Banking System Structure and the Real Effects of Monetary Policy[1]

April 2004

Sharon Blei

Abstract

Banks' credit affects the economy via various channels: its price, collateral requirements, borrowers' net worth and the extent of rationing. Would the intensity of monetary transmission be affected by the structure of the banking sector? The paper presents a spatial model of the banking system with monetary features, aimed to explore the interactions between banking system structure and short-run monetary policy changes. The research indicates that monetary policy changes can, under some conditions, affect the volume of credit, and thereby translate into economic activity. Furthermore: the intensity of transmission depends on credit market structure. The model also shows that given the number of banks in the economy and the extent of differentiation between them as credit providers, monetary tightening may render lending an unprofitable business and thus generate an overall collapse of the credit market – a credit crunch.

[1] I am indebted to Prof. Oved Yosha and Prof Alex Cukierman for their support and advise. I would also like to thank Prof. Assaf Razin for his contributive suggestions. Useful comments from Prof. Alan Drazen and Prof. Zvi Hercowitz and from the participants of the Macroeconomics workshop at the Berglas School of Economics, Tel-Aviv University, are gratefully acknowledged. Errors are those of the author alone.

1. Introduction

The literature identifies a number of channels by which the banking system transmits monetary policy changes. Alongside the traditional Keynesian and monetarist banks' liabilities channel, more recent theories emphasize the role of banks' assets - stemming from credit market informational imperfections and banks' informational advantages as credit providers (see Azariadis and Smith (1993), Bernanke and Blinder (1992), Bernanke and Gertler (1995), Bernanke, Gertler and Gilchrist (1994), Bernanke and Lown (1991), Blinder and Stiglitz (1983) Kashyap and Stein (2000) Meltzer (1995) and Suarez and Sussman (1997, 1999)). Banks' credit affects the economy via various channels: its price, collateral requirements, borrowers' net worth and the extent of rationing. Although the transmission of monetary policy has been accorded extensive attention in the literature, the way by which the intensity of these channels may be affected by the structure of the credit market in general, and of the banking system in particular, remained, to the best of my knowledge, unexplored.

The paper presents a one period Salop-style spatial model of the banking system with monetary features. The structure of the banking system is captured by the number of banks and the extent of differentiation between them as credit providers - which reflects on potential borrowers' credit-accessibility costs. The extent of differentiation between banks summarizes various factors, such as banking sector regulation, banks' deliberate product differentiation strategies, credit market frictions, lack of transparency, etc. The monetary stance is represented by the central bank's short-term interest rate (henceforth the CB rate). Banks procure liquidity from the central bank and offer loan contracts (specifying a debitory rate and collateral requirements) to entrepreneurs, who seek external funding for their projects. The credit market is subjected to asymmetric information regarding entrepreneurs' credit worthiness.

The model yields two main endogenous structural configurations of the credit market – monopolistic competition and local monopolies - depending on the number of banks, the extent of differentiation between them, the CB interest rate and the technological rate of return. It is shown that when the banks act as local monopolists, monetary policy changes affect the economy via a differentiation-driven lending channel. Another result states that the higher the extent of differentiation between banks and the fewer their number, the larger the decline in the CB interest rate required to achieve a given expansionary effect.

The model also shows that in the case of pooling loan contracts, monetary tightening may render lending unprofitable, thus inducing banks to withhold loans - so that the credit market undergoes a credit crunch. The CB's policy can therefore affect the stability of the credit market. Another interesting result is that under pooling loan contracts, the proper functioning of the credit market requires that banks possess some market power over borrowers.

The paper is organized as follows: section 2 presents the theoretical framework; section 3 present and analyses the case where banks offer separating loan contracts; section 4 present and analyses case where banks can offer but pooling loan contracts, and section 5 concludes.

2. The Model

I consider a one period economy, represented by the unit circumference of a circle. The economy is populated by entrepreneurs whose consumption takes place at the end of the period. A single good serves as both consumption and capital good. *n* profit maximizing banks are located symmetrically around the circle. The banks borrow funds from the central bank and offer loans to entrepreneurs[2].

[2] In reality, the central bank lends funds to commercial banks only in the margin. This simplifying assumption would therefore not affect the model's qualitative results.

2.1 Entrepreneurs

A continuum of entrepreneurs are located around the circle, each endowed with *w* units of illiquid wealth that become liquid at the end of the period. Entrepreneurs differ with respect to entrepreneurial skills: there are high-skilled (type *h*) and low-skilled (type ℓ) entrepreneurs. The proportion of type *h* entrepreneurs in the population is *q*.

2.2 Technology

Production is carried out through projects. At the beginning of the period, each entrepreneur faces the opportunity to start a project that requires an investment of one unit of capital. If the entrepreneur is of type *h*, the project will yield a certain output of $R > 1$ units of good by the end of the period. However, if the entrepreneur is of type ℓ, he extracts a private gain of $G > 0$ units of capital from the project, which in turn, generates no output.

Assumption 1: *Had entrepreneurs been able to finance their own projects, then for a type h entrepreneur a project's value would have exceeded its cost, whereas for a type* ℓ *entrepreneur a project's value would have fallen below its cost, that is,* $R > 1 > G$.

Assumption 2: *Even if entrepreneurs' wealth had been liquid, they would not have been able to finance their projects, that is,* $w < 1$.

2.3 The Credit Market

As entrepreneurs do not possess liquid assets, an entrepreneur who wishes to start a project has to borrow the required investment of one unit of capital from a bank. A typical loan contract specifies the loan's interest rate and collateral requirements. If a borrower fails to repay the loan, the bank seizes the collateral. Let $\{r^i, c^i\}$denote the loan contract offered by bank i where r^i and c^i denote the gross interest rate and collateral requirements, respectively.

Assumption 3: *Entrepreneurial skills are the borrower's private information.*

Potential borrowers bear a transportation disutility equivalent to α units of capital per unit of length, which measure the extent of differentiation between banks as credit providers. When $\alpha = 0$, banks provide homogenous credit products; the higher α gets, the higher the extent of differentiation between the loans offered by different banks. The extent of differentiation between banks can summarize a number of differentiating factors. It may reflect banks' deliberate medium/long run strategic choices; banking supervision, geographical factors, the technological state-of-the-art of the banking industry (for example, the use of sophisticated technological tools by financial institutions is likely to diminish the extent of differentiation between banks), etc. The unit circumference circle can be thought of as a spectrum of industries, where each bank specializes in lending to a specific industry. In that sense, the farther the location of an entrepreneur from a given bank, the higher the cost that the bank will incur when evaluating that entrepreneur's loan application. Assuming that banks charge loan applicants for the cost of evaluating their applications, a potential borrower's cost of accessing a given bank's credit will be higher the longer the distance between them. It is however assumed that loan contracts are not distance-contingent. Consider a type t entrepreneur located $x \in \{0, 1/n\}$ units of length away from bank i, then, αx reflects the cost he has to incur in order to access bank i's credit.

Let $V_t^i(x)$ denote the surplus that the entrepreneur can attain by accepting bank i's loan contract, then:

$$(1)\quad V_t^i(x) \;=\; \begin{cases} R - r^i - \alpha x & for \quad t = h \\ G - c^i - \alpha x & for \quad t = \ell \end{cases}$$

The entrepreneur will consider bank *i*'s loan contract beneficial if:

$$V_t^i(x) \;\geq\; 0 \quad ; \quad t \in \{h\,,\, \ell\}$$

Let bank *i*'s closest neighbor be denoted bank ◦; then, the same entrepreneur will prefer the loan contract offered to him by bank *i* to that offered to him by bank ◦ if the former provides him a higher surplus than the latter, that is

$$V_t^i(x) \;\geq\; V_t^o(\tfrac{1}{n} - x)$$

Let the type *t* marginal entrepreneur that borrows from bank *i* be located $x_t^i \in \{0,\ 1/n\}$ units of length away from the bank, then:

$$(2)\quad V_t^i(x_t^i) \;=\; max\{0\;,\; V_t^o(\tfrac{1}{n} - x_t^i)\}$$

Equation (2) states that the marginal type *t* entrepreneur that borrows from bank *i* can be either

(I) Indifferent between starting up his project using bank *i*'s funding to letting it down, and prefers the loan contract offered to him by bank *i* to that offered by bank ◦.

or

(II) Indifferent between the loan contracts offered to him by bank *i* and bank ◦, and favors starting up his project to letting it down;

Let $\bar{x}_t^i$ denote the location of a type *t* entrepreneur that is indifferent between starting up his project using bank *i*'s funding to letting it down. $\bar{x}_t^i$ therefore marks the border of bank *i*'s potential monopoly market (to the right and to the left of the bank *i*). By definition:

$$V_t^i(\bar{x}_t^i) = 0$$

so that

$$(3)\quad \bar{x}_t^i = \begin{cases} \dfrac{R - r^i}{\alpha} & \text{for } t = h \\[2ex] \dfrac{G - c^i}{\alpha} & \text{for } t = \ell \end{cases}$$

Let $\hat{x}_t^i$ denote the location of a type t entrepreneur that is indifferent between the loan contracts offered to him by bank i and bank $\circ$. $\hat{x}_t^i$ therefore marks the border of bank i's potential monopolistic competition market (to the right and to the left of the bank i). By definition:

$$V_t^i(\hat{x}_t^i) = V_t^o(\tfrac{1}{n} - \hat{x}_t^i)$$

so that

$$(4)\quad \hat{x}_t^i = \begin{cases} \dfrac{r^o - r^i + \frac{\alpha}{n}}{2\alpha} & \text{for } t = h \\[2ex] \dfrac{c^o - c^i + \frac{\alpha}{n}}{2\alpha} & \text{for } t = \ell \end{cases}$$

The location of bank i's actual marginal type t borrower, x_t^i, is given by

$$(5)\quad x_t^i = min\{\bar{x}_t^i \, , \, \hat{x}_t^i\}$$

It follows from equation (5) that when $\bar{x}_t^i \leq \hat{x}_t^i$, bank i's marginal type t borrower satisfies (I), so that $V_t^i(\bar{x}_t^i) = 0$ and $V_t^i(\bar{x}_t^i) \geq V_t^0(1/n - \bar{x}_t^i)$. In this case bank i faces an actual monopoly market, as illustrated in figure 1. When $\hat{x}_t^i \leq \bar{x}_t^i$, bank i's marginal type t borrower satisfies (II), so that $V_t^i(\hat{x}_t^i) = V_t^0(1/n - \hat{x}_t^i)$ and $V_t^i(\hat{x}_t^i) \geq 0$. In this case bank i faces an actual monopolistic competition market, as illustrated in figure 2. Substituting equations (3) and (4) into (5) obtains:

(6a) $$x_h^i = \begin{cases} \bar{x}_h^i & \text{if } r^i \geq 2R - \frac{\alpha}{n} - r^o \\ \hat{x}_h^i & \text{otherwise} \end{cases}$$

(6b) $$x_\ell^i = \begin{cases} \bar{x}_\ell^i & \text{if } c^i \geq 2G - \frac{\alpha}{n} - c^o \\ \hat{x}_\ell^i & \text{otherwise} \end{cases}$$

