# Bank Size Heterogeneity and Small Business Finance

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**Abstract**

This paper offers a theoretical explanation for several empirical findings on bank competition and small business finance that lack hitherto a theoretical explanation. First, large banks seem to be more involved in small business finance than used to be hypothesized formerly. Second, the impact of competition on small business finance may be U-shaped and depends on the organizational structure of the banking market. Allowing heterogeneous banks to compete in markets for good and bad borrowers, competition has a different impact on the lending behavior, depending on the shape of the existing market structure. This is due to a constraining risk bearing capacity that limits the scale of lending to small business as a function of riskless lending. In markets dominated by large banks, competition is inimical to small business finance. As the market share of small banks increases, competition is beneficial to SMEs loan access.

**Keywords:** bank competition, small and medium-sized enterprises, spatial differentiation, market structure, heterogeneous banks, heterogeneous borrowers

**JEL–class.:** G 21, D 43, E 43

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# 1 Introduction

The impact of competition and regulation on credit supply is one of the central themes of the economics of banking. Technological advances, regulatory changes and the globalization of financial markets constantly transform the competitive landscape of banking. Not the least the financial crisis and progress in information technologies have had a major impact on the business of financial institutions in the last years.[1] Concerns that these developments impair the supply of loans to small enterprises are frequently expressed. In this paper we address the question whether these concerns are legitimate. To be more precise, we explore the following issues: How does the competitive environment shape the bank size/firm size specialization and how does this affect the total lending to small businesses? Additionally we adapt the regulatory regime to the proposed Basel III accord to understand its impact on the provision of loans to SME's. Lastly we deliver a theoretical explanation for the high penetration of SME markets by large banks.

The internal organization of a bank has been identified recently as an important determinant of their lending technologies. Stein (2002) shows in a theoretical setting how different hierarchical structures can affect the incentives of the loan officers for the collection of different types of information. According to Stein (2002) a hierarchical organization, as it can be found typically in large banks, favors incentives for the collection of "hard" information, while a decentralized organization, as for instance in a small regional bank, is at a comparative advantage in the evaluation of "soft" information.[2] Stein (2002) shows that hard information (e.g., asset-based lending, factoring, leasing, fixed-asset lending, credit scoring, etc.) proves

[1] The banking business has been subject to considerable changes also in former times. The widespread adoption of the automobile in the 1920's thoroughly changed the regional scope of lending relationships (cf. Calomiris (2000)).

[2] Stein's reasoning is in line with the insights of the literature on incentives in organizations, that stress the importance of the allocation of control rights, when the effort level of the managers in not contractable (cf. Aghion and Tirole (1997)).

to be easier to handle in large hierarchical banks. In small banks in turn, hierarchy is less pronounced, favoring the use of soft lending technologies. As a consequence large, hierarchical banks are supposed to have a comparative advantage in the provision of loans to large firms with a reliable and verifiable track record, while small banks should have an edge in small business lending, since small and medium–sized enterprises (SME) are affected more frequently by less transparent business structures. [3].

Taking Stein's argument to its logical conclusion, we should observe segregated markets for the provision of loans to large, transparent firms on the one hand and to smaller, more opaque firms on the other hand. The first segment would be served by large, hierarchical institutions, using "hard" information technologies, while small, regional banks focussing "soft" lending would serve the second segment. In fact, conventional wisdom has taken as given that large enterprises are predominantly served by large banks, while small banks tend to have a competitive advantage in small business lending (Berger et al. (2001)). This wisdom has been challenged recently by Berger and Black (2011) among others[4], who give empirical evidence showing that large banks lend a major part of their loan portfolio to SME's.

So there is something missing in the argument of Stein (2002), if we want to explain the amount of lending to those borrowers, where the bank is supposed to have a competitive disadvantage. In our setup this missing element will be a regulatory constraint or a risk bearing capacity restricting the amount of lending to small businesses. This constraint can be conceived as a regulatory constraint limiting the amount of risk, or as an endogenous choice of the bank to restrict the amount of risk on its books to achieve a desired rating.[5] The banks in the present approach can be of two types and operate in a good or transparent and a bad or opaque market. Either they are large, revealing a comparative advantage for transparent loans,

[3]Cf. Berger and Udell (2002), Petersen and Rajan (2002), Berger et al. (2005), Cole et al. (2004), Uchida et al. (2008), Strahan, Shimizu (2012)

[4]Cf. Ongena and Sendeniz-Yüncü (2011) and de La Torre et al. (2010)

[5]Compare regulatory and economic capital in Elizalde and Repullo (2007).

or they are small, which is equivalent to having a competitive edge in granting loans to opaque borrowers. Our model takes the organizational form or the size of the banks as exogenously given. Even though large banks feature higher lending costs in the market for opaque borrowers, the higher profits they achieve in the segment for transparent borrowers yield a corresponding higher risk bearing capacity, which enables them to lend substantial amounts to small firms. Accordingly, large banks serve a larger share of customers in the SME sector than smaller banks.[6]

Another question we address is how competition does affect total lending volumes to SMEs? We model competition in a simple framework of spatial competition *à* la Hotelling with linear transportation costs, representing information costs borne by the borrower. As the information asymmetry is higher in the opaque market, transportation costs are assumed to be higher there. Similar to Hauswald and Marquez (2006) and Degryse et al. (2009) banks apply spatial pricing, capturing a differentiated pricing behaviour of banks due to informational or local advantages. Heterogeneity of geographical reach of the banks and asymmetric loan pricing is introduced by differential information technology costs of the different bank types.

Empirical studies have failed at giving a definite answer to the question of the impact of competition on SME finance. A study conducted by Degryse and Ongena (2007) uncovered a U-shaped relation between the level of competition and the extent of small business lending. According to the analysis of Presbitero and Zazzaro (2011), the non–monotonic effect is generated by different organizational structures of the local banking sector. In an environment with small, local banks, competition favors SME finance, while competition is detrimental to small business lending, when the market is dominated by large banks.

