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DETERMINANTS OF THE NUMBER OF INFORMATION PRODUCERS IN THE CREDIT MARKET*

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Abstract

According to the theory of financial intermediation, there is one financial intermediary in the credit market. That is, the credit market is monopolistic. Mamy literatures studying the main-bank system in Japan use this idea. However, some empirical evidences suggest that there seem to exist multiple financial intermediaries in the credit market. This implies that we have to take into account such a situation. In this paper, we consider when there are multiple numbers of financial intermediaries in the credit market and how the number of financial intermedisries is determined. And we also consider what is the determinants of the number of financial intermediaries in the credit market.

I. *Introduction*

The development of "Economics of Information" enables us to understand the role of banks (or financial intermediaries). According to this view banks are the economic agents which produce information about the quality of the investment projects and/or the repayment atitudes of borrowers (or firms).[1]

This view attracts many Japanese scholars because of its ability to clarify the economic rationality of main-bank system. Hayakawa [1988] indicates main-bank system as the mechanism which solve two dilemmas ("dilemma of diversification" in the side of lenders and "dilemma of confidentiality" in the side of borrowers) simultaneously.[2] In this view, main bank is the bank which produces the information about borrowers' characteristics monopolistically. Other literatures, such as Schoenholtz and Takeda [1985] and Higano [1987], indicate similar results. In these papers, it is assumed, implicitly or explicitly, that there is only one information producers in the credit market, which is natural consequences from the theory of financial intermediation.

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* This paper is a revised verson of my earlier paper, "Mein banku no keisei katei," Oct. 1990. I thank the participants of Hitotsubashi Finance Seminar and Hitotsubashi-Kobe Finance Seminar for their helful comments.

[1] The literatures which consider banks as information producer are as follows; Leland and Pyle [1977], Diamond [1984], and Ramakrishnan and Thakor [1984].

[2] Diversification is very important for financial intermediaries to work effectively (Diamond [1984]). However, supplying huge amount of fund by only one bank constraints the ability of diversification to the bank. This is the "dilemma of diversification." To borrow funds, it is necessary for borrower to provide much information including confidential information to the lender. In this case, it is difficult to maintain the confidentiality and the cost of avoiding the leakage of information becomes very high. This is the "dilemma of confidentiality."

However, empirical evidence does not seem to support this idea. For example, Miwa [1985] shows that main bank (defined as bank having the highest share in lending to a firm) sometimes changes.[3] This evidence implies that main bank is not the sole information producer. The reason is that, if the main bank is the only information producer in credit market, it has the absolute advantage in lending (associated with information production) and changes of main bank do not occur.

In this paper, we consider the situation that there is possibility that a firm chooses more than two banks as information producers in the credit market. And we consider how the number of information producers (banks) in the credit market is determined.

The content of this paper is as follows. In section 2, we provide the basic model and show the possibility that there exist multiple information producers in the credit market. In this analysis, the important factors are (1) the value of information to the firm, (2) the degree of uncertainty of project returns, and (3) the reputation of information producers which non-information producers have to the information producers. In section 3, we consider the effect of change of these factors on the number of information producers by comparative statics. In section 4, we comment on extensions of the analyses. Some concluding remarks are made in Section 5.

II. *Basic Model*

Consider the newly established firm. The entrepreneur of this firm has the investment project but no funds. So this firm have to raise the required funds from the outside investors to finance the investment. In order to raise funds, this firm provides the information about quality of the investment projects to the outside investors. But the entrepreneur does not reveal the information to the market directly because of the problem of credibility and confidentiality of information.[4] So, he makes use of signaling or screening as the method of providing the information. Notice that, for the signal to work effectively, it is necessary that the structure of the signaling cost is common knowledge among investors, which is not the case to the newly established firm. Therefore, the entrepreneur has to use the screening method, that is he delegates the third party to produce information. In this paper, we consider the bank as the information producer. The entrepreneur raises all the funds from the banks.

Given the amount of the funds of investment project,[5] entrepreneur acts to minimize the cost of financing. For the firm which raises the funds from the banks, the cost consists of two components; the cost of funding and the cost of information production. The cost of funding is the rate of interest which banks charge. On the other hand, the cost of information production is the cost which the entrepreneur pay for the information producer (including the cost of maintaining the confidentiality of information).