Figure 1: Bank *i*'s actual monopoly market

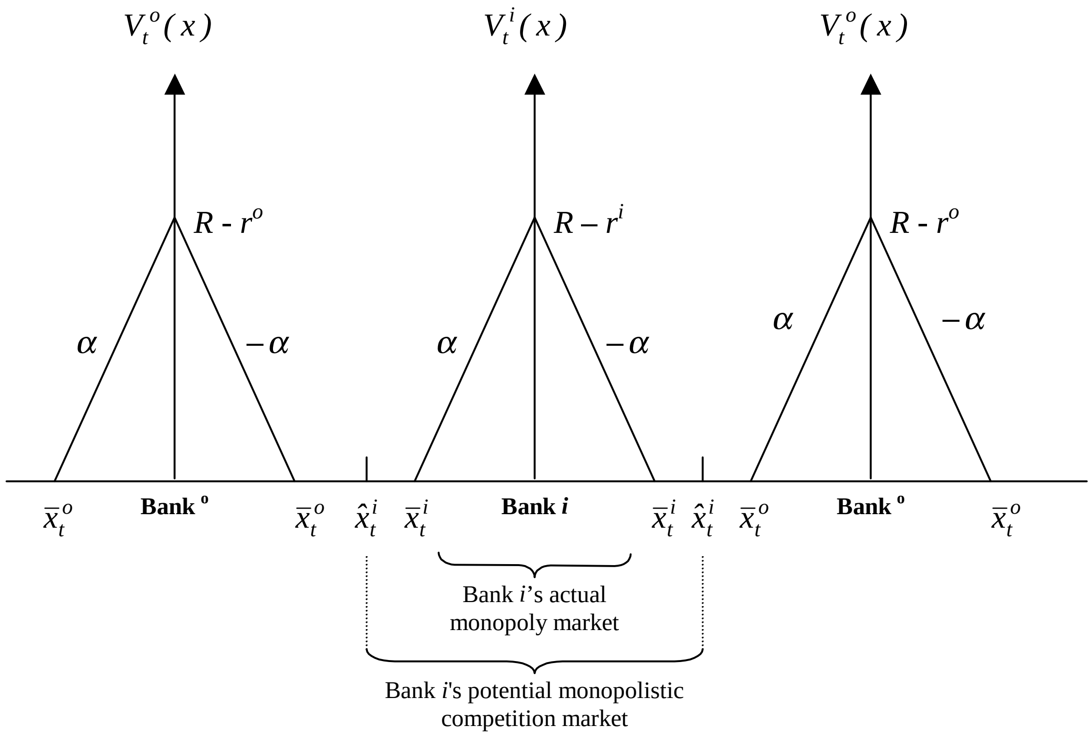
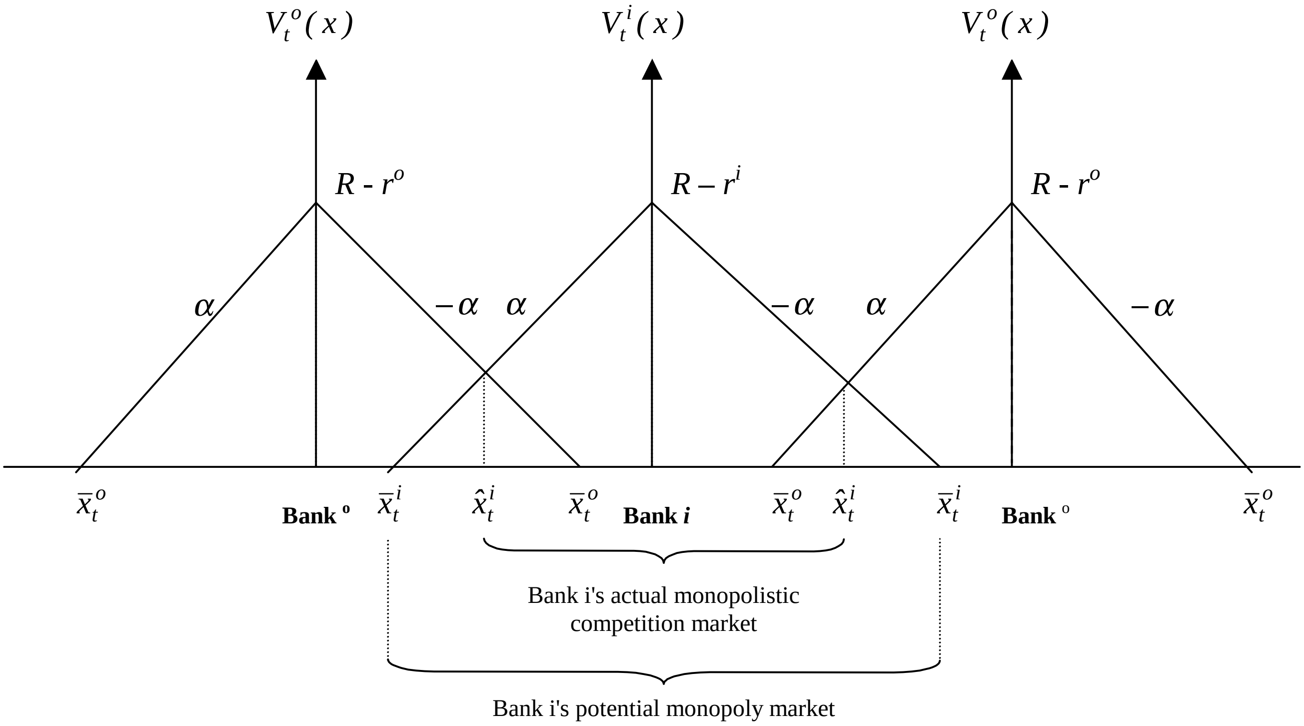


Figure 2: Bank *i*'s actual monopolistic competition market



2.3.1 The demand for loans

Other things being equal, the loan contract offered by bank *i* determines the location of its marginal borrowers, x_h^i and x_ℓ^i, and hence, the demand for loans addressed to it by type *h* and type ℓ entrepreneurs. Let $L_t^i(x_t^i)$ denote the demand for loans addressed to bank *i* by type *t* entrepreneurs; then:

(10a) $L_h^i(x_h^i) = 2qx_h^i$ (10b) $L_\ell^i(x_\ell^i) = 2(1-q)x_\ell^i$

Equations (10a) and (10b) state that type *t* entrepreneurs' demand for bank *i*'s loans equals the number of type *t* entrepreneurs that are located between bank *i* and its marginal type *t* borrower, x_t^i, from both sides. Substituting for x_h^i in (10a) using equation (9a) yields:

$$
(11)\quad L_h^i(x_h^i) = \begin{cases} 2q\overline{x}_h^i = \dfrac{2q}{\alpha}\left(R - r^i\right) & \text{if} \quad r^i \geq 2R - \dfrac{\alpha}{n} - r^o \\ 2q\hat{x}_h^i = \dfrac{q}{\alpha}\left[r^o - r^i + \frac{\alpha}{n}\right] & \text{otherwise} \end{cases}
$$

Since type h entrepreneurs always repay their loans, they are indifferent to collateral requirements and are concerned only by debitory rates. As indicated by the above equation and illustrated in figure 3, type h entrepreneurs' demand for bank i's loans consists of two segments. For debitory rates higher than $2R - \alpha/n - r^o$, bank i faces an actual monopoly market for its loans; this segment of demand will be henceforth referred to as the local monopoly segment. For debitory rates lower than $2R - \alpha/n - r^o$, bank i faces actual competition from bank ^{o}, and hence takes into account its rival's debitory rate when setting its own. That segment of demand will henceforth be referred to as the monopolistic competition segment. As in Salop (1979), the local monopoly segment of demand is of a milder slope than the monopolistic competition segment. Other things being equal, when the credit market is highly differentiated (α is high and/or n is low) and projects' gross return R is sufficiently low, the demand of type h entrepreneurs for bank i's loans may consist of the local monopoly segment alone. In the same manner, when the credit market is only slightly differentiated (α is low and/or n is high) and R is sufficiently high, the demand of high skilled entrepreneurs for bank i's loans may consist of the monopolistic competition segment alone.

Substituting for x_ℓ^i in (10b) using equations (9b) obtains type ℓ entrepreneurs' demand for bank i's loans:

$$
(12) \quad L^i_\ell(x^i_\ell) = \begin{cases} 2(1-q)\bar{x}^i_\ell = \dfrac{2(1-q)}{\alpha}\left(G - c^i\right) & \text{if } c^i \geq 2G - \dfrac{\alpha}{n} - c^o \\ 2(1-q)\hat{x}^i_\ell = \dfrac{1-q}{\alpha}\left[c^o - c^i + \frac{\alpha}{n}\right] & \text{otherwise} \end{cases}
$$

As type ℓ entrepreneurs never repay their loans, they are concerned only by collateral requirements. As indicated by the above equation and illustrated in figures 4, type ℓ entrepreneurs' demand for bank *i*'s loans consists of two segments. Yet, as banks view type ℓ entrepreneurs as undesirable borrowers; the use of the terms local monopolist and monopolistic competitor to describe bank *i*'s behavior in each of these two segments is inappropriate.

Figure 3: Type *h* entrepreneurs' typical demand for bank *i*'s loans

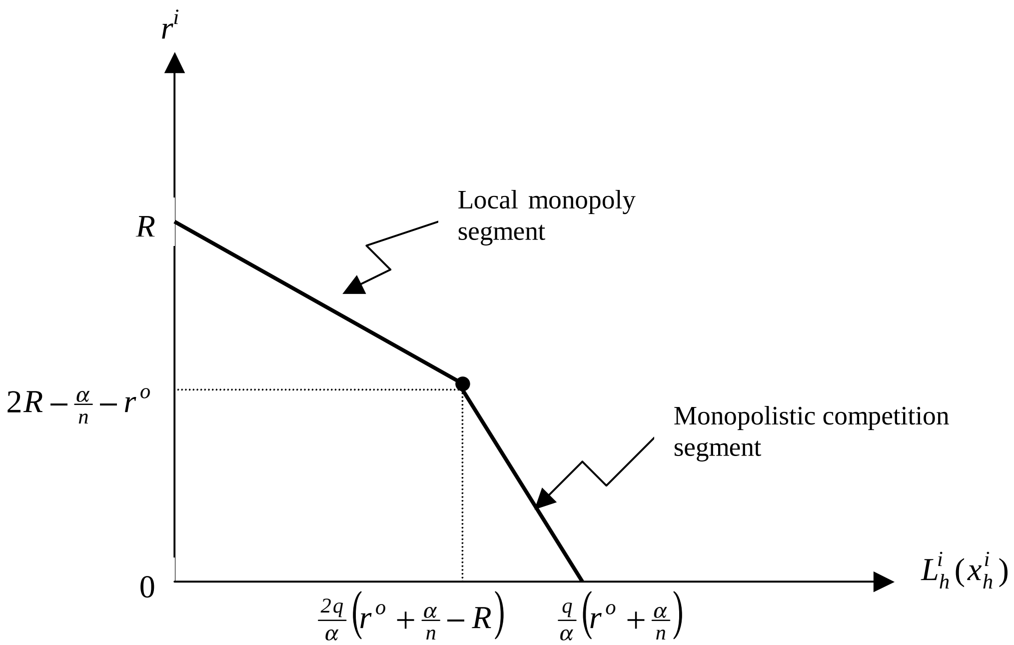
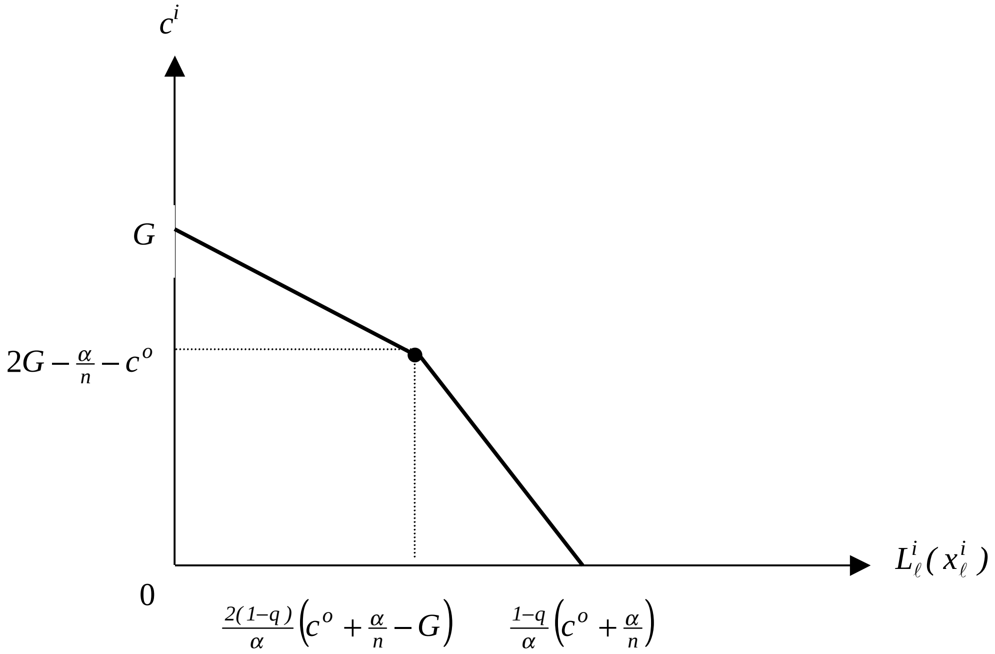


Figure 4: Type ℓ entrepreneurs' typical demand for bank *i*'s loans



Given that type *h* entrepreneurs care only about loans' interest rates whereas type ℓ entrepreneurs are concerned only by loans' collateral requirements, the credit market could technically be thought of as consisting of two sub-markets: one for type *h* entrepreneurs and one for type ℓ entrepreneurs, which project no cross-dependencies on one another[3]. However, given that banks averse lending to type ℓ entrepreneurs, it would be improper to use the terms local monopolists and monopolistic competitors to describe banks' behavior when lending to such undesired borrowers.

[3] The assumption that type *h* entrepreneurs always repay their loans while type ℓ entrepreneurs always default is a workable approximation to a more realistic yet cumbersome structure, in which type *h* entrepreneurs are characterized by a high probability to succeed and, therefore, to repay their loans, whereas type ℓ entrepreneurs have a low probability to succeed and therefore, are more likely to default. Assuming entrepreneurs are conscious of their chances to succeed, type *h* entrepreneurs' borrowing decisions will be more sensitive to interest rates than to collateral requirements, whereas type ℓ entrepreneurs' borrowing decisions will be affected to a greater extent by collateral requirements than by interest rates.

2.5 Equilibrium Collateral Levels

As entrepreneurial talent is private information and type ℓ entrepreneurs never repay their loans, the credit market suffers from adverse selection on the part of type ℓ entrepreneurs. As in Bester (1985) and Besanko and Thakor (1987), collateral can be used, under some conditions, as a screening device.

