loan applications

[16] Since it is inefficient for multiple intermediaries to monitor a single entrepreneur, this convention requires some coordination among entrepreneurs to ensure that each of them is financed by a single intermediary.

[17] This assumption helps us to focus on the competitive outcome where all capital raised by intermediaries is loaned out, as in the monopoly case. More importantly, it rules out cornering of markets. As pointed out by Stahl (1988) and Yanelle (1989), even when intermediaries compete simultaneously in the two markets, competitive outcomes can be sensitive to assumptions of the competitive environment. These complications of competitive intermediation are important, but we ignore them here since our focus is on a direct comparison of monopolistic and competitive intermediation.

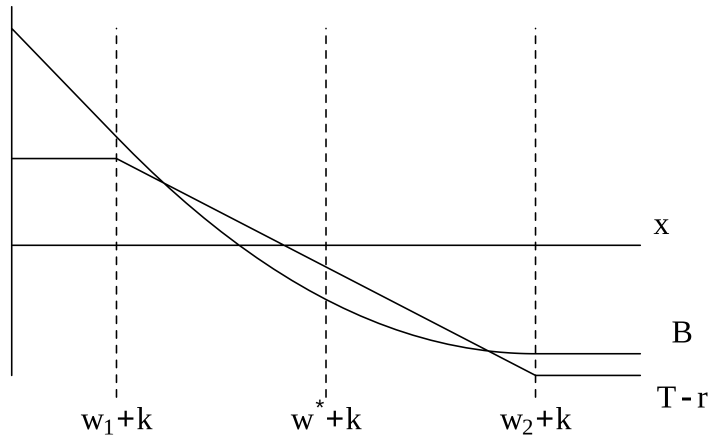

Figure 2. $B(x,k)$ and $T(x,k)-r$ as functions of x for fixed k.

are received; a higher rate would attract all deposits, but since the deviating intermediary may not ration either depositors or entrepreneurs, conditions (i) and (ii) above imply that there is no a menu of loan contracts for the intermediary to avoid bankruptcy.

We construct an equilibrium under competitive intermediation in two steps. In remainder of this subsection, we fix an arbitrary deposit rate and characterize the menu of competitive loan contracts that maximize the expected profits of the entrepreneur subject to the constraint that the intermediary makes non-negative profits. The next subsection we use this characterization of competitive loan contracts to derive the total demand for loan contracts as a function of the deposit rate and find the (unique) equilibrium deposit rate so that the demand equals the supply of deposits. Formally, given any deposit rate r, the loan contracts for entrepreneurs with collateral k solve the optimization problem of $\max_x B(x,k)$ subject to the participation constraint of the intermediary $L(x,k) \geq r$, where $B(x,k)$ is given by (2.2). The participation constraint can be rewritten as $B(x,k) \leq T(x,k) - r$, where $T(x,k)$ is the sum of the loan return to the intermediary and the expected profits of the entrepreneur, as given by (2.4). We now show that under this characterization, the participation constraint of the intermediaries is always binding so that all intermediaries make zero expected profits.

Figure 2 plots $B(x,k)$ and $T(x,k)-r$ as functions of x, for given r and k, for the case in which w is uniformly distributed on $[w_1, w_2]$ and $g < w_2 - w_1$. The relative position of the two functions depends on k and r, as we will see in the proof of the following proposition.

Under the uniform assumption, for face value of debt $x \in [w_1 + k, w_2 + k]$, the total net profit $T - r$ is linear and the expected profit of the entrepreneur B is quadratic. These special properties do not extend to general output distributions, but two properties shown in Figure 2 that do hold for any distribution satisfying Assumption 2.2 are: $B(x, k)$ and $T(x, k) - r$ decrease for $x \in (w_1 + k, w_2 + k)$, and $B(x, k)$ decreases faster than $T(x, k) - r$ in $(w_1 + k, w^* + k)$ and slower in $[w^* + k, w_2 + k)$. The latter property is due to Assumption 2.2, because L is the difference between T and B and is increasing in $(w_1 + k, w^* + k)$ and decreasing in $[w^* + k, w_2 + k)$.

Let $x_c(k)$ denote the solution to the problem of $\max_x B(x, k)$ subject to $B(x, k) \leq T(x, k) - r$, as a function of k, for a given r. We now show that the participation constraint of the intermediaries always binds, and that the competitive loan contract $x_c(k)$ is given by

$$x_c(k) \begin{cases} \text{does not exist}, & \text{for } k < r + k^* - t^* \\ \text{satisfies } L(x_c(k), k) = r, & \text{for } k \in [r + k^* - t^*, r - w_1) \\ = r, & \text{for } k \geq r - w_1. \end{cases} \tag{4.1}$$

The following proposition gives the result in words, where “competitive intermediation” refers to simultaneous price competition in the deposit and loan markets by a finite number of intermediaries which may not ration lenders or borrowers.