For simplicity, let r_0 the rate of interest which the information producer charges to the firm, and r_1 the rate of interest which the non-information producer charges when there

[3] Horiuchi and Fukuda [1987] and Suto and Takahashi [1986] indicate similar result.

[4] It is because the information has same nature as public good has. For details, see Leland and Pyle [1977].

[5] For simplicity, we assume the fund of investment project amounts to 1 throughout the paper.

are no information producer. Clearly, $r_1 > r_0$.[6] We assume that banks can not supply all the funds which the entrepreneur requires to invest, because the banks are subject to the constraint of diversification.[7] So, entrepreneur has to raise the funds from multiple banks. Let the number of the banks which lend the firm m. Banks which are delegated to produce information by the entrepreneur charge the interest rate r_0 to their loan. On the other hand, non-information producing banks do not necessarily charge the interest rate r_0 to their loan because there is a possibility that information producer may make a mistake. Non-information producing banks charge r_0 only when they trust the information prod ucer. Other non-information producers which don't trust the information producers charge the interest rate] r_1. We let the probability that non-information producers do not trust the informa tion producer 1-q. Then, the cost of funding to the entrepreneur when he delegate the information production to n banks is;

$$\sum_{k=0}^{m-n} {}_{m-n}C_k q^k (1-q)^{m-n-k}[(n+k)r_0+(m-n-k)r_1]/m=[\{n+(m-n)q\}r_0+(m-n)(1-q)r_1]/m$$
$$\text{where } {}_tC_s=t!/(t-s)!s!. \qquad (1)$$

By equation (1), we understand that the cost of funding curve is linear and decreasing function of the number of information producer, n.

The cost of information production is also the function of the number of information producing banks. We let the cost function $C(n)$. As the number of information producer increases more and more, it becomes more difficult for the entrepreneur to maintain the confidentiality of the information. Therefore, we can assume $C'(n)>0$ and $C''(n)>0$.[8] In addition, we assume $|dC/dn|<|dR/dn|$ for n sufficiently small and $|dC/dn|>|dR/dn|$ for n sufficiently large.[9]

Thus, when the entrepreneur delegates n banks to produce information, the total cost is

$$L(n)=[\{n+(m-n)q\}r_0+(m-n)(1-q)r_1]/m+C(n)\,.$$

The entrepreneur chooses the number of the information-producing banks to minimize

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[6] We suppose that the interest rate is determined such that the expected return from the loan is equaled to the cost of financing to banks. That is, $r_c=r\int_r^{\bar{x}} f(x)dx+\int_{\underline{x}}^{r} xf(x)dx$, where r_c=the cost of finnacing to banks, r=the rate of interest, $x\in[\underline{x},\bar{x}]$=the return of investment (random variable), $f(x)$=the density function of x. We assume that the density function is $f(x)$ when information about the firm is produced, and $g(x)$ when information is not produced and that the rate of interest is r_0 in the former situation and r_1 in the latter situation. If $f(x)$ dominates $g(x)$ in the sense of first-degree stochastic dominance, $r_1>r_0$. For example, we assume that random variable, x, follows the uniform distribution and that the support of $f(x)$ is $[b,c]$ and the support of $g(x)$ is $[a,c]$, where $a<b$. In this case, $r_1=c-(c^2-2r/(c-a)-a^2)^{1/2}$ and $r_0=c-(c^2-2r/(c-b)-b^2)^{1/2}$. Since $a<b$, $r_1>r_0$.

[7] On this point, see Diamond [1984].

[8] Ramakrishnan and Thakor [1984] considers the effect of the number of information producers on the cost of information production. In their paper, it is shown that the cost of information production is strictly higher when there are two information producers than when there is only one information producer, in the case without internal monitoring. Their result show the possibility of $C'(n)>0$. However, they don't show whether $C''(n)>0$ or not. In this paper, we assujme $C''(n)>0$ because we think it is consistent with our intuition. This is the problem to be proved formally in the future.

[9] This is an essential assumption to this analysis. If it is not true, the conclusion of this paper is altered. In this sense, this is also the problem to be proved formally and/or empirically.

this cost. The optimal number of the information producers, n^*, satisfies the condition $L(n^*-1)>L(n^*)<L(n^*+1)$.