Proposition 1

Equilibrium loan contracts are either separating or pooling, depending on the comparative values of the parameters G and w:

- *If $G \leq w$, banks offer separating loan contracts stipulating an equilibrium collateral level $c^s = G$ (the superscript s stands for "separating").*
- *If $G > w$, banks offer pooling loan contracts (if any) stipulating an equilibrium collateral requirement $c^p = w$ (the superscript p stands for "pooling").*

Proof: Given that type ℓ entrepreneurs always default on their loans, banks would rather offer separating loan contracts that screen such borrowers out of the market. To discourage all type ℓ entrepreneurs from applying for its loan, a bank has to set a collateral level that exceeds the private gain that type ℓ entrepreneurs extract from their projects. Such a policy is feasible only if $G \leq w$, and its corresponding optimal collateral level is $c^s = G$ [4]. If, alternatively, $w < G$, collateral cannot serve as a means of screening borrowers; it can nevertheless be used as a loss-minimizing device: to discourage as many type ℓ entrepreneurs

[4] Although the bank can require entrepreneurs to pledge any amount of collateral between *G* and *w*, there is no point in requiring collateral higher than *G*. Given that any collateral level higher than *G* will be as good as *G* in terms of screening out type ℓ borrowers, it is assumed that the equilibrium level of collateral is *G*.

as possible from borrowing, as well as to minimize the losses inflicted by lending to those who remain undiscouraged, banks will require borrowers to pledge the highest feasible collateral - their entire wealth. The equilibrium collateral level under pooling loan contracts will therefore be $c^p = w$. As will be shown later in section 4, banks may rather withhold credit than offer pooling loan contracts: if banks' potential losses from lending to type ℓ entrepreneurs outweigh their potential gains from lending to type *h* entrepreneurs, they will refrain from providing credit to borrowers.

3. Equilibrium in the case of separating loan contracts

In this section it is assumed that $G \leq w$, so that it is optimal for banks to offer separating loan contracts in which $c^s = G$ and type ℓ entrepreneurs are unwilling to borrow.

3.1 Credit market equilibrium

Banks can borrow funds from the central bank at gross CB interest rate ϕ. The process by which the central bank sets ϕ is beyond the scope of the model; ϕ is therefore considered as a parameter. Bank *i*'s profits are given by

$$(13) \quad \Pi^i\Big|_{c^s} = L_h^i(x_h^i)(r^i - \phi)$$

Where $L_h^i(x_h^i)$ can take two alternative forms (see equation (11)). Let $\bar{r}^i$, $\hat{r}^i$ and $\tilde{r}^i$ denote bank *i*'s debitory rates for which $\bar{x}_h^i < \hat{x}_h^i$, $\hat{x}_h^i < \bar{x}_h^i$ and $\bar{x}_h^i = \hat{x}_h^i$, respectively. Then, by definition: $\bar{r}^i > 2R - \alpha / n - r^o$, $\tilde{r}^i = 2R - \alpha / n - r^o$ and $\hat{r}^i < 2R - \alpha / n - r^o$. It turns out that for the special case where $\bar{x}_h^i = \hat{x}_h^i$ bank *i*'s equilibrium debitory rate is straightforwardly given by $\tilde{r}^{is} = 2R - \alpha / n - r^o$; the bank's problem can be expressed as:

$$(14)\quad \begin{bmatrix} \bar{r}^{is} \\ \hat{r}^{is} \end{bmatrix} \equiv \operatorname{argmax} \begin{bmatrix} \frac{2q}{\alpha}\left(R-\bar{r}^{i}\right)\left(\bar{r}^{i}-\phi\right) \\ \\ \frac{q}{\alpha}\left[r^{o}-\hat{r}^{i}+\frac{\alpha}{n}\right]\left(\hat{r}^{i}-\phi\right) \end{bmatrix}$$

$$s.t.\quad \bar{r}^{i} > 2R-\frac{\alpha}{n}-r^{o} \quad , \quad \hat{r}^{i} < 2R-\frac{\alpha}{n}-r^{o}$$

Solving (14) and using the symmetry between banks yields the following equilibrium interest rates:

$$(15)\quad r^{s} = \begin{cases} \bar{r}^{s} = \frac{1}{2}\left(\phi+R\right) & for \quad \frac{\alpha}{n} > R-\phi \\ \tilde{r}^{s} = R-\frac{\alpha}{2n} & for \quad \frac{2}{3}(R-\phi) \leq \frac{\alpha}{n} \leq R-\phi \\ \hat{r}^{s} = \phi+\frac{\alpha}{n} & for \quad \frac{\alpha}{n} < \frac{2}{3}\left(R-\phi\right) \end{cases}$$

Lemma 1

The comparative values of the relative degree of differentiation between banks, α / n*, and the technological surplus rate,* $R - \phi$*, determine the type of equilibrium that prevails in the credit market:*

$\frac{\alpha}{n} < \frac{2}{3}\left(R-\phi\right)$ *generates a monopolistic competition credit market equilibrium;*

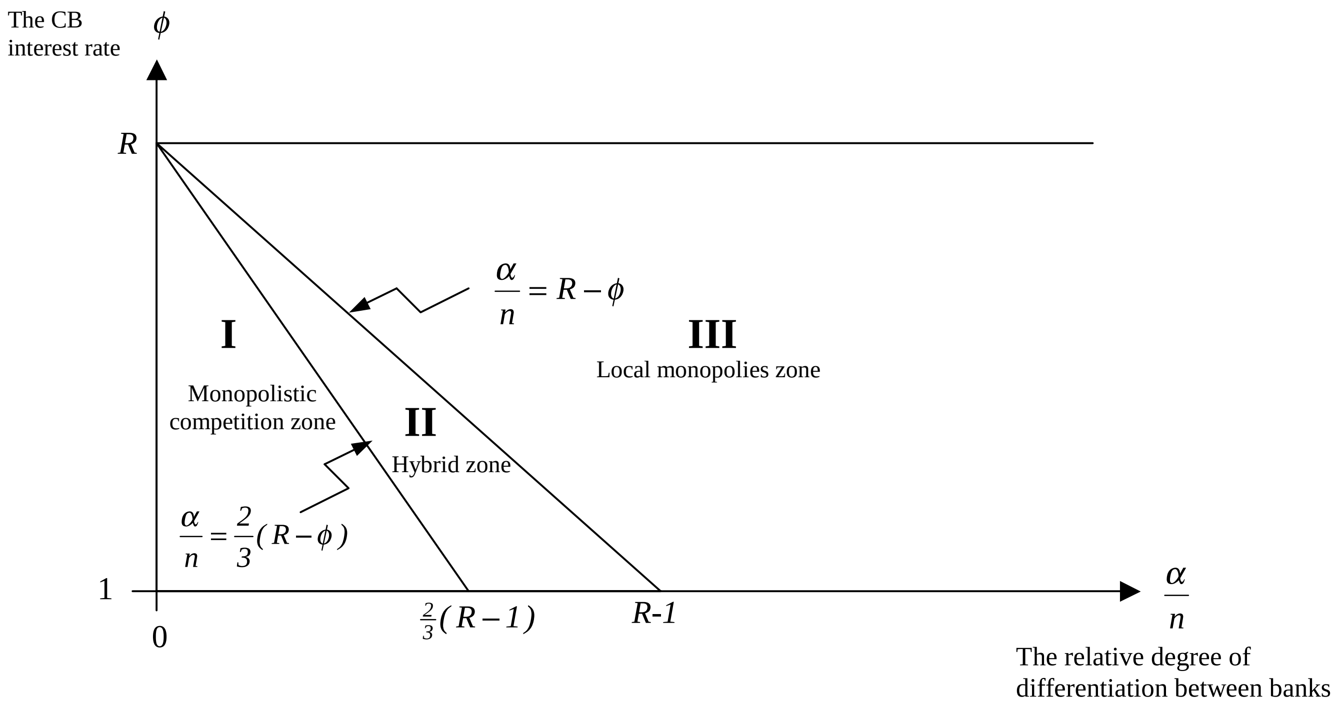
$\frac{\alpha}{n} \geq R-\phi$ *generates a local monopolies equilibrium;*

$\frac{2}{3}(R-\phi) \leq \frac{\alpha}{n} \leq R-\phi$ *generates a hybrid equilibrium - a convergence of the monopolistic competition and the local monopolies equilibria.*

Proof: by definition.

Lemma 1 implies that the comparative values of the degree of relative differentiation between banks, α / n, and the technological surplus rate, R - ϕ, determine the type of equilibrium prevailing in the credit market. Figure 5 provides a mapping of credit market equilibria. The result according to which a hybrid equilibrium exists for an entire range of values of α/n, $\frac{2}{3}(R-\phi) \leq \alpha / n \leq (R-\phi)$, should be regarded as stemming from the model's limitations. Therefore, the outcomes concerning the hybrid equilibrium should not be attributed special concern – although they will be presented for the sake of analytical completeness.

Figure 5: A mapping of credit market equilibria under separate loan contracts



Equation (15) implies that when banks act as monopolistic competitors, an increase in α/n - owing to a greater extent of absolute differentiation between banks and/or a decline in their number - raises the equilibrium debitory rate, which indicates that banks gain greater market power. At the limit case where $\alpha/n = 0$, banks have no market power at all and turn into perfect competitors that make zero profits. Under the hybrid equilibrium, however, the debitory rate oddly declines in α/n - suggesting a weakening of banks' market power. Since the hybrid equilibrium corresponds to the kink in type *h* entrepreneurs' demand for loans (see figure 3), the "perverse" behavior of $\tilde{r}^s$ reflects the local abnormality of the kink. In the case of local monopolies, the credit market is segmented into separate monopoly markets. Given that each bank already enjoys absolute market power in its own locality, a rise in α/n cannot (by definition) provide it with extra market power. Therefore, the debitory rate under local monopolies is invariant to changes in α/n.

Substituting for $\bar{r}^s$, $\tilde{r}^s$ and $\hat{r}^s$ in equation (11) and using the symmetry between banks obtains:

$$(16)\quad x_h^s = \begin{cases} \bar{x}_h^s = \dfrac{R-\phi}{2\alpha} & for \quad \dfrac{\alpha}{n} \geq R-\phi \\ \tilde{x}_h^s = \dfrac{1}{2n} & for \quad \dfrac{2}{3}(R-\phi) < \dfrac{\alpha}{n} < R-\phi \\ \hat{x}_h^s = \dfrac{1}{2n} & for \quad \dfrac{\alpha}{n} \leq \dfrac{2}{3}(R-\phi) \end{cases}$$

Where $\tilde{x}_h^s \equiv x_h^s(\tilde{r}^s)$ denotes the location of a bank's marginal type *h* borrower in the case where $\hat{x}_h^s$ and $\bar{x}_h^s$ converge. Since $\hat{x}_h^s = \tilde{x}_h^s$, equation (16) can be rewritten as:

$$(16')\quad x_h^s = min\left\{\frac{1}{2n} \quad , \quad \frac{R-\phi}{2\alpha}\right\}$$

Given that a bank has two marginal borrowers (one on each side), its actual market occupies $2x_h^s$ units of length. Let m_h^s represent a single bank's market range, then, using equation (16'):

(17) $m_h^s = min\left\{\frac{1}{n} \quad , \quad \frac{R-\phi}{\alpha}\right\}$

Equation (17) implies that under the hybrid and the monopolistic competition equilibria, a single bank's market range depends solely - and negatively - on the number of banks in the system, *n*, whereas under the local monopolies equilibrium it is invariant to *n*. Equation (17) also suggests that a single bank's market range under local monopolies is smaller than 1/*n*; given that banks are symmetrically positioned around the circle, it follows that every local monopoly is separated from its closest neighbor by a buffer zone of ${}^{1}\!/_{n}-(R-\phi)/\alpha$ units of length. As the number of banks in the system grows, the range of individual banks' markets remain unchanged, yet the buffer zones that separate neighboring markets narrow. When the number of banks in the system reaches $\alpha/(R-\phi)$, the buffer zones disappear; each bank faces a market range of 1/*n*, and the hybrid equilibrium takes over.

3.2 The real effects of monetary policy under separating loan contracts

Let b_h^s denote the equilibrium proportion of type *h* borrowers in the type *h* population under separating loan contracts, then:

(18) $b_h^s = n \cdot m_h^s$

Substituting equation (17) for m_h^s yields:

(19) $b_h^s = min\left\{1 \quad , \quad \frac{R-\phi}{\alpha / n}\right\}$

Equation (19) suggests under both the hybrid and the monopolistic competition equilibria all type *h* entrepreneurs borrow, whereas under local monopolies only part of them do so. The explanation is straightforward. The local monopolies equilibrium is the only type of equilibrium that introduces buffer zones between the markets of neighboring banks. Type *h* entrepreneurs that are located within these buffer zones, do not borrow. As the number of banks approaches $\alpha/(R-\phi)$, buffer zones narrow out and the proportion of type *h* borrowers approaches one. From that point on the markets of individual banks adjoin so that all type *h* entrepreneurs procure loans.

Given that the economy-wide population of type *h* entrepreneurs is *q*, the number of type *h* borrowers - and hence, the number of projects established at the beginning of the period - is qb_h^s. By the end of the period these projects mature and yield *R* units of good each. Let y^s represent the economy's total output, then, using equation (19):

(20) $$y^s = Rq \cdot min\left\{1 \quad , \quad \frac{R-\phi}{\alpha / n}\right\}$$

Proposition 2

(a) Under both the monopolistic competition and the hybrid equilibria all type h entrepreneurs borrow, so that output reaches its maximal level of Rq units of good.