PROPOSITION 4.1. *Under competitive intermediation, (i) entrepreneurs with low collateral values do not get loans, (ii) the face value of debt is determined by intermediaries’ zero-profit condition for intermediate collateral values, (iii) the probability of default is zero for entrepreneurs with high collateral values.*

PROOF. Fix r, and consider $B(x, k)$ and $T(x, k) - r$ as functions x for each collateral value k. Depending on k, the two functions may not intersect, and may intersect more than once, as in Figure 2. Since B is weakly decreasing for all x, the solution $x_c(k)$ to the problem of $\max_x B(x, k)$ subject to $B(x, k) \leq T(x, k) - r$ corresponds to the intersection with the smallest x when there are multiple intersections.

For $k \geq r - w_1$, we have $B(0, k) = \overline{w} \geq \overline{w} - r = T(0, k) - r$ and $B(w_1 + k, k) = \overline{w} - (w_1 + k) \leq \overline{w} - r = T(w_1 + k, k) - r$, so B intersects $T - r$ in $[0, w_1 + k]$. Since $B(x, k) = \overline{w} - x$ and $T(x, k) - r = \overline{w} - r$ in this range, the intersection is at $x = r$. The solution $x_c(k)$

in this case is given by the intersection and equals r. For $k \in [r + k^* - t^*, r - w_1)$, we have $B(w_1 + k, k) > T(w_1 + k, k) - r$ and $B(w^* + k, k) = \overline{w} - (p^* + k) \leq t^* - r = T(w^* + k, k) - r$, so the first intersection occurs in $(w_1 + k, w^* + k]$. The intersection gives $x_c(k)$, which satisfies $L(x_c(k), k) = r$ because $T = L + B$ and at the intersection $B = T - r$. Finally, for $k < r + k^* - t^*$, we have $B(w^* + k, k) > T(w^* + k, k) - r$. Because $B(x, k)$ decreases faster than $T(x, k) - r$ for $x \leq w^* + k$, this means that the two curves do not intersect for $x \leq w^* + k$. Further, since $B(x, k)$ decreases slower than $T(x, k) - r$ for $x \in (w^* + k, w_2 + k)$, and since both $T - r$ and B become constant for $x \geq w_2 + k$, it follows from $B(w^* + k, k) > T(w^* + k, k) - r$ that the two functions do not intersect for $x > w^* + k$ either. Since B lies above $T - r$ for all x, there is no solution to the problem of $\max_x B(x, k)$ subject to $B(x, k) \leq T(x, k) - r$. *Q.E.D.*

We can explain the intuition behind Proposition 4.1 as follows. In competing for the loan business, intermediaries strive to maximize the profits of the entrepreneurs subject to their own participation constraint that the loan return is at least r. The highest return on the loan to an entrepreneur with collateral k is $k + t^* - k^*$, achieved by the maximum default contract with face value $w^* + k$. Entrepreneurs with too little collateral $(k < r + k^* - t^*)$ do not get loans because it is not feasible for the intermediary to make non-negative profits from a loan to these entrepreneurs. For all entrepreneurs with adequate collateral $(k \geq k^* + r - t^*)$, since the expected payment P from the entrepreneur decreases with the face value of debt x, competition among intermediaries means that the face value of debt will be the lowest that allows the intermediaries to break even. Thus, the participation constraint of the intermediaries always binds. For entrepreneurs with intermediate values of collateral $(k^* + r - t^* \leq k < r - w_1)$, the participation constraint binds at a point where the probability of default is strictly between 0 and 1. (This is the case depicted in Figure 2.) Note that for the lowest collateral value $k = k^* + r - t^*$ in this range, the two functions $B(x, k)$ and $T(x, k) - r$ are tangent at $w^* + k$, so that the competitive loan contract is the maximum default contract. For entrepreneurs who can provide sufficient collateral $(k \geq r - w_1)$, full collateralization is achieved: they pay back r to the intermediaries regardless of the realized output w, which allows competitive intermediaries to just break even, and collateral values are so high that default will never occur.

Under the competitive loan contracts described by Proposition 4.1, the expected profits of entrepreneurs increase in collateral value k. To see this, note that for the same loan contract, entrepreneurs with more collateral are less likely to default. This tends to reduce the monitoring expenses incurred by the intermediaries and increase the loan returns to them. Competition among the intermediaries then forces down the face value of debt, and allows the entrepreneurs to keep more of the project output. Formally, for the intermediate collateral values $k \in (k^* + r - t^*, r - w_1)$, we can differentiate $L(x_c(k), k) = r$ to get

$$\frac{dx_c(k)}{dk} = \frac{-F(x_c(k) - k) - gf(x_c(k) - k)}{1 - F(x_c(k) - k) - gf(x_c(k) - k)}. \tag{4.2}$$

Since $x_c(k) < w^* + k$, equation (2.5) and Assumption 2.2 imply that the denominator in the above equation is positive. Thus, face value $x_c(k)$ decreases with the collateral value k, implying that the probability of default decreases and the expected profits to the entrepreneurs increase.