Our model is able to explain the empirical findings of a U–shaped relationship and of the organizational influence detected by Presbitero and

[6] The risk bearing capacity can be considered as an endogenous choice to invest in the penetration of the small business sector. A related mechanism is employed by Almazan (2002)

Zazzaro (2011). We find that a binding risk-bearing capacity, as a major element interconnecting the borrower markets, transmits the effects of competition from the transparent borrower market to small business lending. In particular, the inclusion of competition among heterogeneous banks helps to explain empirical observations. Our main findings can be summarized as follows.

1. In markets exhibiting a sufficiently high presence of small banks, small business finance is increasing as competition intensifies, which confirms empirical evidence of for instance Neuberger et al. (2008).

2. If the banking market is primarily shaped by large banks, competition is detrimental to the total SME loan volume, yielding an explanation for the empirical evidence in Petersen and Rajan (1995), Fischer (2005) and Ogura and Yamori (2007).

3. The volume of loans that is granted to bad borrowers is a U-shaped function of competition, if the banking market is heterogeneous. The effect is confirmed by empirical findings in the Belgian banking market by Degryse and Ongena (2007), suggesting a sufficient heterogeneous Belgian market.

Finally, we are interested in the impacts of the new Basel III accord on our model. We show that the introduction of a risk-weighted capital requirement boosts the SME volume of loans. A regulation in terms of a mandatory leverage ratio increases the quantity of SME loans and causes a size contraction of the banking industry. As a consequence of the reduction of market spans in the good market, the level of competition among banks is reduced which benefits small banks to the expense of large banks. With a lower leverage ratio competition tends to be beneficial for SME financing.

The paper is organized as follows. Section two develops our model. The main results are presented in section three, while extensions are discussed in section four. Section five concludes.

# 2 The Model

We consider a model with two dates (t=0,1) and two agents: banks and borrowers. There are two types of banks and two types of borrowers. Banks provide loans to both type of borrowers. We use a model of Hotelling competition, where borrowers approach banks located in their geographic reach. Locations of the borrowers are common knowledge such that banks can perfectly price discriminate borrowers. All players are risk neutral.[7]

## 2.1 Banks

There are two types of banks, large and small, $i \in \{L, S\}$. The fraction of large banks $\alpha$ is common knowledge. If a bank is large, then it has a competitive edge in the good loan segment and a disadvantage in the bad borrower segment, expressed by the following marginal cost parameters:

**Assumption 1:** $c_L^B > c_S^B > c_S^G > c_L^G$,

where $i \in \{L, S\}$ denotes the index of the bank, and $h \in \{B, G\}$ is the index of the borrowers's market segment. This marginal cost parameter can be thought as a measure of information costs of the bank, that is fixed.[8]

Assumption 1 captures the notion that the large bank has an absolute and a comparative advantage in the good market as it has specialized on hard lending technologies. However, in the market for opaque borrowers, soft lending technology may be more useful to discern higher information asymmetry. Thus, small banks have a competitive edge in the bad loan market. Reflecting the assumption, one would expect a certain specialization of small banks on bad borrowers and large banks on good borrowers as already pointed out earlier by Williamson (1988), Stein (2002), Berger and Udell (2002), Cole et al. (2004) and Berger et al. (2004). However, it will become obvious in the course of the investigation that this is not the case. In both segments banks are located on a line of one unit length

[7] A comparable approach to modelling competition has been taken by Marinc (2008).

[8] In the extensions, we discuss the possibility of the banks investing into a production technology that determines $c_i^h$.

respectively. They compete in prices for the borrowers and are able to discriminate their customers as they know their adresses. This feature captures theoretical and empirical insights as revealed by Lederer and Milne (1986), Thisse and Vives (1988) or Degryse and Ongena (2005), Hauswald and Marquez (2006), Agarwal and Hauswald (2006), Degryse et al. (2009).[9] Loans are financed with deposits at a deposit rate $r$. All deposits are fully insured and the insurance premia is assumed to be zero.

## 2.2 Borrowers

There is a continuum of firms called borrowers. There are two types of borrowers, that we will call for simplicity good and bad borrowers. Every borrower needs a loan of 1$ in order to finance a project. Projects of good firms realize a safe return of $Y$, while projects of bad firms realize a return of $Y$ with probability $p_B$ or zero otherwise. The returns of the projects of the bad firm are perfectly correlated.

In order to be granted a loan, borrowers can decide between two competing offers of the adjacent banks. The total costs of the borrower are a composition of the individual interest rate and the transportation cost. When approaching a bank, borrowers incur transportation costs $t \cdot x$, where $x$ is the distance covered. What do these transportation costs represent? The answer is, borrowers have to make several visits to the bank branch to deliver necessary information in order to obtain a loan. Bad borrowers incur higher costs for delivering credible information than good ones. The model reflects this evidence by assuming transportation costs $\gamma t$ ($\gamma > 1$) for the bad and $t$ for the good market. As these transportation costs are used as a measure of competition, this results in a higher level of competition in the good market. Hence, the market for good borrowers is better served

[9] According to Thisse and Vives (1988) mill pricing is never an equilibrium if banks choose policy and price simultaneously and market spans overlap non-negligible. In fact mill pricing only occurs for one particular class of demand functions, that is, negative exponential demand. Hence, we undertake a discriminatory pricing approach and show that mill pricing is a special case that occurs under Bertrand competition or in other words if there are no transportation costs.

than the market for bad borrowers. The model is able to depict efficiency gains resulting from higher competition, as evidenced by Kevin J. Stiroh and Philip E. Strahan (2003). The effect of changing transportation costs can be deduced as follows. On the one hand, in the case of high transportation costs borrowers are highly impeded to shop around for a better offer such that close borrowers may even be locked in to the closest bank if the interest rate of the competing bank and the transportation costs exceed the cash-flow of the project. As a result, the closest bank can extract higher rents from a "locked" borrower. On the other hand, if $t$ is low the market coverage of all banks is expanded such that switching banks gets easier and competition intensifies.