(b) Under the local monopolies equilibrium only a proportion $(R-\phi)/(\alpha/n) < 1$ of type h entrepreneurs borrow, so that output is inferior to its maximal level and mounts to merely $Rq(R-\phi)/(\alpha/n)$ units of good.

Proof: straightforward from equation (20).

Under the monopolistic competition and the hybrid equilibria, output is invariant to the prevailing CB interest rate and the degree of relative differentiation between banks. Under both types of equilibria, a bank's marginal type *h* borrower is located in the midway between the bank and its closest neighbor, so that all type *h* entrepreneurs procure loans and eventual output will reach its maximal level - regardless of the CB interest rate and the degree of relative differentiation between banks. Under local monopolies, however, output demonstrates a negative dependence upon both the CB interest rate and the degree of differentiation between banks. The explanation for that is the following. Under local monopolies, a bank's marginal type *h* borrower is located $(R\text{-}\phi)/2\alpha$ units of length away from the bank, which is closer to the bank than the midway point between it and its neighbor. The higher are ϕ and α, the closer a bank's marginal type *h* borrower gets to the bank, so that the banks monopoly market narrows and the buffer zones separating the monopoly markets of neighboring banks grow wider. Therefore, output will be lower. A fall in the number of banks in the economy, *n*, does not affect the monopoly market of a single bank; yet, it reduces output via the decrease in the number of local monopolies. Therefore, both the CB interest rate and the degree of differentiation between banks negatively affect output under local monopolies.

Proposition 3

(a) *Whenever the credit market is segmented into local monopolies, the central bank can expand the economy's output by lowering the CB interest rate.*

(b) *The higher the degree of differentiation between banks, the larger the decline in the CB interest rate that generates a given expansionary effect.*

Proof: corollary (a): according to proposition 2, under both the hybrid and the monopolistic competition equilibria output attains its maximal level of *Rq* units of good, which is invariant to ϕ. Therefore, monetary policy cannot generate real expansion under these equilibria. Under local monopolies, however, output sums up to $Rq(R\text{-}\phi)/(\alpha/n)$ units of good, which is inferior to its maximal level and declines in the CB interest rate. Hence, whenever the credit market is segmented into local monopolies, a reduction in the CB interest rate generates economic expansion. Corollary (b): let $\bar{y}^s$ denote output under local monopolies, then:

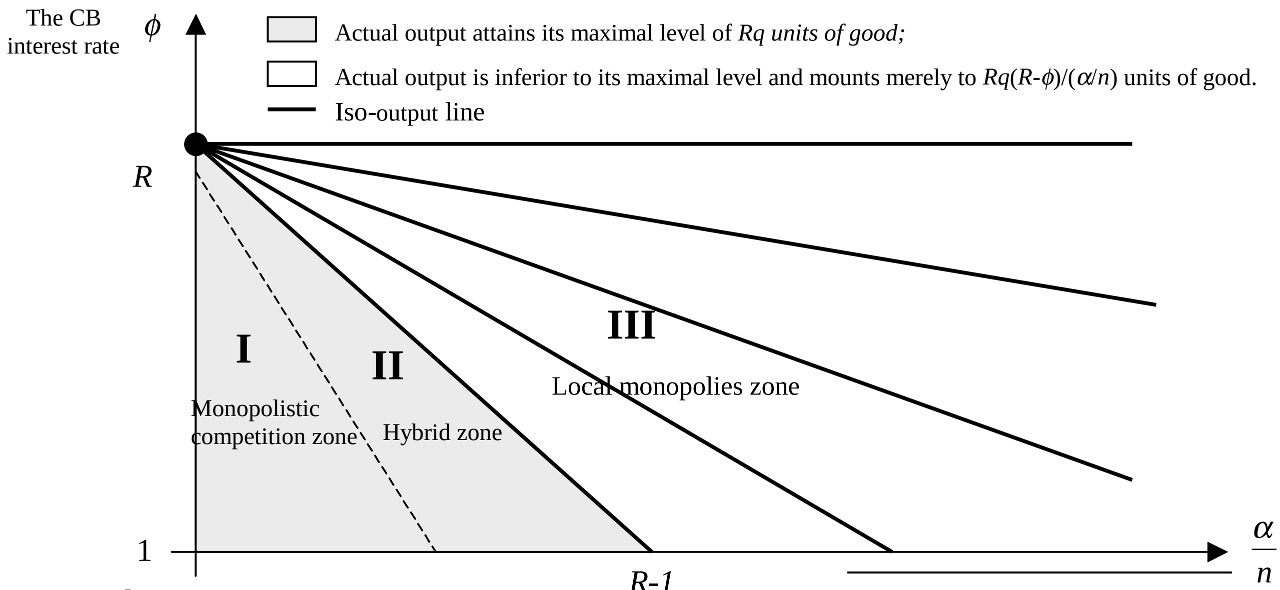
(21) $$\frac{\partial \bar{y}^s}{\partial \phi} = -\frac{Rq}{\alpha / n} < 0$$

(22) $$\frac{\partial \bar{y}^s}{\partial \phi \partial (\alpha / n)} = \frac{Rq}{(\alpha / n)^2} > 0$$

Equation (21) indicates that a change in the CB interest rate induces a change in the opposite direction in $\bar{y}^s$. Equation (22) shows that the higher the degree of differentiation between banks, the milder is the negative effect that a given raise in the CB interest rate bears on $\bar{y}^s$. The explanation for this outcome is simple. A high degree of relative differentiation between banks can stem either from a relatively high degree of absolute differentiation, α, or from a relatively small number of banks, *n*. Under local monopolies, a single bank's market range is $(R\text{-}\phi)/\alpha$. Hence, the higher is α, the milder is the negative effect of a given rise in ϕ on every single bank's market range, and thereby on the number of type *h* entrepreneurs that borrow from it and the output they produce. Then, the fewer the number of local monopolies in the economy, *n*, the weaker the economy-wide manifestation of an increase in ϕ on the total number of type *h* borrowers and total output. Therefore, the higher the degree of relative differentiation between banks, α/n, the milder the negative (positive) real effect of a given increase (reduction) in the CB interest rate. The monetary policy implication of this outcome is, therefore, that the higher the degree of relative differentiation between banks, the larger the reduction in the CB interest rate that is required for the achievement of a given expansionary effect. ■

Figure 6 provides a mapping of output levels under separating loan contracts. The thick, downward slopping lines projecting in a fan-like pattern from the point (*0* , *R*) across the local monopolies zone, are iso-output lines. An iso-output line depicts all the combinations of ϕ and α/n that sustain a given level of output[5]. Higher iso-output lines correspond to lower output levels. The highest iso-output line correspond to zero output, whereas the lowest iso-output line that stretches from the point (*0* , *R*) to the point (*R-1* , *1)*, corresponds to the maximal level of output, *Rq* units of good. Note that the lowest iso-output line also traces the border between the hybrid and the local monopolies zones; all combinations of ϕ and α/n that fall below it sustain the maximal level of output.

Figure 6: A mapping of output levels under separate loan contracts



[5] Note that at the point $\phi = R$ the level of output is undetermined.

0 $\frac{2}{3}(R-1)$

The relative degree of differentiation between banks

The iso-output line that corresponds to a given output level $\bar{y}_0^s$ is given by:

(23) $\phi = R - \frac{\bar{y}_0^s}{Rq} \cdot \frac{\alpha}{n}$

The above equation entails monetary policy implications:

<u>Proposition 4</u>

(a) *When the credit market is segmented into local monopolies, the maintenance of a given output level* $\bar{y}_0^s$ *requires that a unit rise in the degree of relative differentiation between banks must be compensated for by a* $Rq / \bar{y}_0^s$ *units drop in the CB interest rate.*

(b) *The higher the level of output to be maintained along an iso-output line, the lesser the extent to which the CB interest rate has to fall in order to compensate for a one unit rise in the degree of relative differentiation between banks.*

Proof: straightforward from equation (23).

A local monopolies equilibrium generates sub-maximal output, $\bar{y}_0^s < Rq$. Hence, proposition 4 suggests that if the central bank wishes to maintain y_0 after an exogenous unit rise in the degree of relative differentiation between banks, it should lower the CB interest rate by more than one unit; moreover, the higher y_0, the larger the required reduction in the CB interest rate.

4. Equilibrium in the case of pooling loan contracts

Pooling loan contracts introduce the possibility of a credit crunch – an overall collapse of the credit market. The inevitable presence of type ℓ borrowers may render lending an unprofitable business, and thus induce banks to withhold loans. As shall be seen in section 4.2, monetary policy can play an active role in the eventuality of a credit crunch.

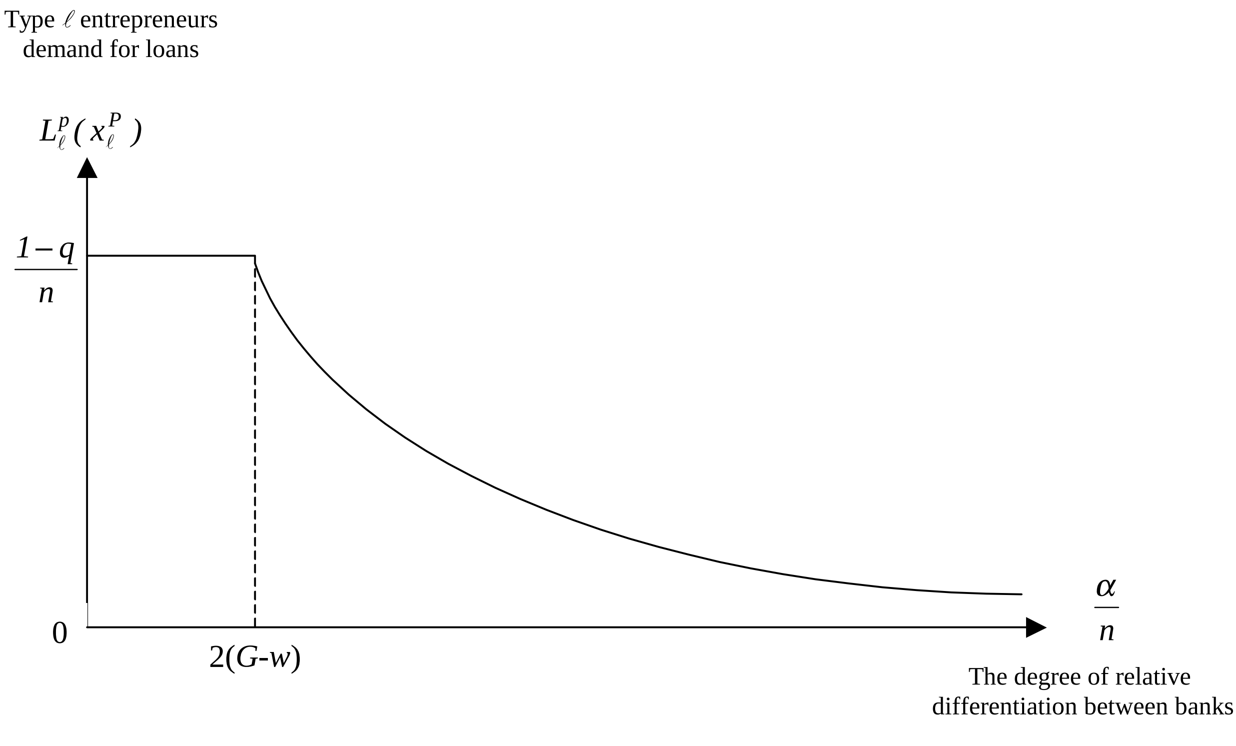
4.1 Type ℓ entrepreneurs' demand for loans under pooling loan contracts

Substituting $c^i = w$ in equation (12) obtains type ℓ entrepreneurs' equilibrium demand for the loans of a single bank under pooling loan contracts:

$$(25) \quad L_\ell^p(x_\ell^p) = \begin{cases} \dfrac{2(1-q)}{\alpha}(G-w) & \text{if } \dfrac{\alpha}{n} \geq 2(G-w) \\[2ex] \dfrac{1-q}{n} & \text{otherwise} \end{cases}$$

The above equation indicates that under pooling loan contracts, type ℓ entrepreneurs' demand for the loans of a single bank depends on the comparative values of α/n and G-w. The explanation for that is the following. The transportation disutility incurred by a type ℓ borrower that is located in the midway between a bank and its closest neighbor is equivalent to a cost of $\alpha/2n$ units of capital, while the surplus he extracts is G-w units of capital. Hence, as long as $\alpha/n < 2(G-w)$, all type ℓ entrepreneurs that lie within $1/2n$ units of length from a bank would like to borrow from it, so that the demand for loans faced by each bank is $(1-q)/n$. When α/n equals $2(G-w)$, type ℓ entrepreneurs that are located half the way between a bank and its closest neighbor are indifferent about borrowing. From that point on, the larger the gap between α/n and $2(G-w)$, the shorter the distance between a bank and the type ℓ entrepreneur who is just indifferent about borrowing from it, so that fewer type ℓ entrepreneurs borrow. Figure 7 illustrates the behavior of type ℓ entrepreneurs' demand for loans under pooling loan contracts.