4.2. Competitive deposit rate

Since the expected profits of entrepreneurs increase in collateral value k, the equilibrium deposit rate is associated with a cutoff collateral value. Only those entrepreneurs with collateral values greater than this cutoff value obtain loans in equilibrium. To determine the equilibrium deposit rate and the cutoff value, we first characterize the cutoff collateral level as a function of deposit rate r, or the demand function for loans. This is accomplished by combining Proposition 4.1 with the participation constraint of the entrepreneur. From Proposition 4.1, the lowest collateral value that allows a competitive intermediary to break even is $k^* + r - t^*$, and the corresponding competitive contract is the maximum default contract. We distinguish two cases, depending on the deposit rate r.

For r lower than t^*, we argue that the cutoff collateral value is precisely $k^* + r - t^*$. Recall that k^* is the highest collateral value such that under the maximum default contract the entrepreneur makes non-negative profits. For deposit rate r lower than t^*, we have $k^* + r - t^* < k^*$, so that the maximum default contract for collateral value $k^* + r - t^*$ allows a competitive intermediary to break even and the entrepreneur to make positive profits. The cutoff collateral value in this case must be $k^* + r - t^*$: if it were lower, intermediaries would not be able to cover the cost of capital (this is shown in Proposition 4.1); if it were higher intermediaries would deviate and make positive profits by offering the maximum default contract to the entrepreneurs who do not get loans. Note that for this portion of the demand function (i.e. $r < t^*$), the marginal entrepreneurs with the cutoff collateral value $k^* + r - t^*$ make positive profits.

For any deposit rate r higher than t^*, we have $k^* + r - t^* > k^*$. The competitive contract given by (4.1) for entrepreneurs with collateral value $k^* + r - t^*$, which is the maximum default contract, would leave them with negative profits. In this case, the cutoff value k is higher than $k^* + r - t^*$, and is determined by the entrepreneur's participation constraint $B(x_c(k), k) = 0$.

We can now show that the demand function defined above is downward sloping.[18] The part corresponding to $r < t^*$ is downward sloping: if the deposit rate is r, the cutoff collateral value is $k^* + r - t^*$, so a higher deposit rate means a higher cutoff and hence a lower demand for loans. The part corresponding to $r > t^*$ is downward sloping too: using equation (4.2), differentiating $B(x_c(k), k) = 0$ with respect to r and noting that $x_c(k)$ also directly depends on r through $L(x_c(k), k) = r$, we have

$$\frac{dk}{dr} = \frac{1 - F(x_c(k) - k)}{gf(x_c(k) - k)},$$

which is positive. Thus, a higher deposit rate r means a higher cutoff collateral value k that satisfies $B(x_c(k), k) = 0$ and hence a lower demand for loans.

The deposit rate r_c and the cutoff collateral value k_c in the competitive equilibrium can then be jointly determined by the intersection of the supply function $S(r)$ and the demand function characterized above. Since both the demand and supply functions are continuous and monotone, a unique crossing of these two functions exists if supply exceeds demand at the highest deposit rate and demand exceeds supply at the lowest rate. Sufficient conditions are easy to find. The highest deposit rate at which there is a positive demand for loans is $\overline{w}$. Recall that the sum of the expected loan return and the entrepreneur's

[18] Note that the demand function is continuous at t^*. For the part corresponding to $r \leq t^*$, the cutoff k is equal to k^* at $r = t^*$. For the part corresponding to $r \geq t^*$, at $r = t^*$ the entrepreneur's participation constraint $B(x_c(k), k) = 0$ is satisfied for $k = k^*$ and $x_c(k) = w^* + k^*$, so the cutoff k is also equal to k^*.

profit is at most $\overline{w}$, when the probability of default is zero. For both the intermediary and the entrepreneur to break even when the deposit rate is $\overline{w}$, the collateral level must be at least $\overline{w} - w_1$ so that default will never occur (see equation 4.1). The demand for loans at $r = \overline{w}$ is therefore $U(\overline{w} - w_1)$. The lowest deposit rate is 0, in which case any entrepreneur can afford a loan, so the demand is $U(k_1)$. Then, if $S(\overline{w}) > U(\overline{w} - w_1)$ and $S(0) < U(k_1)$, a competitive equilibrium exists and is unique.