To assure that entrepreneur delegates information production to at least one bank, we assume

$$C(1)<q(r_1-r_0)\,.$$

Firstly, we consider the case $q=1$, when all the non-information-producing banks trust the information which one bank produces. Since $q=1$, $L(n)=r_0+C(n)$. Then, the cost is minimized when the number of information producers is as small as possinle because $C'>0$. Thus it is optimal when the entrepreneur delegates only one bank to produce information that it, $n=1$. Many literatures on main-bank system, such as Hayakawa [1988], consider this situation.[10]

Next, we consider the case $q<1$.

The condition $L(n)<L(n+1)$ is rewritten as:

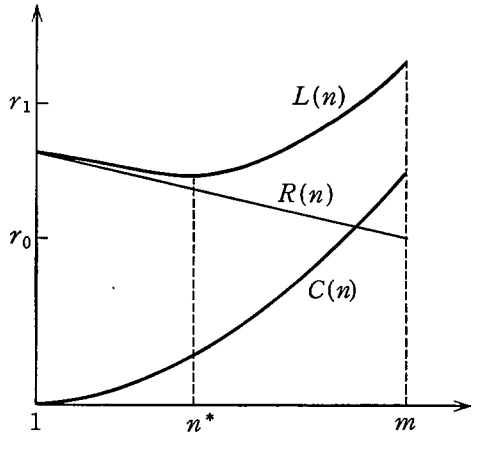
$$(1/m)(1-q)(r_1-r_0)<C(n+1)-C(n).$$

In this inequality, the left hand side implies the amount of cost decreasing when entrepreneur delegates one more bank to produce information and the right hand side implies the amount of cost increasing when the number of the information producers increases one more. Then, the condition that n^* is the optimal number of information producers is

$$C(n^*-1)-C(n^*)<(1/m)(1-q)(r_1-r_0)<C(n^*+1)-C(n^*).$$

As stated above, the total cost consists of the cost of funding and the cost of informa-

FIGURE 1. THE OPTIMAL NUMBER OF INFORMATION PRODUCERS



[10] This statement may be overstatement. Because, as indicated in notes 8 and 9, another assumption on $C'(n)$ and $C''(n)$ changes the conclusion of this paper. However, it is important to notice that earlier papers on main bank system, such as Hayakawa [1988] etc., do not consider the determination of the number of information producers explicitly.

tion production. The former cost is decreasing function of the number of information producers and the latter cost is the increasing function of the number of the information producers. In Figure 1, we depict these two cost curves, $R(n)$ and $C(n)$, and total cost, $L(n)=R(n)+C(n)$, as the function of the number of information producers. Because, by assumption, the entrepreneur delegates at least one banks to produce information, the origin of the graph corresponds to $n=1$.

From the equation (1) and by the assumption on the nature of $C(n)$, the total cost curve $L(n)$ is U-shaped as in the Figure 1. In the Figure 1, the total cost is minimuzed at $n=n^*$ and we understand that there exist multiple numbers of information producers in the credit market. In specific situations such as when the reputation of the information producer is established, when the value of the information to the entrepreneur is very high or when the variance of project returns is very small, the optimal number of information producers becomes to be one. In the situation where the entrepreneur of a new-established firm delegates banks to produce information, such a case is rare. Thus, we conclude that there exists multiple numbers of information producers in the credit market.

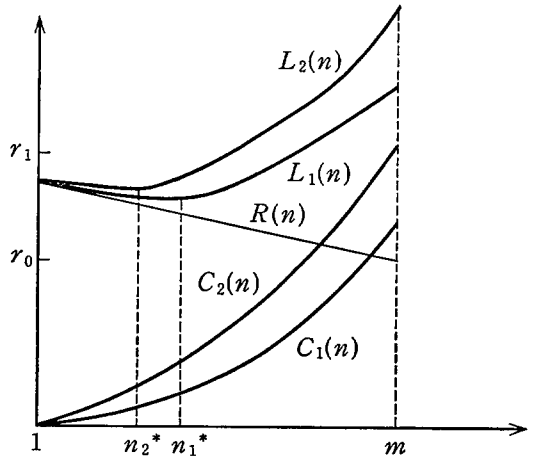
III. *Comparative Statics*

In this sectiom, we analyze the effect of the change of the paraneters of the basic model on the number of information producers.