<u>Figure 7: The effect of the degree of relative differentiation between banks on type ℓ borrowers' equilibrium demand for the loans of a single bank</u>



4.2 Credit market equilibrium

Credit market Nash equilibrium under pooling loan contracts is obtained in two stages. First, each bank maximizes its profit, taking as given the behavior of its close neighbors. Then, if the maximized profit is non-negative, it will choose to provide loans; if, otherwise, its maximized profit is negative, it will refrain from lending.

Bank *i*'s profit is obtained by deducing the loss on loans extended to type ℓ borrowers from the gain on loans extended to type *h* borrowers:

$$(26)\quad \Pi^{i}\Big|_{c^{P}=w} = L_{h}^{i}(x_{h}^{i})(r^{i}-\phi)-L_{\ell}^{p}(x_{\ell}^{p})\cdot(\phi-w)$$

Given that the loss inflicted by type ℓ borrowers, $L_{\ell}^{p}(x_{\ell}^{p})\cdot(\phi-w)$, is already at its optimal level, bank *i*'s profit maximization problem is reduced to maximizing its gain on loans to type *h* entrepreneurs, $L_{h}^{i}(x_{h}^{i})(r^{i}-\phi)$. It turns out that bank *i*'s profit maximization problem under pooling loan contracts is the same as under separating loan contracts. Hence, the equilibrium debitory rates under pooling loan contracts are identical to the ones obtained under separating loan contracts:

$$(27)\quad r^{p} = \begin{cases} \bar{r}^{p} = \bar{r}^{s} = \frac{1}{2}(\phi+R) & \text{for} \quad \frac{\alpha}{n} > R-\phi \\ \tilde{r} = \tilde{r}^{s} = R-\frac{\alpha}{2n} & \text{for} \quad \frac{2}{3}(R-\phi) \le \frac{\alpha}{n} \le R-\phi \\ \hat{r}^{p} = \hat{r}^{s} = \phi+\frac{\alpha}{n} & \text{for} \quad \frac{\alpha}{n} < \frac{2}{3}(R-\phi) \end{cases}$$

The equilibrium distance between a bank and its marginal type *h* borrower under pooling loan contracts are, obviously, also the same as under separating loan contracts:

$$(28)\quad x_{h}^{p} = \begin{cases} \bar{x}_{h}^{p} = \bar{x}_{h}^{s} = \frac{R-\phi}{2\alpha} & \text{for} \quad \frac{\alpha}{n} > R-\phi \\ \tilde{x}_{h}^{p} = \tilde{x}_{h}^{s} = \frac{1}{2n} & \text{for} \quad \frac{2}{3}(R-\phi) \le \frac{\alpha}{n} \le R-\phi \\ \hat{x}_{h}^{p} = \hat{x}_{h}^{s} = \frac{1}{2n} & \text{for} \quad \frac{\alpha}{n} < \frac{2}{3}(R-\phi) \end{cases}$$

x_h^p can take one of three forms ($\bar{x}_h^p$, $\tilde{x}_h^p$ and $\hat{x}_h^p$), depending on the comparative values of α/n and R-ϕ, whereas x_ℓ^p can take one of two forms ($\bar{x}_\ell^p$ and $\hat{x}_\ell^p$), depending on the comparative values of α/n and G-w (see equation (25)). In the *(α/n , ϕ)* space, let:

zone I denote all the combinations of α/n and ϕ for which $x_h^p = \hat{x}_h^p$ and $x_\ell^p = \hat{x}_\ell^p$ *;*

zone II denote all the combinations of α/n and ϕ for which $x_h^p = \tilde{x}_h^p$ and $x_\ell^p = \hat{x}_\ell^p$ *;*

zone III denote all the combinations of α/n and ϕ for which $x_h^p = \bar{x}_h^p$ and $x_\ell^p = \hat{x}_\ell^p$ *;*

zone IV denote all the combinations of α/n and ϕ for which $x_h^p = \bar{x}_h^p$ and $x_\ell^p = \bar{x}_\ell^p$ *;*

zone V denote all the combinations of α/n and ϕ for which $x_h^p = \tilde{x}_h^p$ and $x_\ell^p = \bar{x}_\ell^p$ *;*

zone VI denote all the combinations *of* α/n and ϕ for which $x_h^p = \hat{x}_h^p$ and $x_\ell^p = \bar{x}_\ell^p$;

Given that banks value only type *h* entrepreneurs as desired borrowers, the equilibrium strategic relations between them under pooling loan contracts (as under separating loan contracts) are determined by x_h^p. Therefore, both zones I and VI are monopolistic competition equilibrium zones, both zones II and V are hybrid equilibrium zones, and both zones III and IV are local monopolies equilibrium zones.

<u>Lemma 2:</u>

The number of potential equilibrium zones varies between four and six, depending on the comparative values of R and G-w:

When G-$w > (R$-$1)/2$ *there exist four potential equilibrium zones (zones I – IV);*

When $(R$-$1)/3 < G$-$w < (R$-$1)/2$ *there exist five potential equilibrium zones (zones I – V);*

When G-$w < (R$-$1)/3$ *there exist six potential equilibrium zones (zones I – VI).*

Proof: see the Appendix.

Figures 8 - 10 provide mappings of the equilibrium zones. Figure 8 shows the case where G-w > (R-1)/2; figure 9 presents the case where (R-1)/3 < G-w < (R-1)/2, and figure 10 illustrates the case where G-w < (R-1)/3.

The presence of type ℓ borrowers may render lending an unprofitable business. Clearly, a bank will choose to extend loans only if it can make non-negative profits. Let λ^p be a dichotomous variable such that:

$$(29)\quad \lambda^p = \begin{cases} 1 & if \quad \Pi^p \geq 0 \\ 0 & otherwise \end{cases}$$

λ^p therefore reflects a single bank's equilibrium decision as to whether to provide loans or not.

Proposition 5

In each of the zones I - VI there exists a CB interest rate threshold level above which lending becomes unprofitable, so that banks are unwilling to lend. Thus, tight monetary policy that raises the CB interest rate beyond its threshold level generates a credit crunch. Let $\phi^{I}_{max}, \phi^{II}_{max}, \ldots, \phi^{VI}_{max}$ *denote the CB interest rate threshold levels corresponding to zones I ,II,…,VI , then:*

$$(30a)\quad \phi^{I}_{max} \equiv \frac{q}{1-q}\cdot\frac{\alpha}{n} + w$$

$$(30b)\quad \phi^{II}_{max} \equiv q\left(R - \frac{\alpha}{2n}\right) + (1-q)w$$

(30c) $\phi^{III}_{max} \equiv R + \frac{\alpha(1-q) - \sqrt{2\alpha nq(1-q)(R-w) + \alpha^2(1-q)^2}}{nq}$

(30d) $\phi^{IV}_{max} \equiv R + \frac{2(1-q)(G-w) - 2\sqrt{q(1-q)(G-w)(R-w) + (1-q)^2(G-w)^2}}{q}$

(30e) $\phi^{V}_{max} \equiv \frac{\frac{\alpha q}{n}\left(R - \frac{\alpha}{2n}\right) + 2w(1-q)(G-w)}{\frac{\alpha q}{n} + 2(1-q)(G-w)}$

(30f) $\phi^{VI}_{max} \equiv \frac{q}{2(1-q)(G-w)} \cdot \left(\frac{\alpha}{n}\right)^2 + w$

Proof: see the appendix.

Proposition 5 states that under pooling loan contracts, banks will provide loans as long as the CB interest rate is sufficiently low. The CB interest rate is the banks' per-unit cost of liquidity, and therefore, the marginal (and average) cost of extending a loan. Thus, the higher the CB interest rate, the lower the profitability of lending. For a sufficiently high CB interest rate banks' profits become nil. Any higher CB interest rate would render lending strictly unprofitable and thereby induce the banks to withhold lending. Thus, the economy will undergo a credit crunch [6]– an overall collapse of the credit market. The CB interest rate threshold level is the CB interest rate for which banks just break even. Just as banks' profits depend on the type of equilibrium prevailing in the credit market, so does the CB interest rate threshold level. Therefore, each type of credit market equilibrium yields a different CB interest rate threshold.

[6] It is however important to stress that the present paper is not about credit crunch. The term credit crunch is used to refer to a case where both type *h* and type ℓ entrepreneurs are credit constrained - a technical result due to the symmetry between banks and the focus on the short run (which is the appropriate time-frame for the analysis of monetary policy changes).

Proposition 6

(a) Under monopolistic competition, the CB interest rate threshold level is rising in the degree of relative differentiation between bank,

(b) Under the hybrid equilibrium, the CB interest rate threshold level is declining in the degree of relative differentiation between banks in zone II, and is either declining or rising in the degree of relative differentiation between banks in zone V;

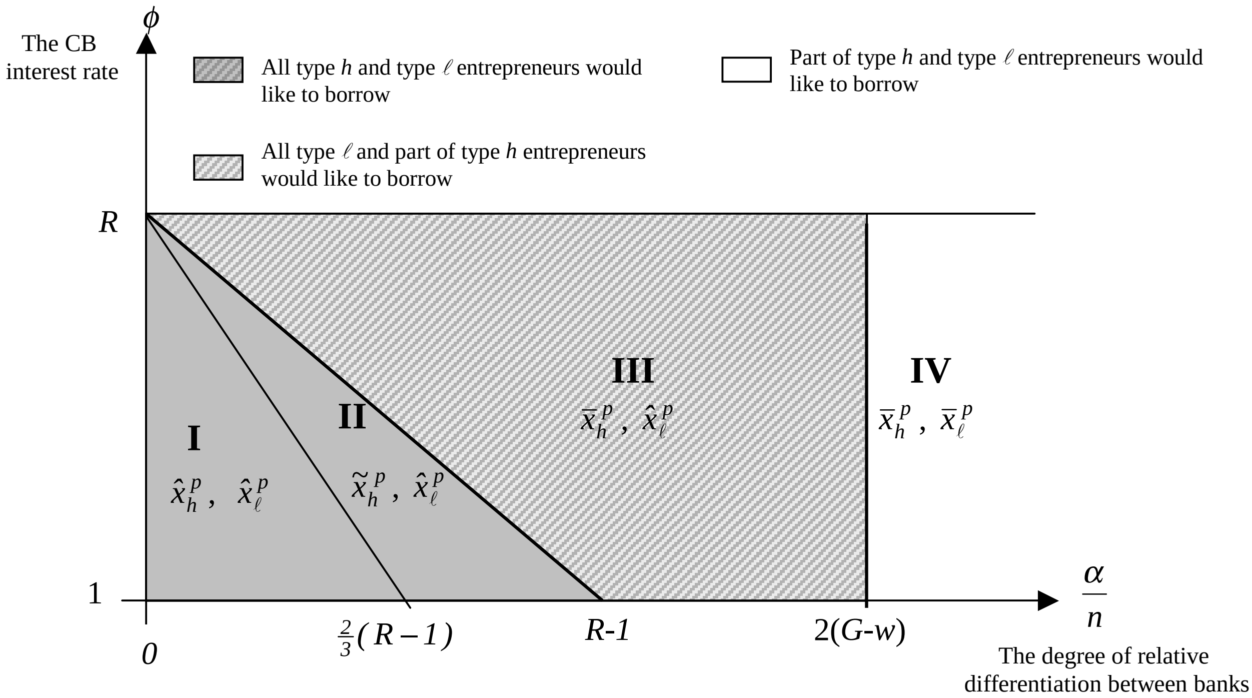
(c) Under local monopolies, the CB interest rate threshold level is declining in the degree of relative differentiation between banks in zone III and invariant to it in zone IV.

Proof: see the Appendix.

Proposition 6 indicates that the relationship between the degree of relative differentiation between banks and the CB interest rate threshold level depends on the equilibrium zone under question. Given that the existence of the hybrid equilibrium zones stems from the model's limitations, corollary (b) in proposition 6 - though presented for the sake of analytical completeness - should not be attributed special concern. The important message of proposition 6 is that under monopolistic competition, the CB interest rate threshold level is a positive function of α/n, the degree of relative differentiation between banks, whereas under local monopolies it is a negative function of α/n in zone III (which holds for sufficiently low α/n values), and invariant to α/n in zone IV (which holds for sufficiently high α/n values).