The equilibrium deposit rate r_c may be located on either of the two parts of the demand function. If $r_c \geq t^*$ (or equivalently $k_c \geq k^*$), marginal entrepreneurs with collateral k_c make zero profits, while if $r_c < t^*$ (or equivalently $k_c < k^*$), marginal entrepreneurs earn positive expected profits. In the first case, the marginal entrepreneur with collateral k_c earns zero expected profits. The entrepreneurs with lower collateral values do not get loans because the deposit rate r_c is too high: there are no loan contracts which provide the competitive return r to the intermediaries and make positive profits for these entrepreneurs. In contrast, when $k_c < k^*$, the marginal entrepreneur with collateral k_c earns strictly positive profits. As in the case of monopolistic intermediation when $k_m < k^*$, there is a discontinuity in the expected profits of the entrepreneurs at the cutoff collateral value k_c: the entrepreneurs with collateral values just below k_c are not financed even though the marginal entrepreneur obtains a loan and makes positive expected profits. The entrepreneurs with collateral just below k_c would be willing to accept the loan contract for the marginal entrepreneur and promise part of the profits to the intermediaries. But the loan returns are already at their unconstrained maximum for the marginal entrepreneur. There is no credible way to transfer the profits to the intermediaries due to the *ex post* monitoring problem.

5. Does Intermediary Market Structure Matter?

In the previous two sections we have analyzed two representative market structures of intermediation: monopoly and competition. In both cases, capital is allocated to entrepreneurs with sufficient collateralizable assets. There is a transfer of surplus from the monopoly intermediary to entrepreneurs as one shifts from monopolistic intermediation to competitive intermediation. But besides this transfer of surplus, does intermediary market structure matter?

5.1. Comparison results

In this section we compare the performance of the credit market under the two structures. Two variables are important in the comparison. One is the equilibrium deposit rate, since it determines the total amount of borrowing and lending in both cases. The other one is the schedule of the face value of debt, since the face value of debt in a loan contract determines the probability of default and hence the amount of goods produced in excess of resources consumed by costly monitoring. We will show below that the credit market performs unambiguously better under competitive intermediation than under monopolistic intermediation: under competition the deposit rate is higher and the total profits generated in each unit of loan contract are greater. We show how the monopoly distortions in terms of less lending and more bankruptcy arise from the monopoly's market powers with the lenders and with the borrowers.

First, comparing the extent of savings mobilization under alternative market structures of intermediation, we have $r_m \leq r_c$ and $k_m \geq k_c$.

PROPOSITION 5.1. *Competitive intermediaries lends less than a monopoly intermediary.*

PROOF. Consider the marginal entrepreneur with collateral k_c under competition. If $r_m > r_c$, then $k_m < k_c$ so this marginal entrepreneur with collateral k_c also gets funded under monopoly. There are two cases. In the first case, $k_c > k^*$ and $r_c > t^*$. Then, $B(x_c(k_c), k_c) = 0$. Since $k_c > k^*$ and the entrepreneur with k_c gets a loan under monopoly, Proposition 3.1 implies $B(x_m(k_c), k_c) = 0$. In the second case, $k_c \leq k^*$ and $r_c \leq t^*$. Then, from Proposition 4.1, $x_c(k_c) = w^* + k_c$. From Proposition 3.1, since $k_c \leq k^*$ and the entrepreneur with k_c gets a loan under monopoly, $x_m(k_c) = w^* + k_c$. In both cases, $B(x_c(k_c), k_c) = B(x_m(k_c), k_c)$, implying $x_c(k_c) = x_m(k_c)$ and thus $L(x_c(k_c), k_c) = L(x_m(k_c), k_c)$. Since $L(x_c(k_c), k_c) = r_c$ and $r_m > r_c$, we have $L(x_m(k_c), k_c) < r_m$, contradicting the optimality of loan contracts under monopoly. *Q.E.D.*

The intuition behind the above proof is simple. If under monopoly the deposit rate is higher and more entrepreneurs get loans, then the last entrepreneur to get a loan under competition is also funded under monopoly. Since competitive intermediaries always make zero-profits, the monopoly intermediary makes negative profits on the loan to this marginal entrepreneur due to a higher deposit rate, which is impossible. The above proof formalizes this argument by showing that this last entrepreneur would be funded with the same loan contract under monopoly and under competition.

The result that competitive intermediaries lends less than a monopoly intermediary may not seem surprising. After all, under-production distortions are often associated with monopolies. However, the monopoly intermediary in our model is not a usual one because it has monopoly power over both the borrowers and the lenders. Are the monopoly distortions in mobilizing less savings the result of monopoly power in the loan market or in the deposit market? The proof of Proposition 5.1 suggests that the distortions arise from the monopoly power in the deposit market. The basic point is that marginal entrepreneurs in both cases have the same form of loan contract, and the monopoly lends less because the cost of capital for the monopoly equals $r + S(r)/S'(r)$, which is higher than the cost r for competitive intermediaries. The standard result in industrial organization models that a greater elasticity of $S(r)$ reduces the monopoly power then implies that in our model of intermediation the monopoly distortions in terms of less lending competitive intermediation are smaller if the savings function is more elastic.

