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22/98

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27.10.1998

Market Structure and Risk Taking in the Banking Industry

SUOMEN PANKIN KESKUSTELUALOITTEITA • FINLANDS BANKS DISKUSSIONUNDERLAG

Suomen Pankki
Bank of Finland
P.O.Box 160, FIN-00101 HELSINKI, Finland
☎ + 358 9 1831

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The views expressed are those of the authors and do not necessarily correspond to the views of the Bank of Finland

[1] Department of Economics, University of Haifa, 31905 Haifa, ISRAEL.
E-mail: ozshy@econ.haifa.ac.il.
[2] Corresponding Author: Department of Economics, Swedish School of Economics, P.O.Box 479, FIN 00101 Helsinki, Finland. E-mail: Rune.Stenbacka@shh.fi.

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Abstract

This study demonstrates that the common view, whereby an increase in competition leads banks to increased risk taking, fails to hold in an environment where consumers can choose in which bank to make a deposit based on their knowledge of the riskiness incorporated in the banks' outstanding loan portfolios. We show that, in the absence of deposit insurance, competition between differentiated banks will increase the returns from diversification. We offer a welfare analysis establishing that introduction of competition into the banking industry can only improve social welfare. However, competition cannot always guarantee that diversification will occur to a socially optimal extent. Finally, we show that deposit insurance would eliminate the beneficial effects of banks competing with asset quality as a strategic instrument.

JEL Classification Numbers: G21, G28, E53

Keywords: Risk taking in banking, banks' portfolio diversification, bank competition, deposit insurance

Pankkien rakennemuutos ja riskinotto

Suomen Pankin keskustelualoitteita 22/98

Oz Shy – Rune Stenbacka
Tutkimusosasto

Tiivistelmä

Tutkimus osoittaa, että yleinen käsitys, jonka mukaan kilpailun kiristyminen johtaisi pankkien riskinoton lisääntymiseen, ei pidä paikkaansa tilanteessa, jossa asiakkaat voivat valita, mihin pankkiin talletuksensa tekevät. Talletuspäätös perustuu tietoon pankkien lainakantaan liittyvistä riskeistä. Talletussuojan puuttuessa kilpailu eriytyneiden pankkien kesken kasvattaa riskin hajauttamisen kannattavuutta. Tutkimuksen hyvinvointitarkastelusta ilmenee, että kilpailu pankkisektorilla voi ainoastaan parantaa yhteiskunnan hyvinvointia. Kilpailun tuominen pankkisektorille ei kuitenkaan voi aina taata, että riskejä hajautetaan yhteiskunnan kannalta optimaalisella tavalla. Tutkimuksen loppupäätelmänä on, että talletussuoja eliminoisi suotuisat vaikutukset, jotka syntyvät siitä, että pankit kilpailevat rahoitusvaateiden laadulla strategisena välineenä.

JEL-luokitusnumerot: G21, G28, E53

Asiasanat: pankkien riskinotto, riskin hajauttaminen pankeissa, pankkikilpailu, talletussuoja

Contents

1 Introduction

A traditional and widespread view postulates that competition for depositors will induce banks to engage in excessive risk taking. Such a view has motivated extensive regulation of the banking industry with the most noticable one being the establishment of the deposit insurance institution. The idea of competition generating financial fragility also seems to underly the commonly used government policy of supporting mergers of failing banks into healthy ones as a measure to increase the stability of banking markets. In this paper we formally investigate the structural relationship between competition for depositors and credit market fragility within the framework of a model where portfolio diversification is made an operational strategic decision of the banks. We demonstrate that the common view according to which an increase in competition leads banks to invest in a more risky portfolio fails to hold in an environment where consumers can choose in which bank to make their deposits based on their knowledge of the risk included in the banks' asset portfolios in addition to deposit rate comparisons. With this kind of consumers, we demonstrate how, in the absence of deposit insurance, competition over customers will lead banks to diversify their portfolios in addition to paying higher interest on demand deposits and savings accounts.

In general, the way whereby banks construct their lending portfolios will affect the risk inferences drawn by depositors (or, more generally, suppliers of capital to banks) and thereby the deposit rate required by these depositors. In fact, the choice of riskiness in the outstanding lending portfolios might constitute an important strategic instrument with respect to the competition taking place among banks. In this respect each bank faces a number of central strategic decisions: Should the bank concentrate its lending activities to a few industries or a few geographical regions (countries) so as to exploit gains from *specialization* based on economics of scale with respect to, for example, monitoring as a way to create a competitive advantage for itself? Or, should the bank invest in a portfolio with *maximal diversification* so as to minimize the risk of its asset portfolio thereby attracting risk averse depositors who will accept a minimal deposit rate?