(1) The value of information to the entrepreneur

Consider the case where the value of information to the entrepreneur increases. In this case, the cost of the information leakage becomes so high that the entrepreneur is willing to pay more to maintain the confidentiality of his valuable information. Thus, the $C(n)$ curve shifts upwards as in the Figure 2 (from $C_1(n)$ to $C_2(n)$). In this situation, the total

FIGURE 2. CHANGES OF THE VALUE OF INFORMATION TO THE ENTREPRENEUR



cost curve, $L_1(n)$, shifts to $L_2(n)$, and the optimal number of information producers decreases from n_1^* to n_2^*. The reason of this decrease of the number of information producer is very simple; it is because the entrepreneur tries to lower the possibility of information leakage by decreasing the number of agents with whom the entrepreneur provide his valuable information.[11]

(2) The reputation of the information producer

Consider the situation where the reputation of the information producer increases. This means the increase of the value of q.

In this case, for all $n<m$,

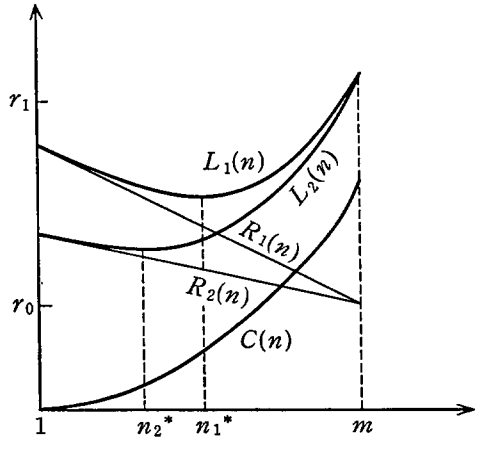
$$dR/dq=(m-n)(r_0-r_1)/m<0.$$

Thus, the cost of funding is lower than before for all $n<m$. When $n=m$, the cost of funding is unchanged. Then, $R(n)$ curve shifts downwards (from $R_1(n)$ to $R_2(n)$), as in the Figure 3, and the decreasing rate of the cost of funding becomes to be smaller than before. As a result, the total cost curve moves from $L_1(n)$ to $L_2(n)$ and the optimal number of information producers decreases from n_1^* to n_2^*. When the reputation of information producers rises, reduction of funding cost is attained by a small number of information producers. Then, the cost of information leakage is high relative to the benefit of reduction of funding cost associated with adding one more information producer. Thus, the number of the information producer decreases.

(3) The degree of uncertainty of project returns

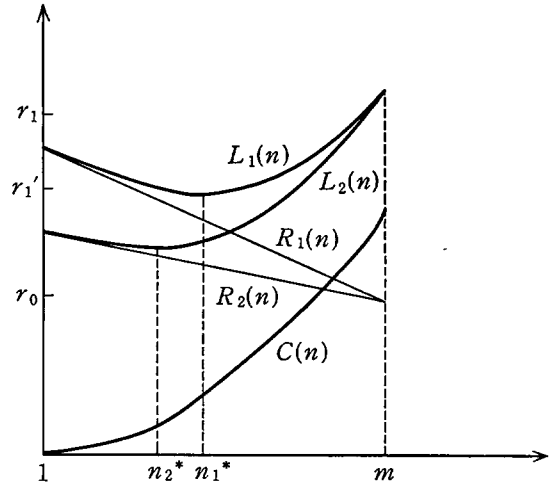
Consider the case where uncertanty of project returns changes. The more uncertain

FIGURE 3. CHANGES OF THE REPUTATION OF INFORMATION PRODUCER



[11] As to the shift of the $C(n)$ curve, there are two possibilities depending on whether the value of $C'(n)$ remains constant or increases. In both cases, the optimal number of information producer decreases.

FIGURE 4. CHANGES OF THE UNCERTAINTY OF PROJECT RETURNS



the returns of project are, the higher is the rate of inteerst charged by non-information producer when there is no information producers. Then, we can think the value (r_1-r_0) as the index of uncertainty of project returns.[12]

When the degree of the uncertainty of the investment project becomes small, that is, when the value of (r_1-r_0) becomes small, $R(n)$ curve shifts form $R_1(n)$ to $R_2(p)$, as in Figure 4. As a result, the total cost curve shifts from $L_1(n)$ to $L_2(n)$ and the optimal number of information producers decreases from n_1^* to n_2^*. The reson of this is similar to the case where the reputation of information producer rises; it is because the decreasing rate of the cost of funding becomes small and the entrepreneur has incentive to decrease the number of information producers.