The next result demonstrates monopoly distortion in each loan contract granted. Comparing the face value of debt for entrepreneurs with any fixed collateral value k, we have $x_m(k) \geq x_c(k)$.

Proposition 5.2. *For entrepreneurs with any fixed collateral value who obtain loans under alternative market structures, default rates are higher under monopolistic than under competitive intermediation.*

Proof. By Proposition 5.1, any entrepreneur with collateral $k > k_m$ is also funded under competition. There are two cases. In the first case, $k > k^*$. Then, by Proposition 3.1, $B(x_m(k), k) = 0$. In contrast, Proposition 4.1 implies that under competition all entrepreneurs that obtain loans earn non-negative expected profits, implying $x_c(k) \leq x_m(k)$.

In the second case, $k < k^*$. Then, by Proposition 3.1, $x_m(k) = w^* + k$. But under competition, $x_m(k) \leq w^* + k$, with strict inequality except for the marginal entrepreneur with collateral k_c. Thus, $x_c(k) \leq x_m(k)$. In either case, default rates are lower under competition for each k above k_m. *Q.E.D.*

The intuition behind Proposition 5.2 can be simply stated as follows. Raising the face value of debt in the loan contract necessarily increases the expected payment to the intermediary. Under competition the loan contract minimizes the expected payment subject to the zero-profit condition of intermediaries, while under monopoly it maximizes the expected payment subject to the monitoring cost incurred by the intermediary and the participation of the entrepreneur. Thus, the face value of debt is higher under monopoly than under competition. Higher face value of debt under monopoly implies higher default rates for each collateral value.

Comparing Propositions 3.1 and 4.1, we see that the monopoly distortion in terms of greater default rates for each loan granted varies across entrepreneurs with different collateral values. The monopoly distortion is the greatest for entrepreneurs with little collateral. Indeed, for entrepreneurs with enough collateral (greater than $\overline{w} - w_1$) full collateralization is achieved and the default rate is zero under both monopolistic and competitive intermediation. The reasons for the monopoly distortion of more bankruptcy do not depend on the monopoly's market power with lenders as represented by the elasticity of savings function. The proof of Proposition 5.2 makes it clear that even if there is a competitive investment opportunity for depositors, which would force the monopoly deposit rate down to the same level as the competitive rate, monopoly debt contracts would still have higher face value of debt and hence higher default rates than competitive debt contracts. The monopoly distortion of higher bankruptcy rates arises solely from the market power with borrowers.

5.2. Comparative statics

Propositions 5.1 and 5.2 can be used to compare impacts on the credit market when exogenous changes in the economy occur. We are particularly interested in different impacts on the credit market as available credit or the monitoring cost changes.

First consider what happens when available credit increases as represented by an outward shift of the savings function $S(r)$. Under both monopolistic intermediation and competitive intermediation, there will be an expansion of credit to collateral-poor entrepreneurs.[19] Under monopoly, a lower cutoff collateral value results, with no changes in the loan contracts for entrepreneurs who obtained loans before the expansion and thus no change in the default rate (see equation 3.1). Gains in loan businesses and profits are absorbed by the monopoly intermediary. Under competition, a lower equilibrium deposit rate due to the credit expansion affects all loan contracts for entrepreneurs (see equation 4.1). The face value of debt decreases for each loan, and default rates fall across all entrepreneurs. Thus, while a monopoly intermediary internalizes the impact of a credit expansion, competitive intermediaries spread the impact throughout the market.

Next, consider the impact of changes in the monitoring cost g. Under both monopolistic and competitive intermediation, a reduction in the cost decreases the cutoff collateral value and increases the deposit rate. The impact on bankruptcy rates, however, is different. A smaller monitoring cost makes it profitable for a monopoly intermediary to extend credit to more entrepreneurs by increasing the deposit rate. However, since the monitoring expense is directly incurred by the intermediary, a cost reduction has no effect on the face value of debt, and hence no effect on bankruptcy rates (see equation 3.1). The benefits of the reduction of the monitoring expense accrue to the monopoly intermediary. In contrast, under competitive intermediation, not only will more savings be mobilized because a decrease in the monitoring cost moves the demand function to the right, but also all entrepreneurs that obtain loans in equilibrium will benefit from a smaller monitoring cost (see equation 4.1). Although the monitoring cost is directly incurred by the intermediaries, competition forces them to transfer the greater surplus to the entrepreneurs through lower face values of debt.

We summarize the findings in this subsection in the following proposition.

[19] The opposite scenario occurs when entrepreneurs with little collateral are squeezed out of the loan market first as loanable funds become scarce. This is what Holmstrom and Tirole (1997) call "flight to quality," and our model provides an alternative explanation. In their model of intermediation, the monitoring problem is *ex ante* instead of *ex post* and entrepreneurs' own capital is liquid but insufficient without outside funding. When outside capital becomes scarce in a credit crunch, entrepreneurs with little capital of their own lose funding because they have too little at stake and cannot credibly commit to proper management of their projects.