The intuition for these results is the following. Since the CB interest rate threshold level is defined as the CB interest rate for which banks just break even, it increases in the profitability of lending. Thus, the direction by which the relative degree of differentiation between banks affects lending profitability is also the direction by which it affects the CB interest rate threshold level. Under monopolistic competition, all type *h* entrepreneurs borrow; yet, as the debitory rate, $\hat{r}$, rises in α/n, banks' profits from lending to type h borrowers also rise in α/n. In zone I, all type ℓ entrepreneurs borrow; given that the loss per loan extended to a type ℓ borrower, $\phi - w$, does not depend on α/n, the losses inflicted on the banks by these undesired borrowers are also invariant to α/n. Thus, the profitability of lending in zone I - and thereby, ϕ^{I}_{max} - rise with α/n. In zone VI, the number of type ℓ borrowers decreases in α/n; as the loss per loan extended to a type ℓ borrower, $\phi - w$, does not depend on α/n, the losses inflicted on banks by type ℓ borrowers decrease in α/n. It follows that the profitability of lending in zone VI - and thereby, ϕ^{VI}_{max} - rise in α/n. Under local monopolies, the number of type h borrowers decreases in α/n; since the debitory rate $\bar{r}$ is invariant to α/n, banks' profits from lending to type h entrepreneurs decline in α/n. In zone III, all type ℓ entrepreneurs borrow, so that the losses they inflict on banks are invariant to α/n. Therefore, the profitability of lending in zone III – and thereby, ϕ^{III}_{max} - decline in α/n. In zone IV, the number of both type h and type ℓ borrowers decreases in α/n; moreover: as α/n grows, the decrease in banks' profits from lending to type h borrowers cancels out the decrease in banks' losses from lending to type ℓ borrowers. Thus, lending profitability in zone IV – and thereby, ϕ^{IV}_{max} - are invariant to α/n. Figures 11 - 13 illustrate the behavior of the CB interest rate threshold levels with respect to the degree of relative differentiation between banks. Figure 11 shows the case where $G - w > R-1$; figure 12 presents two alternative patterns of the case where $(R-1)/3 < G - w < R-1$; figure 13 illustrates three different patterns of the case where $G - w < (R-1)/3$.

<u>Figure 8: A mapping of credit market equilibria under pooling loan contracts where *G - w > R-1*</u>



<u>Figure 9: A mapping of credit market equilibria under pooling loan contracts where (*R-1*)/3 < *G - w* < *R-1*</u>

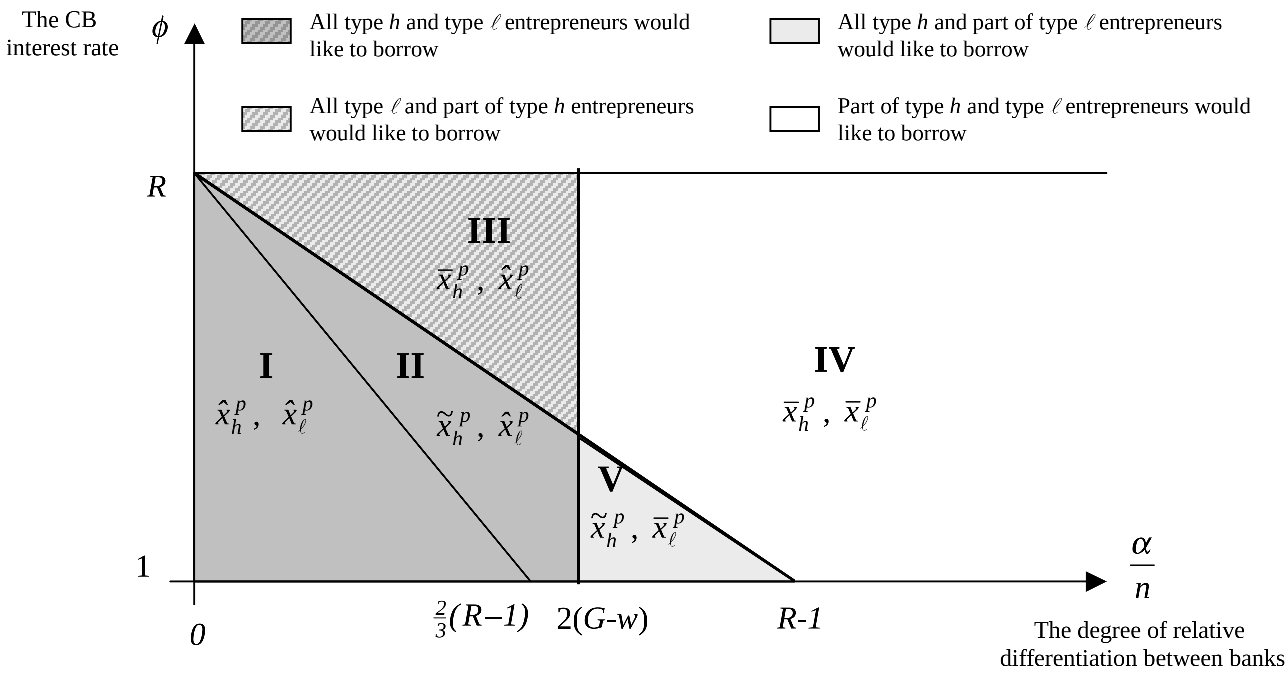


Figure 10: A mapping of credit market equilibria under pooling loan contracts where *G* - *w* < (*R*-1)/3

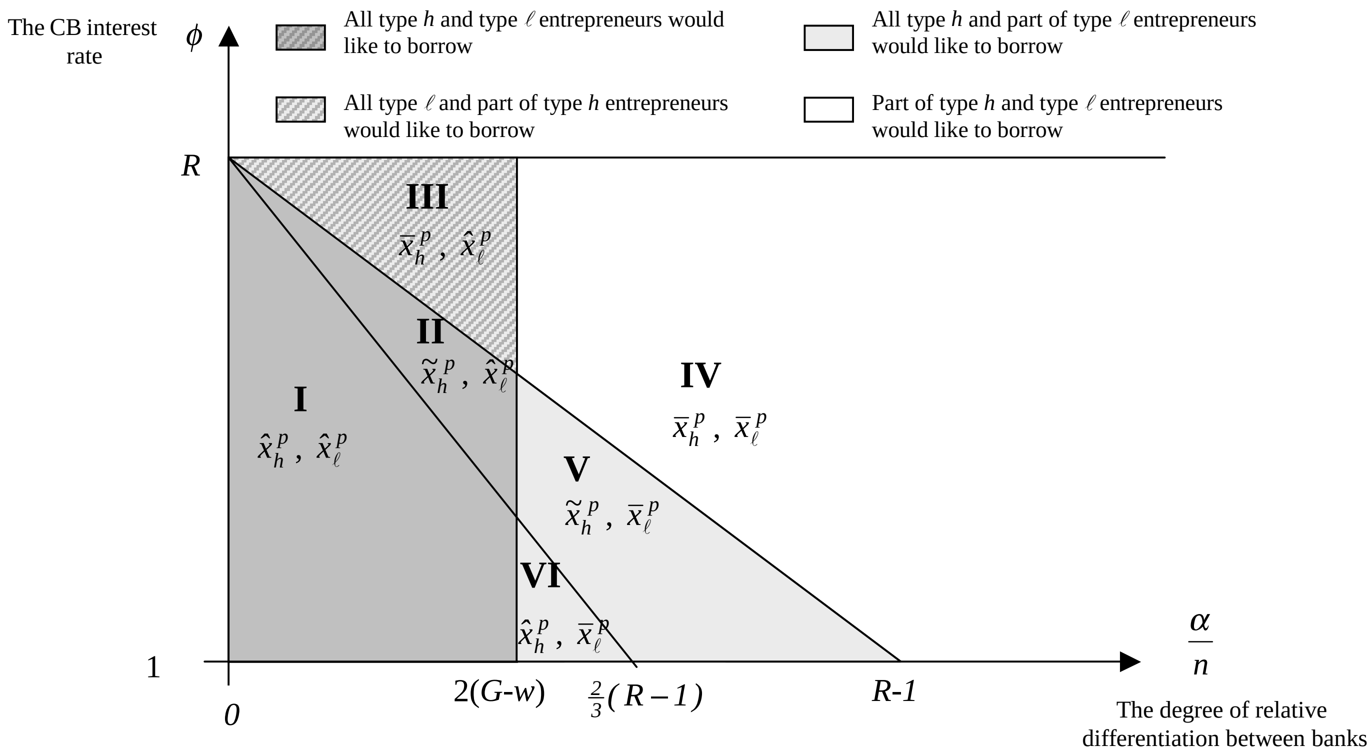
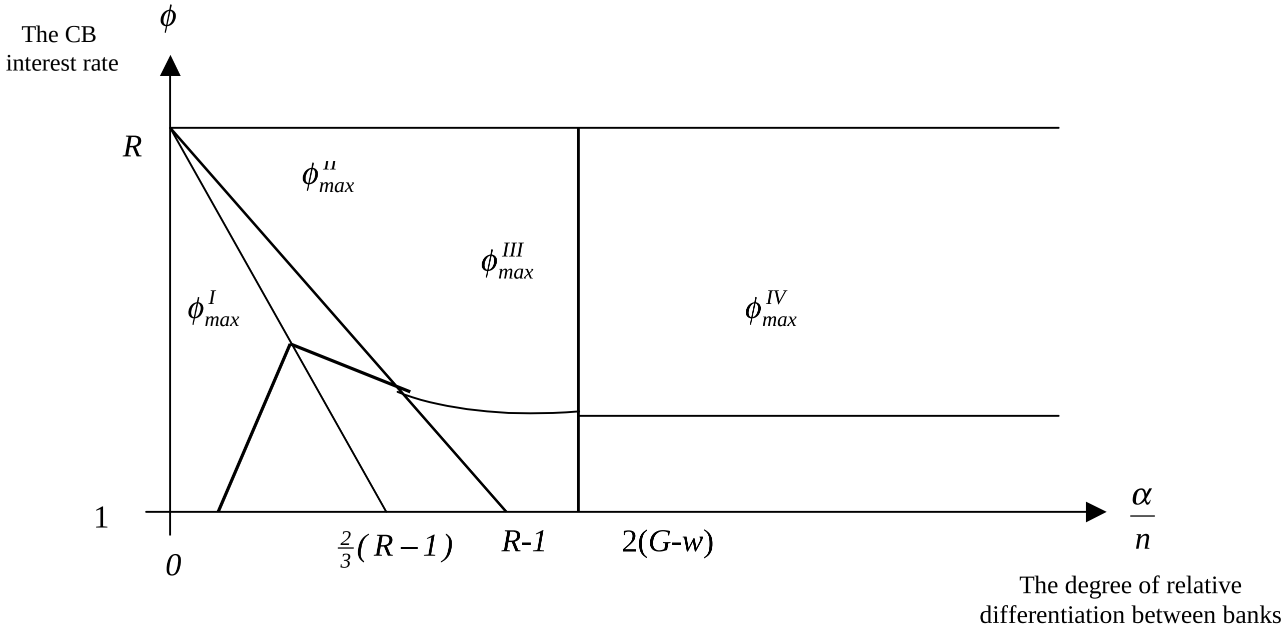
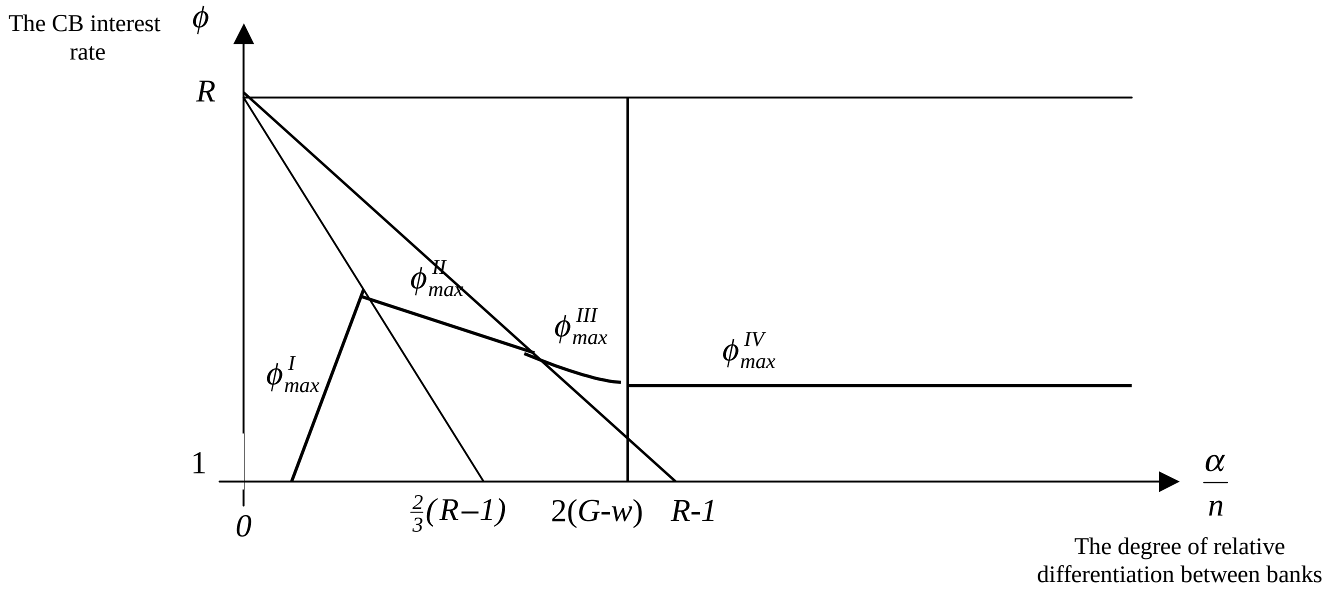


Figure 11: The behavior of CB interest rate threshold levels under pooling loan contracts where *G* - *w* > *R*-1



<u>Figure 12: The behavior of CB interest rate threshold levels under pooling loan contracts where $(R\text{-}1)/3 < G - w < R\text{-}1$</u>