IV. *Some Extensions*

In this section, we extend the basic model in two respects. Firstly, we allow the reputation of the information producer to arise as the number of information producers increases. Secondly, we consider the situation where banks which produce information lend more than the non-information-producing banks.

(1) Reputation of the information producer

In section 2, we assume that even if the number of information producers increases, non-information producers do not alter their belief about the accuracy of the information which they receive from the information producers. However, the more the number of information producers is, the more accurate the information which they produce is thought

[12] See note 6.

to be by non-information producers. In this section, we consider the situation where the reputation of information producer arises as the number of information producers increases. This implies that the probability which non-information producers trust the information producer is the function of the number of information producers and has the property $q'(n)>0$.

Then, the cost of funding is written as:

$$R(n)=[\{n+(m-n)q(n)\}r_0+(m-n)(1-q(n)\}r_1/m.$$

and

$$dR(n)/dn=[1-q(n)+(m-n)q'(n)](r_0-r_1)/m<0 \text{ because of } r_1>r_0.$$

That is, the cost of funding decreases as the number of information producers increases. In addition,

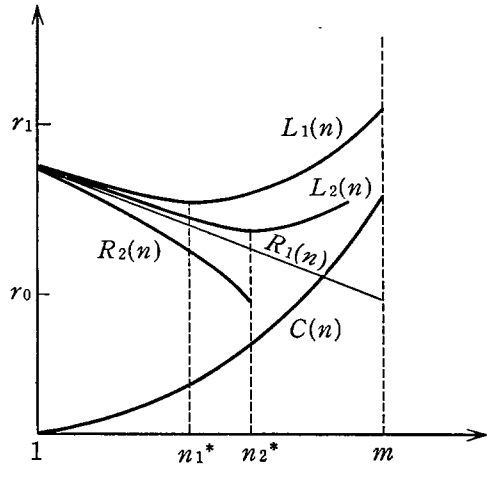
$$d^2R(n)/dn^2=[-2q'(n)+(m-n)q''(n)](r_0-r_1)/m$$

On the other hand, the cost of maintaining confidentiality is unchanged.

Next, we consider the effect of change of reputation on the optimal number of information producers. There are two possibilities depending of the value of $q''(n)$.

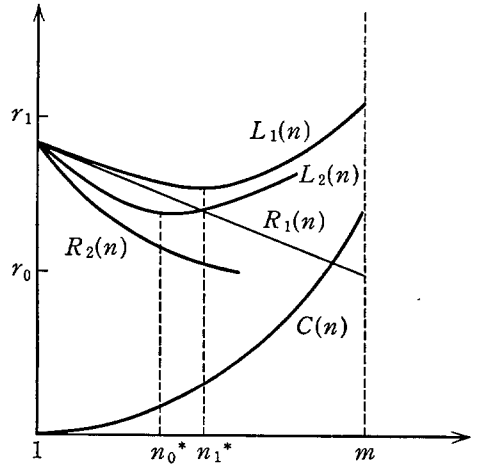
Firstly, we consider the case $q''(n)<0$, which implies $d^2R(n)/dn^2<0$.[13] That is, the cost of funding, $R(n)$, decreases at an increasing rate as the number of information producers increases. In this case, the number of information producers in the credit market is larger than when q is constant (See Figure 5). The reason of this is as follows: The cost reduction by the rise of reputation outweights the increase of cost of confidentiality. This leads the entrepreneur to exploit the benefit of funding cost reduction and to have incentive to increase the number of information producers.

FIGURE 5. THE REPUTATION OF INFORMATION PRODUCER: CASE I



[13] Even if $q''(n)>0$, $d^2R(n)/dn^2<0$ as long as $q''(n)<2q'(n)/(m-n)$.