Proposition 5.3. *In a market expansion due to either an increase in the credit supply or a decrease in the monitoring cost, the default rate for the pre-existing loans is unaffected under monopolistic intermediation while it falls under competitive intermediation.*

Our results have important policy implications. Credit market liberalization is especially crucial in economies with an inelastic supply of credit and significant monitoring costs. Government policies of promoting savings may have limited result in facilitating growth of the credit market if the intermediary sector remains uncompetitive, because the benefits of an expansion of credit mostly accrue to the intermediaries with no impact on bankruptcy rates or the demand for credit by entrepreneurs. Similarly, in a monopolized credit market reducing monitoring cost merely transfers greater profits to the monopoly intermediary without reducing bankruptcy rates.

5.3. Robustness analysis

To conclude this section we provide two extensions of our main results regarding the comparison between monopolistic and competitive intermediation. First, we have assumed that a borrower's collateral is worth the same to the lender (or the intermediary) after liquidation as it is to the borrower. However, one characteristic of collateral may be that lenders often value liquidated collateral less than the borrower, even if there is no direct cost in liquidating the collateral. For example, the liquidation value of collateral to the intermediary can be only a fraction of its original value to the borrower. Imagine the extreme case that the value of liquidated collateral is 0 to any intermediary. In this case, we need to make the assumption that the distribution function F is weakly convex, which replaces Assumption 2.2 and guarantees that the expected gross return L for the intermediary is concave in the face value x. Then, we can still write the face value of debt in a maximal default contract as $k + w^*$, where w^* is no longer a constant but a function of k.

The rest of the analysis goes through as before. The immediate effect of introducing zero liquidation value of collateral is that the expected loan return $L(x, k)$ to the intermediary shifts downward for any face value of debt x and collateral level k. Under monopoly, the resulting effect on loan contracts is a reduced face value of debt and a reduced default rate. Under competition, the result is exactly the opposite. The different effects of zero liquidation value arise because the maximal default contract becomes a less effective way for the monopoly intermediary to exact profits, while recovering the deposit rate promised to lenders becomes more difficult for competitive intermediaries.

Although introducing zero liquidation value reduces the gap in terms of default rate between monopoly and competition, our comparison results regarding the two intermediary market structures (Propositions 5.1and 5.2) remain valid. Relative to competitive intermediation, monopolistic intermediation still leads to two distortions: higher default rates and less aggregate lending. Introducing zero liquidation value changes both monopoly and competitive loan contracts, but the face value of debt remains higher under monopoly because it maximizes the expected payment to the monopoly intermediary while it minimizes the expected payment to competitive intermediaries. Moreover, introducing zero liquidation value does not alter the fact that marginal entrepreneurs under both monopoly and competition have the same form of contract (maximal default contract), so the monopoly lends less due to a higher cost of raising capital from lenders.

For the second extension, imagine that the value of collateral that each entrepreneur is no longer public information but instead is known only to the entrepreneur. Additionally, entrepreneurs can choose to put up only part of their collateral in the loan contract with the intermediary. Since the entrepreneurs who can provide higher levels of collateral make more profits, competitive intermediation is not affected by the alternative assumption of private collateral information. The same is true under monopolistic intermediation when the marginal entrepreneurs make zero expected profits ($k_m > k^*$). However, when the marginal entrepreneurs make positive expected profits ($k_m < k^*$), the loan contracts for entrepreneurs with collateral level below k^* do not provide the correct incentives for entrepreneurs to reveal the value of their assets as $B(x_m(k), k)$ decreases in k.

We can show that the optimal strategy for the intermediary is to choose a cutoff level of collateral and give loans only to those who can provide collateral exceeding the cutoff level. Further, it is optimal for the monopoly to offer the maximum default contract to marginal entrepreneurs with the cutoff collateral level in order to minimize the surpluses given away.

The face value of debt for any reported collateral level about the cutoff is determined by the incentive compatibility constraint that all entrepreneurs who obtain loans make at least the expected profits as the marginal entrepreneur does under the maximum default contract. The important difference between the case of private information and the case of public information is that, despite the same concavity of $L(x, k)$, the solution the monopoly's optimization problem under private collateral information turns out not to have an interval of collateral levels where the entrepreneur's incentive constraint is slack.

Under monopolistic intermediation, whether collateral information is public or private does not affect the extent of savings mobilization. This is because the marginal entrepreneur's contract takes the same form of the maximum default contract under the two information structures. Since in either case the first-order condition requires the expected loan return from the marginal entrepreneur to equal the marginal cost of obtaining the loan, the cutoff collateral level must be the same. Thus, monopolistic intermediation with private collateral information involves the same distortion of less lending as compared to competitive intermediation. This is consistent with our conclusion that this type of distortion arises from monopoly power in the deposit market.