## 2.3 Market Interconnection through Regulation

For various reasons, banks are constrained to keep their probability of default below some level $\phi$. This constraint can be conceived as a regulatory constraint limiting the amount of risk, or as an endogenous choice of the bank to restrict the amount of risk on its books to achieve a desired rating. Given the simplistic structure of the probability distribution of the loans, this implies a no–loss restriction on the total profits of the bank, as long as $\phi < 1 - p_B$.[10] As an immediate consequence of the risk bearing constraint, the amount of lending in the two markets by the two types of banks will be closely connected. Since defaults are perfectly correlated, the only way to comply with the risk bearing capacity in the bad borrower market is to achieve large enough profits in the good market. Therefore, the extent of lending in the market for bad borrowers is restricted by the profits realized in the market for good borrowers. This is most relevant for the small banks, whose informational advantage in the market for bad borrowers might be useless, since missing profits inhibit this advantage to be played out. At the same time large profits in the market for good borrowers and the miss-

[10] Using more general return distributions or correlations would not change our results. Instead of the no–loss restriction, we would have a constraint restricting the first $\phi$–quantile of the losses. Compare Elizalde and Repullo (2007).

ing competition of the small banks will increase the share of lending to bad borrowers by the large banks. Thus, the volume of loans in the bad borrower segment is limited by the profits in the good borrower segment.

## 2.4 The Case of two Banks

In a first step we consider the case of two banks, that compete on two lines of one unit length in the good borrower and the bad borrower segment. To this end, the loan demand functions of both banks in the good market are derived. Depending on the magnitude of the loan demand, we distinguish two cases. Firstly, if both banks are able to attract all borrowers close by the neighboring bank, then there is *"full market competition"*. Secondly, if one bank is not able to cover the entire market, the competitor enjoys a local monopoly in its neighbourhood. We call that the *"monopoly i case"*. According to assumption 1 large banks serve local monopolies. In reality, these monopolies arise if there are information monopolies from combining lending and underwriting or there is a demand for particular large amounts of funding, such that the large borrower finds himself locked in.

In a next step, profits for the two market regimes are computed. Subsequently, profits in the good borrower segment are used as a risk–bearing buffer against losses in the market for bad borrowers.

### 2.4.1 The Market for Good Loans

Banks $i$ and $j$ are located at the end of a line of one unit length and borrowers are located inbetween. When choosing the best offer, the good borrower compares the interest rates $r_i^G$ and $r_j^G$ of the banks and the transportation costs for the distance to be traveled. Therefore, the borrower is indifferent if

$$Y - r_i^G - tx = Y - r_j^G - t\left(1 - x\right), \tag{1}$$

where $x$ denotes the distance of the borrower from bank $i$.

The indifferent borrower is the most distant borrower the bank can approach and all borrowers within this distance demand a loan at bank $i$ of size 1. Therefore the location of the indifferent borrower can be interpreted as the loan demand of bank $i$. Note, that the lowest interest rate the bank is able to offer is its marginal costs for granting the loan, $r + c_i^G$. Figure 1 offers a graphical illustration of the banks pricing behavior in the model. Substituting $r + c_i^G$ for $r_i^G$ and manipulating (1), one can easily derive the resulting demand for bank $i$

$$x_i^G = \frac{c_j^G - c_i^G}{2t} + \frac{1}{2}. \qquad (2)$$

The information technology cost difference and the level of transportation costs determine the gain in market share. Thus, if $i = L$ and $j = S$, bank $i$ gains additional market share and bank $j$ loses relatively to the symmetric competition case. The shift of the market share from one bank to the other is the more significant, the lower the transportation costs are, representing rising efficiency of the banking sector with higher levels of competition. It is assumed that the information technology cost advantage of the large bank does not surpass the transportation cost advantage of the small bank concerning its closest borrower in order to assure the existence or a positive market share of small banks.

**Assumption 2:** $\Delta c = c_S^G - c_L^G < t$.

Assumption 3 ensures that the market is covered if two small banks compete with each other, so that loan availability and competition in the good borrower market is higher than in the bad borrower market.

**Assumption 3:** $Y - r - c_S^G - \frac{t}{2} > 0$.

Let us now consider *"full market competition"*, that is, the competitor bank poaches borrowers in the closest vicinity of the domestic bank. Formally this is tantamount to

$$t < U_j \qquad (3)$$

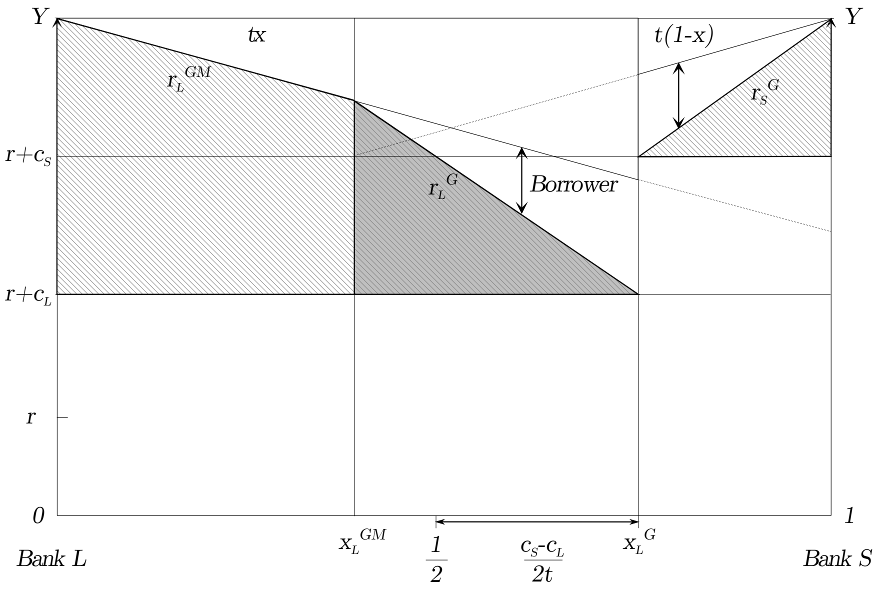


Figure 1: The figure depicts competition among a large and a small bank. The market coverage of the large bank $i$=$L$ covers the whole market, $U_L \geq t$. Hence, competition between bank $i$ and $j$ takes place in the middle and the right part of the figure. To the contrary, the small bank $j$=$S$ is not able to attract all borrowers of bank $i$ offering the latter a local monopoly, $U_S < t$, that is shown on the left hand side of the graphic. The shaded areas represent the profits of both banks. The dotted lines represent the prolongations of the borrowers travel cost. The intersection of the dotted line and $r+c$ represents the market coverage of bank $i$,$j$. The two triangles on the top of the figure display the transportation costs born by the borrower. Further, it is pointed out that borrowers obtain a positive rent only if banks compete with each other. The rent increases with growing proximity to the competitor.