In the present paper we build a formal model of strategic competition between banks in order to analyze this tradeoff between specialization and diversification. In particular, our model makes it possible to provide answers for the following questions: Will competition between banks generate lending portfolios which are too risky? Equivalently, will a financial intermediation industry with competition between the banks channel funding to projects which represent a too risky portfolio from a social point of view? Further, we investigate how the consequences of credit market competition are related to the regulatory environment in the form of the widely-used deposit insurance policy.

Existing research has identified a number of mechanisms justifying the view that competition tends to destabilize credit markets by increasing the equilibrium bankruptcy risk. One branch of the literature has focused on how the consequences of adverse selection, generated by the inability to observe the characteristics of borrowers, are linked to the market structure in the lending industry. Riordan (1993) applied auction theory to the bank loan market and demonstrated how more intense market competition may damage market performance. Broecker (1990) introduced exogenous credit testing in a model recognizing the fundamental property that competition in lending rates tends to reduce the average quality of loans. In a model exploring the relationship between the incentives of banks for costly information acquisition based on ex ante project monitoring and the market structure of the banking industry, Kanniainen and Stenbacka (1998) find that competition between banks will typically undermine the incentives of banks to avoid classification errors. Thus, their analysis identifies a tradeoff between the degree of lending competition and the incentives of banks to acquire information. Caminal and Matutes (1997) have analyzed the welfare consequences of increased concentration in the lending industry in a model where banks choose between credit rationing and monitoring in order to alleviate an underlying moral hazard problem. They show that an increase in market power will induce banks to raise their lending rate while at the same time also strengthening the bank's incentives for project-specific monitoring. These effects typically operate in opposite directions implying that there need not be a monotonic relationship between lending industry concentration and social welfare.

In the present paper, in order to capture the tradeoff between high interest paid on deposits and low risk, we introduce monitoring costs into the model. In the absence of monitoring costs, banks profit maximizing action is to fully diversify their portfolio, since the reduced risk will raise the utility of a depositor, thereby allowing the bank to reduce interest rates on deposits. However, if monitoring costs are present, and if monitoring costs increase with the degree of the banks' diversification, banks are forced to evaluate the tradeoff between the utility depositors attach to low risk and the cost of monitoring which is minimized when risk is maxmized.

The relationship between the market structure of the lending industry and the diversification of banks' loan portfolios has been investigated using a number of approaches. Matutes and Vives (1995) have examined the consequences of imperfect competition for deposits on the risk taking incentives of banks. Their model characterizes in detail the roles played by limited liability, deposit insurance, deposit market competition and observability of banks' asset portfolios in determining the risk taking incentives of banks. In a related paper (Matutes and Vives (1996)) the same authors demonstrate how the welfare implications of deposit insurance are linked to the banking market structure. In that model the possiblility of a bank failure allows for the emergence of vertical differentiation through the formation of expectations by depositors, and this is a central mechanism of the competition taking place in their model. Winton (1997) focuses on the question of how investors' beliefs interact with bank competition, entry, and regulation to influence the resulting market structure in the banking industry. His analysis centers around the link between bank size and diversification of a bank's loan portfolio as well as on the implication of this link on how a customer's choice of bank will create an adoption externality such that investors' beliefs are self-fulfilling in a rational expectations equilibrium. Hellwig (1998) investigates the incentives of financial intermediaries to underdiversify under different types of financing contracts and under various assumptions about project technologies. As the adoption externality based on the link between bank size and diversification of banks' asset portfolios is fairly well understood from the research contributions cited above, our attention in the present paper will focus on a model where the portfolio diversification is a crucial and explicit operational strategic decision variable of all banks.