The difference between the two information structures is in bankruptcy rates. The loan contracts granted by a monopoly intermediary when collateral is private information have smaller probabilities of default than when collateral information is public. This is because the monopoly must give incentives, in terms of lower face value of debt, for entrepreneurs to reveal their true collateral level. Thus, consistent with our observation that monopoly distortions of more bankruptcy arise from monopoly power in the loan market, a weakening in monopoly power with borrowers due to private collateral information improves loan contract performance in terms of bankruptcy rates. Nonetheless, compared to competitive intermediation, bankruptcy rates are still high.

6. Concluding Remarks

Our paper belongs to the extensive line of literature that compares monopolistic intermediation to competitive intermediation. Much of this literature studies the type of frictions and externalities that can make a concentrated banking sector preferable, in terms of greater bank lending or smaller default risk, to a perfectly competitive one. Petersen and Rajan (1995) show that with incomplete markets and imperfect information, monopoly power can increase the incentive of intermediaries to finance new firms with no record of performance. Winton (1997) assumes fixed intermediation costs and adoption externalities, and argues that the belief of investors that small intermediaries are risky can be self-fulfilling because of imperfect diversification. Allen and Gale (2000) show that due to limited liability of the bank and their use of debt contracts, an increase in competition in the banking sector has the effect of encouraging banks' risk-seeking behavior.

The present paper differs from those cited above by focusing on the credit risk of the real sector of the economy, and on the total amount of investment when borrowers are heterogeneous and loan contracts are collateralized. We offer two contrasting results: monopolistic intermediation induces less lending and higher bankruptcy rates than competitive intermediation. We are not aware of any empirical works on comparing default risks under different intermediary market structures, but there is a body of evidence that is broadly consistent with the result that a high level of concentration reduces credit access for borrowers with little collateralizable assets.

In a cross-sectional study of U.S. firms, Black and Strahan (2000) find a smaller number of newly financed firms in states with a higher level of bank concentration. Extending the international dataset compiled by Rajan and Zingales (1998), Cetorelli and Gambera (2001) find that bank concentration has on average a depressive effect on industrial growth. In addition, Berger, Kashyap, and Scalise (1995) establish direct evidence that larger banks devote smaller proportions of their assets to small business lending. Similarly, Berger and Udell (1996) find that large banks focus more on financially secure loans, as predicted by our model. These empirical findings are supported by related studies that examine the effect of bank M&A on small business lending, including Peek and Rosengren (1998), Strahan and Weston (1998), Berger, Saunders, Scalise and Udell (1998), and Avery and Samolyk (2000). The general finding is that post-M&A, large banks reduce lending to small unsecured businesses. Moreover, Berger, Goldberg and White (2001) find that the post-M&A reduction in small business lending by large banks has an external effect on lending by smaller banks. To the extent that a merged bank gains market power, such empirical evidence provides additional support to the prediction of our model.

Within our framework of costly monitoring, we have made a number of assumptions to facilitate the analysis. One assumption is that the size of the loan is fixed and independent of collateral level. When intermediaries choose the size of each loan as well as the face value of debt, a higher face value of debt may correspond to a smaller size of the loan and therefore may not increase the default risk. The other assumption is that all entrepreneurs have the same investment project. When projects differ, there will be a second-degree price discrimination role for the risky debt contract—the monopoly intermediary will want to design a schedule of debt contracts so as to induce self-selection by entrepreneurs—in addition to the role of perfect discrimination according to collateral value studied in the present paper. Relaxing these and other assumptions remains our immediate target for future work. Finally, our model focuses on the risk of default and on the role of collateral, while oversimplifying other aspects of financial intermediation as stressed by Broecker (1990), Petersen and Rajan (1995), Winton (1997) and Allen and Gale (2000). How to incorporate project screening, relationship lending, imperfect diversification and limited bank liability into our framework remains a challenge that needs to be met in future research.

References

Allen, F., and D. Gale (2000): "Comparing Financial Systems," MIT Press, Cambridge, MA.

Altman, E. (1984): "A Further Empirical Investigation of the Bankruptcy Cost Question," *Journal of Finance* 39, 1067-89.

Avery, R. B., and K. A. Samolyk (2000): "Bank Consolidation and the Provision of Banking Services: The Case of Small Commercial Loans," Working Paper, Federal Deposit Insurance Corporation.

Barro, R. (1976): "The Loan Market, Collateral, and Rates of Interest," *Journal of Money, Credit and Banking* 10, 170-83.

Berger, A. N., L. G. Goldberg, and L. J. White (2001): "The Effects of Competition on the Supply of Small Business Credit," *European Financial Review* 5, 115-139.