with $U_j = Y - r - c_j^G$. As the market coverage of bank $j$ extends up to bank $i$, the latter does not enjoy a local monopoly. Note that $\frac{U_j}{t}$ represents the market coverage of the bank.[11]

Manipulating (1) and setting $r_j^G$ to $r + c_j^G$ we obtain the price function of bank $i$:

$$r_i^G = c_j^G + r + 2t(\frac{1}{2} - x). \tag{4}$$

Bank $i$ can demand at least the marginal costs of bank $j$ with a positive markup if the borrower is closer to bank $i$ and a markdown for borrowers that are located closer to the competitor. The cutoff of the markdown is

[11]$U_j$ can be interpreted as the residual value that remains with the most distant borrower of bank $j$ to finance the transportation costs. If $\frac{U_j}{t} > 1$ the market span of the bank $j$ covers the whole area between two adjacent banks.

$c_L^G - c_S^G$. More precisely, banks appropriate the cost advantage to their nearest competitor bank. This advantage consists of the information technology cost differential between the banks and the transportation cost difference of the borrower to the respective banks.

Next, if

$$t > U_j \tag{5}$$

the competitor bank $j$ is unable to make an offer to the borrower located at bank $i$. Hence, bank $i$ enjoys a local monopoly. It is called the *"local monopoly i"* case. Formally, the monopoly market share is represented by the market area between two adjacent banks that is not in the range of bank $j$, that is up to borrower $x_i^{GM}$ with

$$x_i^{GM} = 1 - \frac{U_j}{t}. \tag{6}$$

As the transportation costs and the interest rate offered by the adjacent bank is larger than the cash flows of the project of the good borrowers in the monopoly area, bank $i$ extracts the total rents of the project net of transportation costs, $r_i^{GM} = Y - tx$, and prices competitively in the overlapping area where borrowers still have the possibility to switch

$$r_i^{GM} = \begin{cases} c_j^G + r + 2t(\frac{1}{2} - x) & \text{if } x \geq x_i^{GM} \\ Y - tx & \text{if } x < x_i^{GM}. \end{cases} \tag{7}$$

It is now straightforward to calculate the profits for each bank in the good market segment. In the "local monopoly $i$" case profits of the bank are the sum of the profits in the local monopoly area and of the competitive pricing in the overlapping area:

$$\pi_i^G = \int_0^{x_i^{GM}} (r_i^{GM} - r - c_i^G)dx + \int_{x_i^{GM}}^{x_i^G} (r_i^G - r - c_i^G)dx. \tag{8}$$

"Full market competition" profits are computed by applying the competitive pricing for the whole market demand:

$$\pi_i^G = \int_0^{x_i^G} (r_i^G - r - c_i^G)dx \tag{9}$$

In the market for good borrowers, profits in the "monopoly i" and the "full market competition" cases are obtained by integrating (8) and (9).

We can distinguish 4 different cases of competing banks. In the homogeneous scenarios, we have a large bank competing with another large bank and a small bank competing with another small bank: $((i,j) = \{(L,L);(S,S)\})$. The heterogeneous scenarios yield mixed pairs of banks: $((i,j) = \{(L,S);(S,L)\})$. Depending on the scale of the market coverage of the competing bank $U_j$, the profits in the four relevant cases assume the following form: with *"full market competition"*, $t < U_j$,

$$\pi_i^G = \begin{cases} \frac{t}{4} & \text{if } (i,j) = \{(L,L);(S,S)\} \\ \frac{(t+(c_j^G - c_i^G))^2}{4t} & \text{if } (i,j) = \{(L,S);(S,L)\}\,. \end{cases} \tag{10}$$

and in the *monopoly* $i$ case, $t > U_j$,

$$\pi_i^G = \begin{cases} \frac{2U_j}{2} - \frac{t}{4} - \frac{U_j^2}{2t} & \text{if } (i,j) = \{(L,L);(S,S)\} \\ \frac{2U_j + (c_j^G - c_i^G)}{2} - \frac{t}{4} + \frac{\frac{1}{2}\Delta c^2 - U_j^2}{2t} & \text{if } (i,j) = \{(L,S);(S,L)\}\,. \end{cases} \tag{11}$$

#### 2.4.2 The Market for Bad Loans

In this market, small banks have a competitive advantage and large banks find it more difficult to get access to the bad borrowers. Since we are interested in markets where loan access to SMEs is restricted, the market is not fully covered and banks act as monopolists. The banks charge their borrowers $r_i^B$ so that $p_B(Y - r_i^B) - \gamma tz = 0$, where $z$ represents the distance in the bad borrower market.

The borrower that is located at greatest distance of bank $i$ is charged the minimum interest rate, namely the deposit rate plus the information technology costs.

$$p_B(Y - r - c_i^B) - \gamma tz \geq 0. \tag{12}$$

Rearranging the latter equation yields the loan demand of bank $i$ in the bad borrower market when there is no constraint on the provision of loans:

$$z_i = \frac{p_B(Y - r - c_i^B)}{\gamma t}. \tag{13}$$

The bank complies with the risk bearing constraint, if the profits in the good loan segment are large enough to reimburse the deposits which financed the loan demand of the bad borrowers:

$$\pi_i^G - rz_i \geq 0, \tag{14}$$

In this case, the bank's total profit is always nonnegative if bad borrowers do not repay and therefore its probability of default is lower than the risk bearing constraint $\phi$. In the following, we assume that the regulatory capital constraint always binds in equilibrium. This implies that the quantity of loans $z_i$ in the bad borrower segment is restricted:

$$z_i = \frac{\pi_i^G}{r}. \tag{15}$$

To ensure that the market for bad borrowers is not covered, we assume

**Assumption 4:** $\frac{\pi_i^G}{r} + \frac{\pi_j^G}{r} < 1$.

The assumption is based on evidence pointing to lower competition levels in local markets (Lang (1996)) and credit rationing phenomena for SMEs (Kevin J. Stiroh and Philip E. Strahan (2003)). The risk bearing capacity binds, if

**Assumption 5:** $c_i^B < Y - r - \frac{\pi_i^G t}{p_B r}$.[12]

Hence, we postulate sufficient low information technology costs in the bad borrower market, such that demand without restriction would be higher than in case of restriction.