In the present study we construct a model of a differentiated banking industry in which banks are engaged in two-stage competition based on (i) how to diversify their loan portfolios and (ii) how much interest to offer for deposits. Our study demonstrates that the common view according to which an increase in competition leads banks to increased risk taking fails to hold in an environment where consumers can choose in which bank to make a deposit based on their knowledge of the riskiness incorporated in the banks' outstanding loan portfolios. We show, that in the absence of deposit insurance, competition between differentiated banks will increase the returns from diversification. We are able to characterize the possible subgame perfect diversification equilibria, the symmetric as well as the asymmetric ones, for different configurations of parameter values. We offer a welfare analysis establishing that introduction of competition into the banking industry can only improve social welfare. However, competition cannot always guarantee that diversification will occur to a socially optimal extent. Finally, we show that deposit insurance would eliminate the beneficial effects from banks competing with asset quality as a strategic instrument.

The paper is organized as follows. Section 2 introduces a model of a differentiated banking industry with no deposit insurance where consumers gain utility from interest paid on demand deposits and saving accounts, whereas their utility declines with an increase in the risk taken by their chosen bank. Section 3 solves for the equilibrium deposit rates and the banks' subgame perfect portfolio divesification choices under comptition. In Section 4 we study a monopoly banking industry and we analyze the effects of introducing deposit insurance. Section 5 introduces a welfare analysis of the effects of introducing (or removing) deposit insurance. Section 6 investigates the consequences of banks facing out-of-industry competition from alternative investment or saving opportunities. Finally, Section 7 offers our concluding comments.

2 A Model of the banking industry

Consider an economy with two profit-maximzing banks, called bank 1 and bank 2. There is a continuum of investors, each with one unit of currency (say \$1) to deposit into an interest-bearing account at one (and only one) of the banks.

2.1 Banks

Banks compete for investors by paying interest to each consumer who makes a deposit. We denote by r_i the deposit rate offered by bank i, $i = 1, 2$. Banks subsequently lend the funds acquired to risky business projects.

In the long run the banks make decisions regarding the riskiness of their asset portfolios. It seems reasonable to view the bank's portfolio decision as an irreversible commitment relative to the interest rate decisions, because the portfolio assets are typically loan contracts for illiquid projects operating over a long period of time. Typically, it is associated with substantial costs to renegotiate loan contracts regarding financed projects and therefore the bank's asset portfolio cannot be changed very quickly.

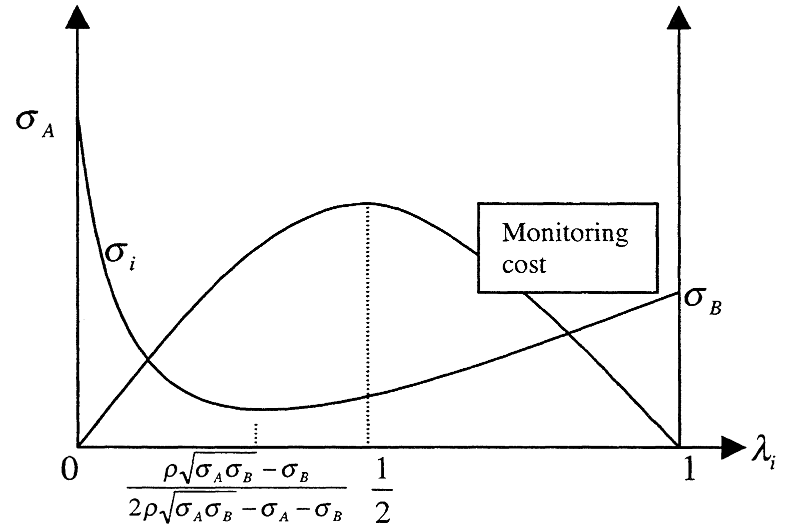
When banks compete with respect to their choices of portfolio riskiness they must anticipate the effects of their portfolio choice on the resulting interest rate equilibrium. To capture such effects we apply subgame perfectness as the equilibrium concept for banks' diversification decisions.

We capture the diversification choice of banks within the framework of a very simple stylized model. The bank can invest the funds it attracts into entrepreneurial projects of two types: A and B. The investment return to the bank is stochastic. By lending to a project of type A the expected return (per unit of investment) is α while the type-A variance is σ_A. Similarly, a type-B project has the expected return β and variance σ_B. The return distributions of the two types of projects are assumed to be statistically correlated with the correlation coefficient $\rho(-1 \le \rho < 1)$. With banks being able to diversify across these two types of projects with correlated return distributions, the relationship between the bank's portfolio variance, its portfolio configuration, and the project variances follows the well-known relationship

$$\sigma_i = \lambda_i^2 \sigma_A + (1-\lambda_i)^2 \sigma_B + 2\lambda_i(1-\lambda_i)\rho\sqrt{\sigma_A}\sqrt{\sigma_B}, \qquad (2.1)$$

where λ_i denotes the proportion of project A in the lending portfolio of bank i (i = 1, 2). Figure 1 illustrates how bank i controls its portfolio's risk, σ_i by mixing project types in its investment portfolio.