FIGURE 6. THE REPUTATION OF INFORMATION PRODUCER: CASE II



Secondly, we consider the case $q''(n)>2q'(n)/(m-n)$, which implies $d^2R(n)/dn^2>0$. That, is, the cost of funding, $R(n)$, decreases at a decreasing rate as the number of information producer increases. In this case, the optimal number of information producers is smaller than when q is constant (See Figure 6). The reason of this is as follows; When the reputation of information producers rises rapidly as the number of information producer increases, it is possible for the entrepreneur to enjoy the reduction of financing cost by delegating a small number of banks to produce information. Thus, the reduction of funding cost outweights the increase of cost of maintaining confidentiality only when the number of information producers is very small and the entrepreneur has the incentive to lower the number of information producers.

(2) The information producer lends more

In section 2, we assume the loan size does not depend on whether the lender is information producer or not. In this section, we consider the situation where information-producing banks lend more than non-information-producing banks.

Let A the loan size the information producer lends and B the loan size the non-information producer makes. Because, by producing information, the information producer is more informed about the firm, the lending cost of the information producer is lowered. Thus, A>B. A and B satisfy the equation $nA+(m-n)B=1$. We assume that the loan size of information producer is constant. So, the loan size of the non-informtaion producer, B, is the function of the number of information producers and becomes smaller as the number of information producers increases. Further, we assume $mA>1$.

In this situation, the cost of funding is written as

$$R(n)=r_0[nA+(m-n)B(n)q]+(m-n)B(n)(1-q)r_1$$

and the cost of confidentiality $C(n)$ is unchanged.

Then,

$$dR(n)/dn=r_0[A+B'(n)(m-n)q-Bq]+B'(n)(m-n)(1-q)r_1-B(1-q)r_1$$

The sign of dR/dn is indeterminate because the sign of the first term is indeterminate. When

$$[B(n)-B'(n)(m-n)](r_1-r_0)q<-\{r_0A+[B'(n)(m-n)-B(n)]r_1\}$$

the cost of the funding, $R(n)$, decreases as the number of information producers increases.[14] In this equation, the right hand side means the decrease of funding cost by the increase of one more non-information producer through the increase of one more information producer, which we call direct effect of increase of information producer on the cost reduction. The left hand side of the equation means the decrease of the total funding cost through the increase of one more information producer, which we call the indirect effect of incraese of information producer on the cost reduction. That is, the equation means that the cost of funding decreases when the direct effect is larger than the indirect effect. We can conclude that, in this case also, there is the possibility to exist multiple numbers of information producers in the credit market.

V. *Concluding Remarks*

In recent years, many literatures on the main bank system have assumed, explicitly or implicitly, that there is one information producer in the credit market. In this papr, we question whether there is one information producer in the credit market. We consider how is the number of information producers in the credit market determined and show that there is the possibility to exist multiple numbers of information producers in the credit market.

Next, we consider the determinants of the number of information producers. As a result, we show that the number of information producers increases, (1) as the value of information to the entrepreneur becomes high, (2) as reputation of information producer rises, and (3) as the uncertanty of project returns becomes small. These results of comparative statics are consistent to our intuition.

Furthermore, we extend analysis in two respects; (1) when the reputation of the information producer arises as the number of information producers increases, and (2) when the information producers lend more than the non-information producers do. We also show that, in these cases, there is the possibility to exist multiple numbers of information producers in the credit market.

The conclusion of this paper has an important implication to the empirical study on the main bank system. That is, it is important to classify banks in two groups (the information-producing banks and the non-information-producing banks) and analyze the relationship between these two groups, instead analyzing the one bank which has the highest share in lending.[15]

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[14] $[B(n)-B'(n)(m-n)](r_1-r_0)>0$ because $B(n)>0$, $B'(n)>0$, $m>n$, and $r_1>r_0$. In addition, $r_0A+[B'(n)(m-n)-B(n)]r_1<0$. Suppose this is not true. From the equation $nA+(m-n)B(n)=1$, $A+B'(n)(m-n)-B(n)=0$, which implies $A=B(n)-B'(n)(m-n)$. Thus, $r_0A>[B(n)-B'(n)(m-n)]r_1$ means $r_0>r_1$. Contradiction. So we have $r_0A=[B'(n)(m-n)-B(n)]r_1<0$. From these results, $q>0$.

[15] Sasaki [1992] introduces the concept of "corebank" (group of banks which have close relationships with a firm) and studies the stability of relationships between corebanks and the firm.

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