## 2.5 The Market with $n$ Heterogeneous Banks

Consider the more general n-bank case. Every bank competes with exactly one other bank. Banks are matched randomly. When matched two banks compete à la Hotelling on a line segment of length 1. There is a fraction $\alpha$ of large banks, and a fraction $1 - \alpha$ of small banks. In the following we

[12] See Appendix.

are interested in the aggregate supply of loans to the bad borrower market. Since this supply depends on the distribution of the banks, we consider the average aggregate supply that can arise. This is the expected sum of loan supplies of all banks, where the expectation is taken over all possible matches of the banks. On average the fraction of pairs consisting of two large banks will be $\alpha^2$, the fraction of mixed pairs will be $2\alpha(1-\alpha)$, and the fraction of pairs of small banks will be $(1-\alpha)^2$.

Average aggregate profits in the good borrower segment are

$$\Pi^G = n(\alpha^2 \pi_{LL}^G + \alpha(1-\alpha)(\pi_{LS}^G + \pi_{SL}^G) + (1-\alpha)^2 \pi_{SS}^G). \tag{16}$$

With a binding risk–bearing capacity, the loan demand of bank $i$ in the bad borrower segment is

$$z_i = \frac{\pi_i^G}{r}. \tag{17}$$

Plugging (16) into (17) yields the average aggregate supply of loans to the bad borrower segment:

$$L^B = n\frac{1}{r}\begin{cases} \frac{t}{4} + \frac{\alpha(1-\alpha)\Delta c^2}{2t} & \text{if } t < U_S \\ \alpha\frac{t}{4} + (1-\alpha)(U_S - \frac{t}{4} + \frac{\alpha\Delta c^2 - U_S^2}{2t}) & \text{if } U_S < t < U_L \\ E(Uj) - \frac{t}{4} - \frac{E(U_j)^2}{2t} + \alpha(1-\alpha)\frac{(c_j-c_i)^2}{2t} & \text{if } U_L < t \end{cases} \tag{18}$$

with $E(c)$ expressing the expected production costs $\alpha c_L^G + (1-\alpha)c_S^G$.

We distinguish three different regimes. Firstly in regime 1, if $t < U_S$, all banks can easily make an offer to the most distant borrower in the good market, so that no borrower is locked in and there is "full competition" for both banks. In the second regime, if $U_S < t < U_L$, the small bank is not able to reach the most distant borrower in the good market segment. Consequently, the competing bank serves a local monopoly. In the third regime, both banks enjoy local monopolies.

# 3 Results - SME Volume of Loans

## 3.1 Homogeneous Banks

In this section we analyse the impact of competition on the expected SME volume of loans. Homogeneity is achieved by setting $c_S = c_L$. As a result, the second regime of the latter chapter vanishes. It is now posssible to proof that

**Proposition 1:** *In a homogeneous banking sector the equilibrium SME volume of loans is a hump-shaped function of competition. In particular, if* $t > \hat{t}$ *then* $\frac{\partial L^B}{\partial t} < 0$ *and for* $t < \hat{t}$ *then* $\frac{\partial L^B}{\partial t} > 0$.

According to Proposition 1, as transportation costs fall, the bad borrowers volume of loans initially increases at high levels of transportation costs. After a critical competition threshold $\hat{t}$ is exceeded, $t < \hat{t}$, the volume of loans decreases with rising competition. If we consider the proposition intuitively, it seems that for sufficient large monopoly areas of the banks, volume of loans for bad borrowers rise with competition. As with further decreasing transportation costs a certain market coverage is achieved, competition is detrimental to small business finance.

In particular, two opposing effects are responsible for this outcome. Firstly, with decreasing transportation costs, all banks can charge their borrowers higher interest rates in the monopoly area, as the borrowers pay less to travel to the bank. Therefore, profits of both banks rise. This "travel cost effect" is the larger the larger the monopoly area of the banks is or the higher transportation costs are.

Second, falling transportation costs extend the market span of both banks, reducing the monopoly area of all banks. This negative "market power effect" is the larger the smaller the monopoly area is. The reason for this result can be explained as with lower transportation costs the competitor penetrates the core market of the incumbent bank which yields the highest profits. Following the previous argumentation, one can derive the following thumb rule. At high levels of transportation costs which is equal to low competition, the travel cost effect dominates the market power effect, leading to increasing volume of loans. For lower transportation costs, the negative market power effect increasingly dominates the travel cost effect and the volume of loans declines with increasing competition. The standard Salop result implies that competition is always beneficial for bad borrowers, if the market coverage of the banks is not too large.

## 3.2 Heterogeneous Banks

In this section we assume a sufficient high level of bank heterogeneity. Particularly, let the marginal cost difference be $c_S - c_L > \sqrt{2}U_S$. It can be shown, that regime 1 and regime 3 are ruled out following this assumption.[13]

**Proposition 2:** *In a sufficient heterogeneous banking sector, the SME volume of loans is increasing with increasing competition* $\frac{\partial L^B}{\partial t} < 0$*, if* $\alpha < \alpha_1$*, and decreasing with competition* $\frac{\partial L^B}{\partial t} > 0$ *for* $\alpha > \alpha_2$*.*

According to Proposition 2, the direction of the competitive SME loan volume effect depends on the market structure. Furthermore, it gets obvious that the level of heterogeneity in the banking sector does not just depend on the cost differences of the banks, but on the share of small and large banks which are present in the market. More specificly, if $\alpha < \alpha_1$, the banking market is rather homogeneous and small in average size, as there is a low share of large banks in the market. As a consequence of the narrow market spans of the small banks, the travel cost effect dominates the market power effect. Thus, if there is a sufficient high share of small banks, the loan access of SMEs is improved with increasing competition. Conversely, for banking industries that are of large size in average, expressed by $\alpha > \alpha_2$, SME access to loans is hampered with lower transportation costs, as the market power effect dominates the travel cost effect. In other terms, if the banking industry is small in size and quite homogeneous, higher competition leads to reduced information asymmetry without eroding the bank's informational rents from its local core markets too intense. Accordingly, total profits mount, leading to a higher risk bearing capacity that allows to lend higher volumes to the SME sector. For a sufficiently large banking sector, market penetration is already quite advanced, so that higher com-

[13]Proof Appendix.

petition destroys local rents and declining overall profits of the sector are the result.