Berger, A. N., A. K. Kashyap, and J. M. Scalise (1995): "The Transformation of the U.S. Banking Industry: What a Long Strange Trip It's Been," *Brooking Papers on Economic Activity* 2, 55-218.

Berger, A. N., A. Saunders, J. M. Scalise, and G. F. Udell (1998): "The Effect of Bank Mergers and Acquisitions on Small Business Lending," *Journal of Financial Economics* 50, 187-229.

Berger, A. N., and G. F. Udell (1996): "Universal Banking and the Future of Small Business Lending," in A. Saunders and I. Walter eds., *Financial System Design: The Case of Universal Banking*, Irwin, Burr Ridge, IL, 559-627.

Bernake, B. and M. Gertler (1989): "Agency Costs, Net Worth, and Business Fluctuations," *American Economic Review* 79, 14-31.

Besanko, D. and A. Thakor (1987): "Collateral and Rationing: Sorting Equilibria in Monopolistic and Competitive Credit Markets," *International Economic Review* 28, 671-89.

Black, S.E. and P.E. Strahan (2000): "Entrepreneurship and Bank Credit Availability," Working Paper, Federal Reserve Bank of New York.

Broecker, T. (1990): "Credit-worthiness Tests and Interbank Competition," *Econometrica* 58, 429-452.

Cetorelli, N. and M. Gambera (2001): "Banking Market Structure, Financial Dependence and Growth: International Evidence from Industry Data," *Journal of Finance* 56, 617-48.

Diamond, D. (1984): "Financial Intermediation and Delegated Monitoring," *Review of Economic Studies* 51, 393-414.

Franks, J. and W. Torous (1994): "How Firms Fare in Workouts and Chapter 11 Reorganization," *Journal of Financial Economics* 35, 349-70.

Gale, D. and M. Hellwig (1985): "Incentive-Compatible Debt Contracts: The One Period Problem," *Review of Economic Studies* 52, 647-63.

Holmstrom, B. and J. Tirole (1997): "Financial Intermediation, Loanable Funds and the Real Sector," *Quarterly Journal of Economics* 112, 663-91.

Marquez, R. (2002): "Competition, Adverse Selection, and Information Dispersion in the Banking Industry," *Review of Financial Studies* 15, 901-926.

Peek, J., and E. S. Rosengren (1998): "Bank Consolidation and Small Business Lending: It's not Just Bank Size that Matters," *Journal of Banking and Finance* 22, 799-819.

Petersen, M.A. and R. Rajan (1995): "The Effect of Credit Market Competition on Lending Relationship," *Quarterly Journal of Economics* 110, 407-43.

Rajan, R. (1992): "Insiders and Outsiders: The Choice between Informed and Arm's-length Debt," *Journal of Finance* 47, 1367-1400.

Rajan, R. and L. Zingales (1998): "Financial Dependence and Growth," *American Economic Review* 88, 559-86.

Riordan, M. (1993), "Competition and Bank Performance: A Theoretical Perspective," in Mayer, C. and X. Vives, editors, *Capital Markets and Financial Intermediation*, Cambridge University Press.

Schmidt-Mohr, U. (1997): "Rationing versus Collateralization in Competitive and Monopolistic Credit Markets with Asymmetric Information," *European Economic Review* 41, 1321-42.

Shaffer, S. (1998), "The Winner's Curse in Banking," *Journal of Financial Intermediation* 7, 359-392.

Stahl, D.O. (1988): "Bertrand Competition for Input and Walrasian Outcomes," *American Economic Review*, 78, 189-201.

Stiglitz, J. and A. Weiss (1981): "Credit Rationing in Markets with Imperfect Information," *American Economic Review* 71, 393-410.

Strahan, P. E., and J. Weston (1998): "Small Business Lending and the Changing Structure of the Banking Industry," *Journal of Banking and Finance* 22, 821-845.

Townsend, R. (1979): "Optimal Contracts and Competitive Markets with Costly State Verification," *Journal of Economic Theory* 21, 265-93.

Williamson, S. (1987a): "Costly Monitoring, Optimal Contracts and Equilibrium Credit Rationing," *Quarterly Journal of Economics* 102, 135-45.

Williamson, S. (1987b): "Financial Intermediation, Business Failures, and Real Business Cycles," *Journal of Political Economy* 95, 1196-212.

Winton, A. (1997): "Competition among Financial Intermediaries When Diversification Matters," *Journal of Financial Intermediaries* 6, 307-46.

Yanelle, M. (1989): "The Strategic Analysis of Intermediaries," *European Economic Review* 33, 294-301.

Yanelle, M. (1997): "Banking Competition and Market Efficiency," *Review of Economic Studies* 64(2), 215-39.

Yosha, O. (1997): "Diversification and Competition: Financial Intermediation in a Large Cournot-Walrasian Economy," *Journal of Economic Theory* 75, 64-88.