Pattern (a):



Pattern (b):

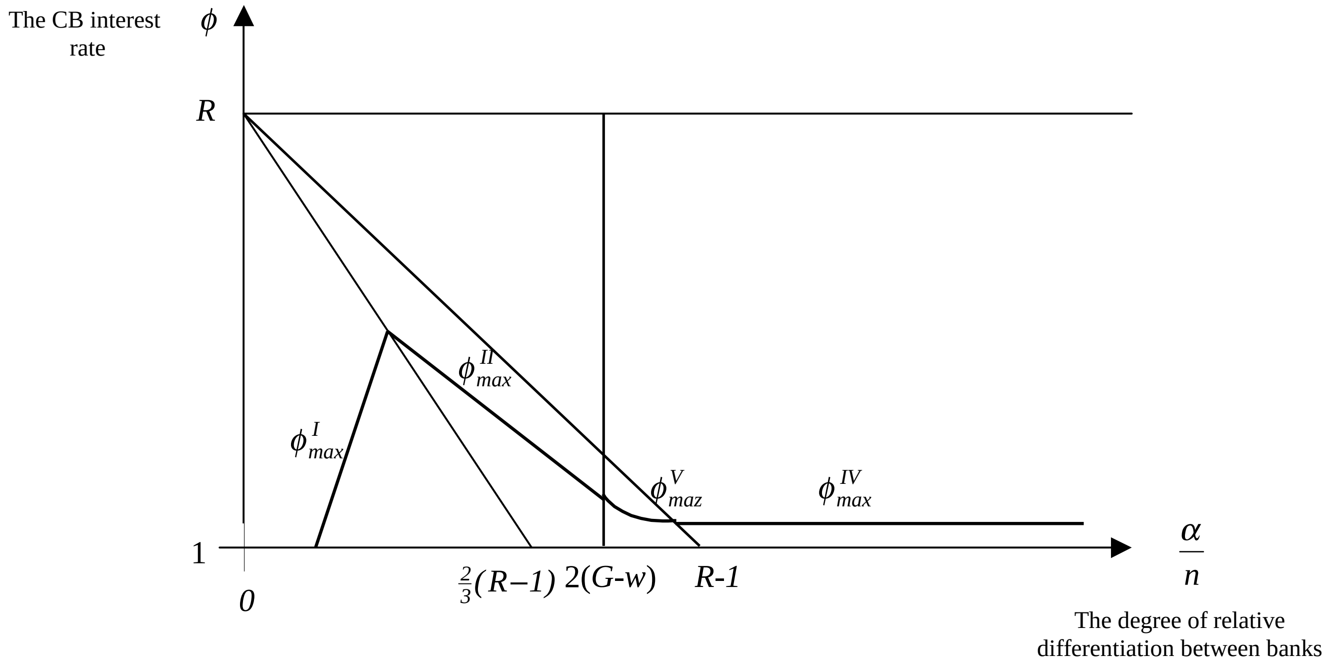
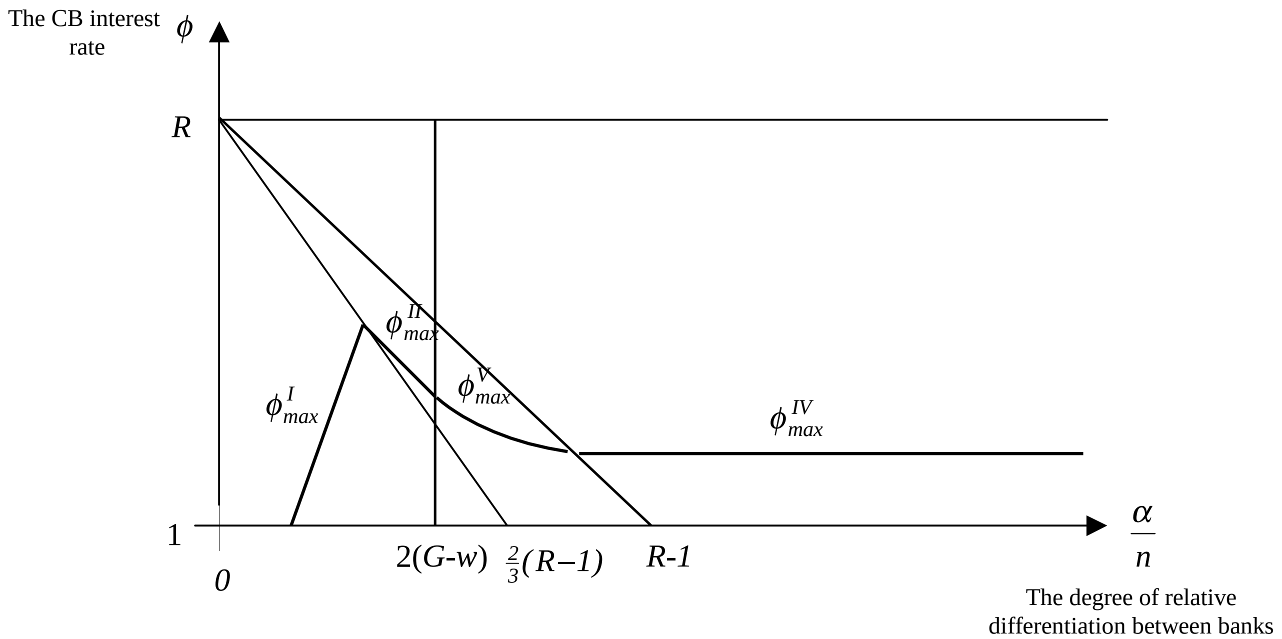
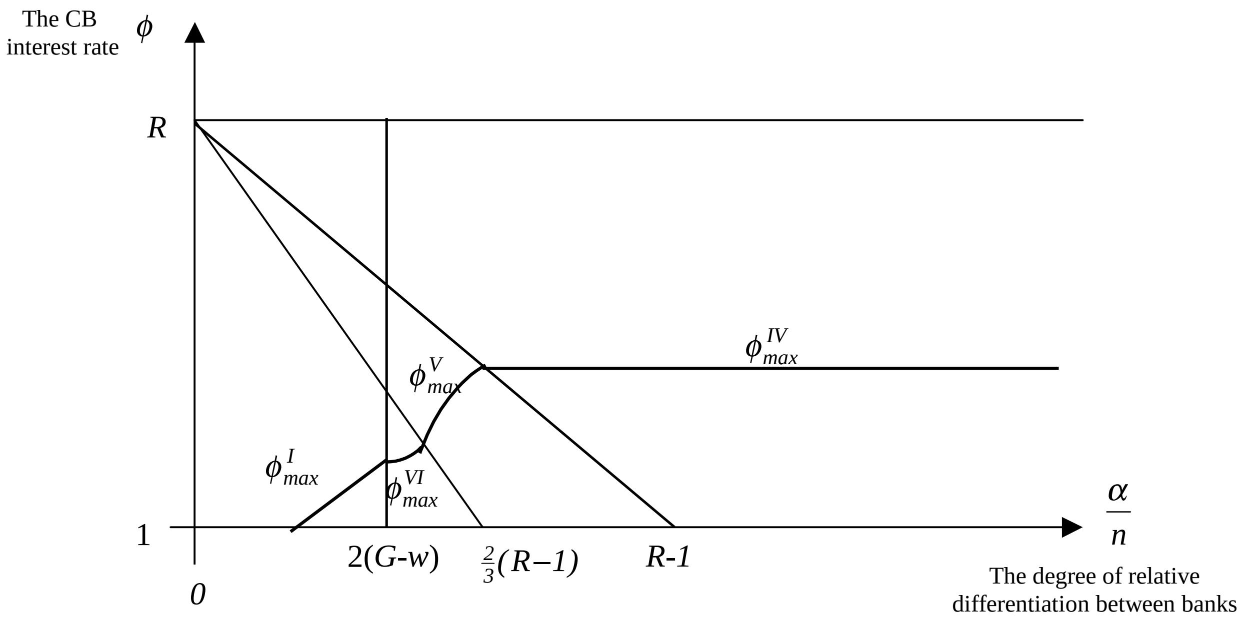


Figure 13: The behavior of CB interest rate threshold levels under pooling loan contracts where *G* - *w* < (*R*-*1*)/*3*

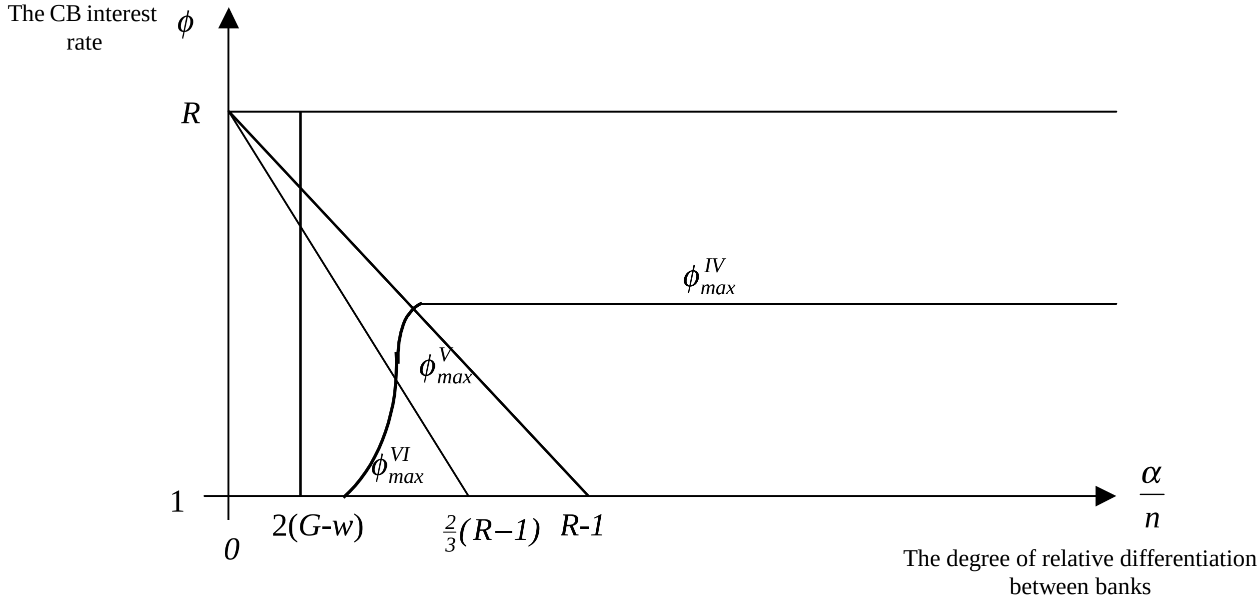
Pattern (a):



Pattern (b):



Pattern (c):



<u>4.3 The real effects of monetary policy under pooling loan contracts</u>

Given that only type *h* entrepreneurs can produce industrial output, the economy's output under pooling loan contracts is captured by:

(32) $y^{p} \equiv \lambda^{p} Rq \cdot min\left\{1 \quad , \quad \frac{R-\phi}{\alpha / n}\right\}$

By comparing the above equation to equation (20) one can see that y^{p} can be expressed as:

(33) $y^{p} \equiv \lambda^{p} y^{s}$

Equation (33) states that output under pooling loan contracts is identical to output under separating loan contracts with one reservation: unlike in the case of separating loan contracts, the credit market under pooling loan contracts may undergo a credit crunch – in which case output becomes null. Therefore, all the outcomes regarding the real effects of monetary policy under separating loan contracts (see section 3.2) hold under pooling loan contracts as well; yet, in addition, under pooling loan contracts tight monetary policy may cast the economy into a credit crunch.

5. Concluding Remarks

The paper points that banking system structure may, under some condition, affect the transmission of monetary policy. In the short run, where the number of banks in the system is given, both the stance of monetary policy and the degree of relative differentiation between banks are found to determine the type of credit market equilibrium.

When the credit market is highly differentiated and /or the central bank's monetary stance is highly restrictive, banks act as local monopolies. Under this type of equilibrium, the credit market is segmented into separate monopoly markets. Moreover, due to the high compound cost of credit (the debitory rate plus the cost of access to credit) not all type h entrepreneurs can access the credit market. Thus, the economy-wide credit volume – and thereby, real activity - fall bellow their maximal levels. This state of affairs calls for central bank intervention: by relaxing its monetary stance, the central bank will induce banks to lower debitory rates; the resulting reduction in the compound cost of credit to borrowers will thus expand the economy-wide credit volume – and with it – real activity. This mechanism is reminiscent of the well known bank lending channel of monetary transmission; yet, unlike the bank lending channel, through which monetary policy relaxation expands the volume of lending by rendering relatively low-return projects profitable, the transmission mechanism here described operates by rendering loans attractive to peripheral entrepreneurs, who previously refrained from borrowing due to the high compound cost of credit. Thus, whereas the bank lending channel is driven by projects' differential expected returns, the transmission mechanism generated by the model is driven by borrowers' differential compound costs of credit - induced by the differentiation between banks as credit providers. Another important result pertaining to the local monopolies equilibrium is that the greater the extent of credit market differentiation, the weaker the intensity of transmission - or, alternatively - the larger the change in monetary policy required to achieve a given real effect.