**Proposition 3:** *If the banking industry is of intermediate size, $\alpha \in (\alpha_1, \alpha_2)$, the SME volume of loans granted by the banks is a U-shaped function of the level of competition. If $t > \hat{t}$ then $\frac{\partial L^B}{\partial t} > 0$ and for $t < \hat{t}$ observe that $\frac{\partial L^B)}{\partial t} < 0$.*

Following Proposition 3, high heterogeneity reverses the results obtained under homogeneity. For high levels of transportation costs, the market coverage is low. Hence, the market power effect outweighs the travel cost effect of both banks, since the redistribution of market share from small to large banks is low. In that case, losses incurred by small banks are significantly higher as in a homogeneous banking sector, as large banks poach borrowers in their vicinity. In contrast, the additional profits which are generated by large banks under heterogeneity are low compared to the losses of small banks. The result occurs as large banks can not charge high interest rates to their new borrowers due to the high travel costs of the latter. In other words, stealing borrowers does hardly pay off as transportation costs are high. As a result, if $t > \hat{t}$, loan access of SMEs deteriorates with increasing competition. If transportation costs are low, poaching borrowers gets more profitable and large banks find it easier to exploit scale economies more effectively, having better access to more distant located borrowers. In this constellation, $t < \hat{t}$, competition benefits the small and medium-sized sector.

# 4 Basel III Regulation

In chapter 3 we considered a constraining risk bearing capacity which tied the possibility to grant bad borrower loans to the profits generated in the good borrower segment. This approach was convenient to stress the repercussions of competition on the SME volume of loans in the most traceable way. In order to adapt the model closer to reality, this section introduces two different forms of capital regulation which are both considered in the ongoing consultation process on the Basel III scheme. First, we consider a risk-weighted capital requirement as it is currently practiced under Basel II. Further, we allow for the introduction of a leverage ratio which has been proposed to curb model risks, arising at the bank level from incorrect estimations of the true risk-weights. In this chapter we asssume that equity capital is scarce and costly. More precisely, we assume $\rho > r$ postulating that equity capital is more expensive than deposits. In light of Modidgliani-Miller one may argue that the costs of equity are decreasing with higher capital ratios as bank risk is coming down. In the banking sector, however, there is an important caveat as small banks are predominantly financed by insured deposits and large banks benefit from the implicit too big to fail guarantee.[14] In this vein, increased equity financing lowers the public subsidies and is costly on the bank level.

## 4.1 Risk-Weighted Capital Requirements

According to the Basle Accord risk weights are designed to tailor the capital requirement adequately to the underlying asset risk. Referring to the model, this means that capital buffers are merely required for bad loans. In the bad borrower market this signifies that refinancing costs increase thereby decreasing the market area which can be covered by the bank, $z_i = \frac{p_B(Y - r(1-k_B) - k\rho - c_i^B)}{\gamma t}$. However, we assume the risk-bearing capacity to

[14]Miller (1995) himself argued that in the banking sector the MM theorem holds only if the regulator designs its measures in a social efficient way, that is, the regulations should resemble the measures undertaken by a private lender, charging an adequate risk premium and requiring collateral. In practice the deposit insurance risk premium is rarely priced correctly – a positive excepetion concerns the U.S. where the premium is priced with respect to the equity ratio and the asset quality. With respect to the Basel standards that represent the capital requirements Miller himself judges:"Surely no private lending institution using anything arbitrary as the definitions under the Basel accords could hope to survive long as a major player in a competitive lending market." For empirical evidence that the MM-theorem is not fully applicable in the banking sector see Miles et al. (2011)

be binding. Hence, the volume of loans in the SME segment equals

$$E(L^B) = n\frac{1}{r(1-k_B)}\begin{cases} \frac{t}{4}+\frac{\alpha(1-\alpha)\Delta c^2}{2t} & \text{if } t<U_S \\ \alpha\frac{t}{4}+(1-\alpha)(U_S-\frac{t}{4}+\frac{\alpha\Delta c^2-U_S^2}{2t}) & \text{if } U_S<t<U_L \\ E(Uj)-\frac{t}{4}-\frac{E(U_j)^2}{2t}+\alpha(1-\alpha)\frac{(c_j-c_i)^2}{2t} & \text{if } U_L<t. \end{cases} \quad (19)$$

This shows that the relaxation of the risk-bearing capacity is driven by a lower volume of deposit financing so that the loan volume in the SME borrower segment experiences an upward shift.

**Proposition 4:** *In an environment with risk sensitive capital regulation, the risk bearing capacity of banks is relaxed so that the volume of SME loans increases with higher levels of equity financing. The impact of competition does not change.*

## 4.2 Leverage Ratio

The leverage ratio is calculated as a ratio of assets to tier 1 capital. As this is the inverse to an equity ratio, in the following we consider a mandatory equity capital ratio which has to be held independent of the quality of the respective assets in the portfolio. This interpretation is tantamount to a capital requirement for all types of loans which we denote by $k_l$ in the following. The introduction of a leverage ratio to the model has a twofold implication. First, the volume of loans increases due to a relaxation of the risk bearing capacity. Second, as marginal costs increase even in the good borrower segment, the market span of bank *i,j* in the good borrower market is reduced and the monopoly area of the large bank is increasing with $k_l$

$$x_i^{GM} = \frac{1}{n} - \frac{Y - c_S - r(1-k_l) - k_l\rho}{t}. \quad (20)$$

Put differently, a reduction of the market span of both banks is accompanied by an increase of the large bank's local monopoly. This can be interpreted as a decrease of competition in the good borrower market. We have shown in chapter 3 that competition in the good borrower segment is especially beneficial to large banks. Hence, the reduction of competition due to the introduction of a leverage ratio is harmful for large banks and beneficial for small banks.