Figure 1. **The effect of portfolio selection on the risk taken by bank i and on its monitoring cost**



As intuition suggests, Figure 1 shows that the portfolio variance is minimized when

$$\lambda_i = \frac{\rho\sqrt{\sigma_A\sigma_B} - \sigma_B}{2\rho\sqrt{\sigma_A\sigma_B} - \sigma_A - \sigma_B} < \frac{1}{2} \quad \text{if} \quad \sigma_A > \sigma_B.$$

If both projects bear the same risk ($\sigma_A = \sigma_B$), then risk is minimized under equal mix ($\lambda_i = ½$). The risk is maximized when the bank decides to specialize in the more risky project only (in this case, project A). Since (2.1) describes a unique relationship between the portfolio investment proportion λ_i and the portfolio variance, we find it justified (and associated with no loss of generality) to express the diversification decision as a decision with respect to λ_i.

There are several interpretations of the two types of investment projects. They may represent projects belonging to different industries in a two-industry economy. Our subsequent use of terminology will mostly refer to this interpretation. However, formally the model could equally well be understood to capture a bank's geographical portfolio diversification across investments in geographically segmented markets like different countries.

In order for the bank's lending activities to achieve the return distributions outlined above the bank has to acquire a large amount of industry-specific knowledge in order to gain competence in being qualified to properly evaluate the projects applying for funding. We assume that each bank is able to develop such monitoring capabililities by specializing its lending activities into one particular type of projects (one particual industry). By diversifying its lending activities into several industries the bank cannot fully exploit the available gains from specialization in monitoring. We capture such a feature by assuming the bank to face a monitoring technology described by a cost function

$$C(\lambda_i) = c\lambda_i(1-\lambda_i), \quad c \geq 0, \quad \text{and} \quad 0 \leq \lambda_i \leq 1. \tag{2.2}$$

Figure 1 illustrates how monitoring costs are affected by diversification. Thus, we can think of (2.2) as a normalized method for capturing the phenomenon that the banks have access to a monitoring technology exhibiting gains from industry-specific specialization. We can view c as a parameter capturing the gains from specialization. Clearly, by specializing its lending activities into one industry, i.e., $\lambda_i = 0$ or $\lambda_i = 1$, the cost function (2.2) would be minimized with a value of zero, while the costs would be maximized at c/4 when $\lambda_i = ½$. In this respect we can view (2.2) as a representation of the costs from diversifying the lending portfolio.

2.2 Investors

We focus on a horizontally differentiated banking industry. The investors are uniformly distributed with a uniform density on the unit interval segment $[0,1]$ in accordance to increased preference for bank 2 (alternatively, increased distance from bank 1). With uniform density, we normalize the total mass of investors to equal one. The two competing banks are located at the endpoints of the unit interval segment: bank 1 is located at 0 while bank 2 is located at 1. Each investor is endowed with one unit of funds and faces a linear transportation cost at rate $\tau \geq 0$. Further, the parameter $\gamma \geq 0$ captures the degree of risk aversion by the investors. When offered the interest rate r_i by bank i (i = 1, 2) the surplus accruing to an investor located at x, $0 \leq x \leq 1$, is given by

$$U(x) = \begin{cases} r_1 - \tau x - \frac{\gamma}{2}\sigma_1 & \text{if he invests in bank 1} \\ r_2 - \tau(1-x) - \frac{\gamma}{2}\sigma_2 & \text{if he invests in bank 2} \end{cases} \tag{2.3}$$

Our model captures the idea of investors applying a generalized mean-variance criterion as the basis for their selection of bank. The mean-variance criterion is embedded in a location model of horizontal differentiation, where, of course, the interpretation of "transportation costs" need not be restricted to costs of traveling to a particular bank. As Matutes and Vives (1996) argue, banks could reasonably be differentiated based on offering "different combinations of services valued by depositors such as ATM network sizes, consumer credit facilities, availability in foreign countries etc.".