When the credit market is relatively little differentiated and/or the monetary stance is rather loose, banks operate as strategic monopolistic competitors. Under monopolistic competition, the overall volume of credit attains its maximal level, so that a single bank cannot expand its market share without reducing that of its counterparts. Thus, under monopolistic competition, monetary policy relaxation cannot enhance real activity. It is important to stress that had there been a range of projects in the model, each yielding a different return, monetary policy would have generated real effects under monopolistic competition as well - through a traditional bank-lending channel. Yet, even then, the real effects generated under monopolistic competition would have been weaker than the ones produced under local monopolies, which, on top of the traditional bank lending channel, involves a credit-differentiation driven transmission channel.

Another outcome of the paper is that tight monetary policy can be conducive to a credit crunch. When potential borrowers have little wealth to pledge as collateral, banks cannot use collateral requirements as a means of screening worthy borrowers from unworthy ones. The inevitable presence of unworthy borrowers lowers banks' profits and may even render lending unprofitable – in which case the banks will refrain from extending credit. Given that the cost of procuring loanable funds from the central bank has, too, a negative effect on banks' profitability, the central bank can play an active role in restoring the banks' profitability and the proper functioning of the credit market (in the short-run) by loosening its monetary stance. In the same way, it may be the case that monetary tightening generates a credit crunch. Therefore, the central bank's short-term monetary policy affects – via banks' profits – the stability of the banking sector. In the light of this result, the central bank should be cautious when considering the use of contractionary policy, and take into account the prevailing structure of the banking system.

The paper also points at the relationship between credit market structure and the eventuality of a credit crunch. Under monopolistic competition, the relative differentiation between banks positively affects banks' profits. Therefore, the higher the extent of differentiation between banks and the smaller their number, the higher the CB interest rate above which the credit market will undergo a credit crunch. Under local monopolies, however, the relative differentiation between banks has either a negative effect or no effect at all on banks' profits, and thereby, on the CB interest rate above which the credit market undergoes a credit crunch.

To the best of my knowledge, there are neither theoretical nor empirical works concerning the effect of credit market structure on monetary policy transmission. This paper therefore calls for follow-up research. The framework presented in the recent paper can be elaborated in many ways. One of many interesting directions for future research would be to check the long-run implications of the relation between credit market structure and monetary policy. In the long run, both the number of banks in the system and the degree of differentiation between banks can be treated as endogenous variables. The extent of differentiation between banks summarizes a variety of factors, among them, banking system regulation and bank's deliberate strategic differentiation policy. It would therefore be contributive to the understanding of the interactions between credit market structure and central bank policy to investigate the long run relationship between the number of banks in the industry, banking system regulation and the long-run monetary stance. Other elaborations of the present framework would be the introduction of a foreign credit market or the possibility of mergers and branching. It would be also important to conduct an empirical research and examine whether the data supports this paper's theoretical predictions.

Appendix

Proof of proposition 5

By substituting equations (25), (27) and (28) into equation (26) and using the definition of each equilibrium zone, one obtains the profits of a single bank under pooling loan contracts in each equilibrium zone:

(A1) $\Pi^{I} = \frac{\alpha q}{n^2} + \frac{(1-q)(w-\phi)}{n}$,

(A2) $\Pi^{II} = \frac{q}{n}\left(R - \frac{\alpha}{2n} - \phi\right) + \frac{(1-q)(w-\phi)}{n}$,

(A3) $\Pi^{III} = \frac{q(R-\phi)^2}{2\alpha} + \frac{(1-q)(w-\phi)}{n}$,

(A4) $\Pi^{IV} = \frac{q(R-\phi)^2}{2\alpha} + \frac{2(1-q)(G-w)(w-\phi)}{\alpha}$,

(A5) $\Pi^{V} = \frac{q}{n}\left(R - \frac{\alpha}{2n} - \phi\right) + \frac{2(1-q)(G-w)(w-\phi)}{\alpha}$,

(A6) $\Pi^{VI} = \frac{\alpha q}{n^2} + \frac{2(1-q)(G-w)(w-\phi)}{\alpha}$,

Equation (29) states that under pooling loan contracts, a bank will be willing to provide loans as long as its profits are non-negative. It conditions for the non negativity of a bank's profits in each equilibrium zone can be expressed as a condition on ϕ, namely, that f does not surpass a certain threshold:

(A7) $\Pi^{I} \geq 0 \;\; iff \;\; \phi \leq \frac{\alpha q}{n(1-q)} + w \;\equiv\; \phi^{I}_{max}$

(A8) $\Pi^{II} \geq 0 \;\; iff \;\; \phi \leq q\left(R - \frac{\alpha}{2n}\right) + (1-q)w$

(A9) $\Pi^{III} \geq 0 \;\; iff \;\; nq\phi^2 - 2[nqR + \alpha(1-q)]\phi + nqR^2 + 2\alpha(1-q)w \geq 0$

By solving the roots of the quadratic expression $nq\phi^2 - 2[nqR + \alpha(1-q)]\phi + nqR^2 + 2\alpha(1-q)w$, and recalling that the relevant values for the discount window rate range from 1 to *R*, (A9) can be re-written as:

$$\text{(A10)}\quad \Pi^{III} \geq 0 \ \ iff \ \ \phi \leq R + \frac{\alpha(1-q) - \sqrt{2\alpha nq(1-q)(R-w) + \alpha^2(1-q)^2}}{nq} \equiv \phi_{max}^{III}$$

$$\text{(A11)}\quad \Pi^{IV} \geq 0 \ \ iff \ \ q(R-\phi)^2 + 4(1-q)(G-w)(w-\phi) \geq 0$$

By solving roots of the quadratic expression $nq\phi^2 - 2[nqR + \alpha(1-q)]\phi + nqR^2 + 2\alpha(1-q)w$, and recalling that the relevant values for the discount window rate range from 1 to *R*, it can be checked that (A11) can be re-written as:

$$\text{(A12)}\quad \Pi^{IV} \geq 0 \ \ iff \ \ \phi \leq \frac{qR + 2(1-q)R - 2\sqrt{q(1-q)(G-w)(R-w) + (1-q)^2(G-w)^2}}{q} \equiv \phi_{max}^{IV}$$

Note that:

$$\text{(A13)}\quad \phi_{max}^{IV} \geq 1 \ \ iff \ \ \frac{q}{(1-q)} \geq \frac{4(G-w)(1-w)}{(R-1)^2}$$

Equation (A13) states that unless the proportion of type *h* entrepreneurs in the population is sufficiently high, banks would not be able to make non-negative profits in zone IV.

$$\text{(A14)}\quad \Pi^{V} \geq 0 \ \ iff \ \ \phi \leq \frac{q\frac{\alpha}{n}\left(R - \frac{\alpha}{2n}\right) + (1-q)(G-w)w}{q\frac{\alpha}{n} + 2(1-q)(G-w)} \equiv \phi_{max}^{V}$$

$$\text{(A15)}\quad \Pi^{VI} \geq 0 \ \ iff \ \ \phi \leq \frac{q\left(\frac{\alpha}{n}\right)^2}{2(1-q)(G-w)} + w \equiv \phi_{max}^{VI}$$

Proof of proposition 6

Proof of corollary (a)

By definition, both zones I and VI are monopolistic competition equilibrium zones. Differentiating equation (30a) with respect to α/n gives:

(A16) $$\frac{\partial \phi^{I}_{max}}{\partial\left(\frac{\alpha}{n}\right)} = \frac{q}{1-q} > 0$$

Differentiating equation (30f) with respect to α/n obtains:

(A17) $$\frac{\partial \phi^{VI}_{max}}{\partial\left(\frac{\alpha}{n}\right)} = \frac{q}{(1-q)(G-w)} \cdot \frac{\alpha}{n} > 0$$

Thus, both ϕ^{I}_{max} and ϕ^{VI}_{max} are rising in α/n.

Proof of corollary (b)

By definition, both zones II and V are hybrid equilibrium zones. Differentiating equation (30b) with respect to α/n yields:

(A18) $$\frac{\partial \phi^{II}_{max}}{\partial\left(\frac{\alpha}{n}\right)} = -\frac{q}{2} < 0$$

Differentiating equation (30e) with respect to α/n and rearranging gives:

(A19) $$\frac{\partial \phi^{V}_{max}}{\partial\left(\frac{\alpha}{n}\right)} = \frac{2(1-q)(G-w)\left(R-\frac{\alpha}{n}-w\right)-\frac{q}{2}\left(\frac{\alpha}{n}\right)^2}{\left[q\frac{\alpha}{n}+2(1-q)(G-w)\right]^2}$$

Thus, ϕ^{V}_{max} is rising in α/n iff $-q\left(\frac{\alpha}{n}\right)^2 - 2(1-q)(G-w)\frac{\alpha}{n} + 2w(1-q)(G-w) > 0$.

Solving the roots of $-q\left(\frac{\alpha}{n}\right)^2 - 2(1-q)(G-w)\frac{\alpha}{n} + 2w(1-q)(G-w)$ and recalling that α/n must be positive obtains:

(A20) $$\frac{\partial \phi_{max}^{V}}{\partial\left(\frac{\alpha}{n}\right)} > 0 \quad iff \quad \frac{\alpha}{n} < \frac{(1-q)(G-w) + \sqrt{(1-q)^2(G-w)^2 + 2qw(1-q)(G-w)}}{q}$$

Thus, ϕ_{max}^{II} declines in α/n whereas ϕ_{max}^{V} can either rise or decline in α/n.

<u>Proof of corollary (c)</u>

By definition, both zones III and IV are local monopolies equilibrium zones. Differentiating equation (30c) with respect to α/n obtains:

(A21) $$\frac{\partial \phi_{max}^{III}}{\partial\left(\frac{\alpha}{n}\right)} = \frac{1-q}{q}\left[1 - \frac{q(R-w) + (1-q)\cdot\frac{\alpha}{n}}{\sqrt{2q(1-q)(R-w)\cdot\frac{\alpha}{n} + (1-q)^2\cdot\left(\frac{\alpha}{n}\right)^2}}\right],$$

It follows from equation (A21) that ϕ_{max}^{III} is rising in α/n if and only if the expression in the square brackets in the right hand of the equation is positive. It can be checked that:

(A22) $$1 - \frac{q(R-w) + (1-q)\cdot\frac{\alpha}{n}}{\sqrt{2q(1-q)(R-w)\cdot\frac{\alpha}{n} + (1-q)^2\cdot\left(\frac{\alpha}{n}\right)^2}} > 0 \quad iff \quad q(R-w) < 0$$

Assumptions 1 and 2 imply that $R > w$; thus, $q(R-w) > 0$, so that ϕ_{max}^{III} is declining in α/n.

Equation (30d) indicates that ϕ_{max}^{IV} does not depend on α/n. Thus, under local monopolies the discount window rate threshold level either declines in α/n (in zone III) or is invariant to α/n (zone IV).

References

Azariadis, C., and B.D. Smith, **"Adverse Selection in the Overlapping Generations Model: The Case of Pure Exchange"**, Journal of Economic Theory, August 1993, Vol. 60(2): 277-305.

Bernanke, B. S., and A. S. Blinder, **"The Federal Funds Rate and the Channels of Monetary Transmission"**, The American Economic Review, September 1992, Vol. 82(4): 901-921.

Bernanke, B. S., and M. Gertler, **"Inside the Black Box: The Credit Channel of Monetary Policy Transmission"**, Journal of Economic Perspectives, 1995, Vol. 9(4): 27-48.

Bernanke, B. S., M. Gertler and S. Gilchrist, **"The Financial Accelerator and the Flight to Quality"**, Review of Economics and Statistics, February 1996, Vol. 78(1): 1-15.

Bernanke, B. S., and C. S. Lown, **"The Credit Crunch"**, Brookings Papers on Economic Activity, 2:1991: 205-247.

Besanko, D. and Thakor A. V., **"Collateral and Rationing: Sorting Equilibria in Monopolistic and Competitive Credit Markets"**, International Economic Review, October 1987, Vol. 28(3): 671-689

Bester, H., **"Screening versus Rationing in Credit Markets with Imperfect information"**, The American Economic Review, September 1985, 75(4), 850-855.

Blinder, A. S., and J. Stiglitz, **"Money, Credit Constraints and Economic Activity"**, The Americam Economic Review, Papers and Proceedings, 1983, Vol. 73: 297-302.

Kashyap, A. K., and J. C. Stein, **"What Do a Million Observations on Banks Say About the Transmission of Monetary Policy?"**, The American Economic Review, June 2000, Vol. 90(3): 405-427.

Meltzer, A. H., **"Monetary, Credit and (Other) Transmission Processes: A Monetarist Perspective"**, Journal of Economic Perspectives, 1995, Vol. 9(4): 49-72.

Salop, S. C., **"Monopolistic Competition with Outside Goods"**, The Bell Journal of Economics, Spring 1979, Vol. 10(1): 141-156.

Suarez, J., and O. Sussman, **"A Stylized Model of Financially Driven Business Cycles"**, mimeo, CEMFI, Madrid, 1993.

- - - - - - - - - - - - - - - - - - - **"Financial Distress and the Business Cycle"**, Oxford Review of Economic Policy, Autumn 1999, 15(3): 39-51.