$$\frac{\partial \pi_i^G}{\partial k_l} = \frac{2(r-\rho)(t-U_j)}{t} \text{ if } U_S < t < U_L.^{15} \tag{21}$$

This gets obvious by considering the two terms in the numerator of (21). Qua assumption $(r-\rho)$ is negative. In turn, the sign of $(t-U_j)$ depends on the size of the bank. If $i = L$ and $j = S$, the derivative is negative and vice versa if $i = S$ and $j = L$, since poaching borrowers away from the small banks gets costlier. Let us now consider how a change of the market constellation in the good borrower segment influences the impact of competition on lending volumes in the SME sector. One can interpret a reduction of overall market spans as a contraction of the banking industry. As the industry is smaller in average size now, banks are smaller in size which makes it less costly to handle soft information or a specialization in more local lending for the whole banking industry. An intensification of competition prompts the competitors to concentrate on their comparative advantages. A smaller size of the banking industry translates into better competitiveness in generating soft information which is especially important when it comes to financing SMEs. As a result competition favours increasingly SME financing with higher leverage ratios. Proposition 7 summarizes the main results of this paragraph.

**Proposition 5:** *The leverage ratio softens the risk bearing constraint and leads to an increase of the SME volume of loans. It further induces a contraction of the banking industry regarding the average size. This is beneficial for small banks and costly for large banks. In sequence the level of competition is reduced and efficiency advantages lose importance. In total, lending gets more local, promoting SME finance with rising levels of competition.*

[15] $U_i = Y - r(1-k_l) - c_i - k_l\rho$

# 5 Efficiency

In our model the level and the risk of investment does not depend on the distribution of the surplus. As a consequence efficiency is simply optimized by maximizing the number of loans at the lowest possible transportation costs. Since all borrowers in the good market segment are served anyway, and, due to the risk bearing constraint, the amount of borrowing in the bad market segment depends on the profits generated in the good market segment, efficiency is increased by letting the banks obtain as much surplus in the good borrower market as possible. This is achieved by a monopolistic banking structure. The optimal scale of the business areas of the banks can be found by maximizing the aggregate surplus of the two banks in the two market segments. In the case of two symmetric banks cost minimization implies that the market should be split up evenly between the two banks. In the case of one large bank and a small bank, there is tradeoff between lower costs for the large banks in the good borrower segment, which is in favor for a larger market range of the large bank, and lower costs and a larger market share for the small banks in the bad borrower segment. Since the scale of lending in the bad borrower segment depends on the profits in the good borrower segment, increasing the market share of large banks in the good borrower segment has an adverse effect on the amount and the profitability of lending in the bad borrower segment, since it increase high cost lending to distant borrowers at the expense of lower cost lending to more proximate borrowers.

The aggregate surplus in the good borrower market is

$$\hat{\pi}_i^G(\hat{x}) + \hat{\pi}_j^G(\hat{x}) = \int_0^{\hat{x}} (Y - tx - c_i^G - r)dx + \int_{\hat{x}}^1 (Y - t(1-x) - c_j^G - r)dx$$

where $\hat{x}$ is the boundary between the market range of the two banks and $\hat{\pi}_h^G$, $h = i, j$ are the monopoly profits of the banks. With a binding risk bearing constraint the supply of loans in the bad borrower segment is restricted by the profits in the good segment. Therefore, the aggregate surplus in the bad borrower segment is:

$$\int_0^{\hat{\pi}_i^G/r} p_B(Y - \gamma tx - r - c_i^B)dx + \int_0^{\hat{\pi}_j^G/r} p_B(Y - \gamma tx - r - c_j^B)dx.$$

Increasing $\hat{x}$ has two effects. First it increases the profits of bank $i$ at the expense of bank $j$ in the good borrower market. Second it increases the range of lending in the bad borrower market of bank $i$ and decreases the range of bank $j$. But if $c_i^B > c_j^B$ these are less efficient and more distant loans. If the cost differential $c_j^G - c_i^G$ is large and $c_i^B - c_j^B$ is small, the optimal market shares will involve a larger share for the good banks, while the small banks should enjoy a larger market share in the opposite case.

# 6 Concluding Remarks

The contribution of the article to the competition and small business finance literature is threefold. One main insight of the model gives a theoretical explanation for the observation that large banks in the U.S. and several developing countries are extensively engaged in the SME market, though conventional wisdom assumes comparative advantages of small banks in this segment. We argue that the presence of banks in the SME market is linked to the level of competition in other segments. If the level of competition in the tranparent borrower market is rather high, this induces a high presence of large banks in the SME market, since their endogenously generated risk bearing capacity in the transparent borrower market allows them to grant a considerable volume of small business loans. In other terms, large banks concentrate on SMEs that are less opaque, whereas small banks try to insulate from competition by progressively focusing on opaque borrowers or local business. An implication that remains to be tested.

A further insight resulting from the model explains the impact of banking competition on total SME lending. If banks are heterogeneous in their information technology costs, we find that the structure of the banking market is of major relevance for the repercussions of competition on small business lending. In particular, competition promotes SME lending if the banking market is primarily marked by small banks and vice versa. In sufficient heterogeneous banking markets, there is a U-shaped relation between competition and total SME lending volume.

In light of the current transition from Basel II to Basel III, the model lastly examines the competitive effects of a mandatory leverage ratio on the banking market and its consequences for small business loans. As banks have to comply with the leverage ratio, the overall level of competition among banks and the average size of banks is reduced, leaving more profits to less efficient and smaller banks. Policy concerns that SME lending will suffer from tighter regulation is needless, as the focus of lending becomes increasingly local. Thus, if it is the objective to improve the financing situation of SMEs, there is no trade off between a leverage ratio and competition.