2.3 Sequence of banks' decisions

The two banks are engaged in two-stage competition. In stage II, banks take their portfolio investment decision variables, λ_1 and λ_2, as given and simulanuosly choose the interest rates, r_1 and r_2. In stage I, banks choose investment allocations, λ_1 and λ_2. We will be solving for a subgame-perfect equilibrium of such a two-stage game.

3 Equilibrium diversification and interest rates

Initially, we will concentrate on the stage of interest rate competition between the banks taking the portfolio investment allocations as given. Then, we solve for the equilibrium portfolio allocations of the two banks.

3.1 Stage II: Interest rate competition

We now assume that the risk averse investors (depositors) are able to observe the riskiness exhibited by the asset portfolios held by the two competing banks. In line with the standard procedure for the analysis of price competition in models of horizontal differentiation, we start by identifying the location of an investor indifferent between the competing banks. If offered the interest rate r_i by bank i, i = 1, 2, the location $\bar{x}$ of the indifferent investor is determined by

$$r_1 - \tau\bar{x} - \frac{\gamma}{2}\sigma_1 = r_2 - \tau(1-\bar{x}) - \frac{\gamma}{2}\sigma_2,$$

from which we find that

$$\bar{x}(r_1, r_2) = \frac{1}{2\tau}\left[r_1 - r_2 - \frac{\gamma}{2}(\sigma_1 - \sigma_2) + \tau\right]. \tag{3.1}$$

Bank 1 takes λ_1, λ_2 and r_2 as given and chooses its interest rate r_1 in order to maximize profits

$$\pi_1(r_1, r_2) = \bar{x}(r_1, r_2)\left[\alpha\lambda_1 + \beta(1-\lambda_1) - r_1\right] - c\lambda_1(1-\lambda_1). \tag{3.2}$$

Analogously, bank 2 takes λ_1, λ_2 and r_1 as given and chooses its interest rate r_2 so as to maximize

$$\pi_2(r_2, r_1) = (1 - \bar{x}(r_1, r_2))[\alpha\lambda_2 + \beta(1-\lambda_2) - r_2] - c\lambda_2(1-\lambda_2). \tag{3.3}$$

By differentiating (3.2) with respect to r_1 and (3.3) with respect to r_2 we find the best-response function of bank i to be

$$r_i(r_j) = \frac{1}{4}[2\alpha\lambda_i + 2\beta(1-\lambda_i) + \gamma(\sigma_i - \sigma_j) - 2\tau] + \frac{r_j}{2}, \quad \text{where } i, j = 1, 2, \text{ and } i \neq j. \tag{3.4}$$

From (3.4) we can directly observe that the best-response functions are upwards sloping meaning that the interest rate decisions are strategic complements. By solving the system of equations defined by these two best-response functions we find the Nash equilibrium deposit rates to be

$$r_i^* = \frac{1}{3}[(\alpha - \beta)(2\lambda_i + \lambda_j) + 3\beta] + \frac{\gamma}{6}(\sigma_i - \sigma_j) - \tau, \quad \text{where } i, j = 1, 2, \text{ and } i \neq j, \tag{3.5}$$

Equations (3.5) constitute a unique Nash equilibrium[1] with respect to the deposit interest payments for all possible diversifications of banks' portfolios. From (3.5) we can make a number of interesting observations.

Proposition 1. *For any given portfolio choices of the banks (i.e., given λ_1 and λ_2),*

(a) the equilibrium interest payment of any bank falls with an increase in the differentiation (transportation cost) parameter, τ ;
(b) the equilibrium interest paid by any bank increases with the bank's and the rival bank's investment level in project A if and only if project A yields a higher return than project B; formally, for all $i, k = 1, 2$, $dr_i^* / d\lambda_k > 0$ if and only if $\alpha > \beta$;
(c) the equilibrium interest paid by a bank increases with the risk taken by the bank.

Proposition 1 can be explained as follows. First, note that there is a slight difference between interest payment competition and the standard Bertrand price competition resulting from the fact that higher interest payments on demand deposits (or saving) implies lower profits to banks, whereas in the standard Bertrand model, higher equilibrium prices increase profits. Next, the first part of the proposition then follows, since an increase in the differentiation parameter lessens competition between the banks which implies that banks can pay lower interest to investors. This result can be applied in many important contexts. For

[1] Strict concavity of the two profit functions (3.2) and (3.3) is verified by observing that $d^2\pi_i / d(r_i)^2 = -1/\tau < 0$.

example, it can be applied to capture how depositors benefit from increased financial integration like that which has taken place within the framework of the European Union. Namely, increased financial integration can be interpreted as a reduction in the transportation cost parameter, τ, which, according to Proposition 1 (a) results in higher interest paid on demand deposits.