# 7 Appendix - Proofs

**Assumption 5**

*The risk bearing capacity is binding in the bad borrower market, if*

$$\frac{p_B(Y - r - c_i^B)}{\gamma t} > \frac{\pi_i^G}{r}. \tag{22}$$

*As regime 1 and 3 are ruled out (see further below), we consider only regime 2. Hence, the risk bearing capacity is binding, if the costs in the bad borrower market are not too high*

$$c_i^B < Y - r - \frac{\pi_i^G \gamma t}{p_B r}. \tag{23}$$

**Proof expected profit.**

*As banks compete to both sides on the circle, the expected profit for an entering bank can be described as*

$$\begin{aligned} E(\pi) &= \alpha^3 \pi_{LLL} + \alpha(1-\alpha)^2(\pi_{LSS} + \pi_{SLS} + \pi_{SSL}) \\ &+ \alpha^2(1-\alpha)(\pi_{SLL} + \pi_{LSL} + \pi_{LLS}) + (1-\alpha)^3 \pi_{SSS}. \end{aligned} \tag{24}$$

*Setting* $\pi_{LLL} = 2\pi_{LL}$ *this is equivalent to*

$$\begin{aligned} E(\pi) &= \alpha^3 2\pi_{LL} + \alpha(1-\alpha)^2(2\pi_{LS} + 2\pi_{SL} + 2\pi_{SS}) \\ &+ \alpha^2(1-\alpha)(2\pi_{SL} + 2\pi_{LS} + 2\pi_{LL}) + (1-\alpha)^3 2\pi_{SS}. \end{aligned} \tag{25}$$

*Simplifying the latter equation yields* (16).

**Proof of Proposition 1**

*As the inflection point occurs only in the case* $t > Y - r - c$ *it is sufficient to differentiate regime 3 of* (19) *with respect to* $t$. *Rearranging the* *equation for $\hat{t}$ and setting $c_i = c_j$ we obtain*

$$\hat{t} = \sqrt{U^2}. \tag{26}$$

**Proof that there is no regime 1 and 3 if $c_S - c_L > \sqrt{2}U$**

*First, we prove that regime 1 does not exist. Regime 1 is characterised by $Y - r - c_S > \frac{t}{n}$. Rearranging $c_S - c_L > \sqrt{2}U$ and inserting into scenario 1 condition yields $Y - r - c_L - \sqrt{2}(Y - r - c_S) > \frac{t}{n}$. Reorganizing this equation yields $c_S - c_L > \frac{t}{n} + (\sqrt{2} - 1)(Y - r - c_S)$. Since, the latter term is positive, the result contradicts assumption 2. q.e.d.*

*Second, scenario 3 is tantamount to $\frac{t}{n} > Y - r - c_L$. Inserting the heterogeneity condition and rearranging, yields $\frac{t}{n} > (1 + \sqrt{2})U$, which contradicts assumption 3. q.e.d.*

**Proof of Proposition 2 and 3**

*Differentiating regime 2 ($U_S < t < U_L$) of (19) with respect to t yields*

$$\frac{\partial L^B}{\partial t} = \frac{1}{r}(\frac{\alpha}{4} + (1-\alpha)\left(-\frac{1}{4} - \frac{-U_S^2 + \Delta c^2 \alpha}{2t^2}\right)). \tag{27}$$

*Further simplifying delivers*

$$= \frac{1}{r}((\frac{\alpha}{2} - \frac{1}{4}) + (1-\alpha)(\frac{U_S^2 - \alpha \Delta c^2}{2t^2})). \tag{28}$$

*Observe that this equation is monoton negative, if $\alpha < \alpha_1 = min\left\{\frac{1}{2}; \frac{U_S^2}{\Delta c^2}\right\}$ with $\frac{U_S^2}{\Delta c^2} < \frac{1}{2}$ as $\Delta c > \sqrt{2}U_S$. Further, see that $\frac{\partial L^B}{\partial t} > 0$ if $\alpha > \alpha_2 = max\left\{\frac{1}{2}; \frac{U_S^2}{\Delta c^2}\right\} = \frac{1}{2}$ as shown above. For $\alpha \in (\alpha_1; \alpha_2)$ the sign of $\frac{\partial L^B}{\partial t}$ changes and delivers a U-shaped relation q.e.d.*

**Proof of Proposition 4**

*Considering a capital requirement for the risky and bad loans the risk bearing capacity is modified to*

$$\pi_i^G - rz_i(1 - k_B) \geq 0 \tag{29}$$

*so that* $z_i = \frac{\pi_i^G}{r(1-k_B)}$*. Plugging* (16) *into* $z_i$ *and differentiating the equation with respect to* $k_B$ *yields*

$$\frac{\frac{\alpha}{4} + (1-\alpha)\left(-\frac{1}{4} - \frac{\frac{1}{2}(c_S-c_L)^2\alpha-(Y-r-c_S)^2}{2t^2}\right)}{r(1-k_B)^2} > 0. \tag{30}$$

**Proof of Proposition 5**

*An introduction of a leverage ratio changes the profit function of the bank*

$$\pi_{ik_l}^G = \int_0^{x_i^{GM}} (r_i^{GM} - r(1-k_l) - k_l\rho - c_i^G)dx + \int_{x_i^{GM}}^{x_i^G} (r_i^G - r(1-k_l) - k_l\rho - c_i^G)dx \tag{31}$$

*and the risk bearing capacity*

$$\pi_{ik_l}^G - rz_i(1-k_l) \geq 0. \tag{32}$$

*Applying the same procedure as above and differentiating with respect to* $k_l$ *delivers*

$$\begin{aligned}\frac{\partial \pi_{ik_l}^G}{\partial k_l} &= \frac{(1-\alpha)(r-\rho)(Y-(1-k_l)r-k_l\rho-c_S)}{(1-k_l)rt^2} \\ &+ \frac{\frac{\alpha}{4} + (1-\alpha)\left(-\frac{1}{4} - \frac{\frac{1}{2}(c_S-c_L)^2\alpha-(Y-(1-k_l)r-k_l\rho-c_S)^2}{2t^2}\right)}{(1-k_l)^2 r}.\end{aligned} \tag{33}$$

*The first term is negative in sign, indicating the shift to a smaller sized industry that is dealing increasingly with soft information and SMEs. The second term is similar to the Proof of Proposition 5, however, smaller in size.*

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