The second part of Proposition 1 is intuitively somewhat less obvious, and therefore requires some explanation. Suppose for the moment that $\alpha > \beta$. When a bank changes its portfolio towards the high-return investment (project A), it generates higher profits from investments and therefore intensifies the competition between the banks as these are 'able' to pay a higher return to their depositors. This behavior can be easily seen by looking at the best-response functions given in (3.4). Equation (3.4) shows that if a bank increases its investment in project A, its best-response function shifts upward if project A is the high-return project, while it shifts downward otherwise.

The third part of Propostion 1 can be explained as follows. If a bank increases the risk associated with its investments, the bank becomes less attractive to consumers. This has two effects on demand: the demand for deposits facing the bank decreases and in addition the demand becomes more elastic. It is the second effect that causes the bank to increase its interest payment to partially restore the loss of demand stemming from the increase in its investment risk.

We conclude the second stage analysis by characterizing the market shares in equilibrium. Substituting (3.5) into (3.1) yields

$$\bar{x}^* = \frac{1}{2} + \frac{(\lambda_1 - \lambda_2)(\alpha - \beta)}{6\tau} - \frac{\gamma(\sigma_1 - \sigma_2)}{12\tau}. \tag{3.6}$$

Equation (3.6) reveals the following.

Proposition 2. *For any given portfolio choices of the banks (i.e., given* λ_1 *and* λ_2 *),*

(a) the market share of a bank decreases with its investment risk, and increases with the risk taken by the rival bank:
(b) the market share of a bank inceases when it increases its investment in the higher-return project; formally, $d\bar{x}^*/d\lambda_1 > 0$ *and* $d\bar{x}^*/d\lambda_2 < 0$ *if and only if* $\alpha > \beta$.

The first part of Proposition 2 follows from the assumption that portfolio risk is undesirable for investors. The second part follows from the second part of Proposition 1, since an increase in the investment share of the high-return project will increase the interest paid on deposits which will attract more customers to the bank.

We define the equilibrium interest rate functions $r_i(\lambda_1, \lambda_2) = r_i^*$ based on (3.5). Substituting (2.1) into (3.5) we have

$$r_i(\lambda_1,\lambda_2)=\frac{1}{3}\left[(\alpha-\beta)(2\lambda_i+\lambda_j)+3\beta\right]$$
$$+\frac{\gamma}{6}\left\{\sigma_A\left[(\lambda_1)^2-(\lambda_2)^2\right]+\sigma_B\left[(1-\lambda_1)^2-(1-\lambda_2)^2\right]\right. \tag{3.7}$$
$$\left.+2\rho\sqrt{\sigma_A\sigma_B}\left[\lambda_1(1-\lambda_1)-\lambda_2(1-\lambda_2)\right]\right\}-\tau.$$

Analogously, we define the market share in equilibrium $\bar{x}^*=x(\lambda_1,\lambda_2)$ in accordance with (3.6). For the subsequent analysis of the banks' subgame perfect diversification decisions we substitute the equilibrium interest rate $r_i(\lambda_1,\lambda_2)=r_i^*$ as well as the equilibrium market share $\bar{x}^*=x(\lambda_1,\lambda_2)$ into the profit functions.

3.2 Stage I: Portfolio choice

For a given portfolio diversification choice of bank 2, λ_2, bank 1 makes its diversification decision, λ_1, to maximize

$$\pi_1(\lambda_1,\lambda_2)=x(\lambda_1,\lambda_2)\left[\lambda_1\alpha+(1-\lambda_1)\beta-r_1(\lambda_1,\lambda_2)\right]-c\lambda_1(1-\lambda_1). \tag{3.8}$$

Similarly, for a given portfolio diversification choice of bank 1, λ_1, bank 2 chooses λ_2 to maximize

$$\pi_2(\lambda_1,\lambda_2)=[1-x(\lambda_1,\lambda_2)]\left[\lambda_2\alpha+(1-\lambda_2)\beta-r_2(\lambda_1,\lambda_2)\right]-c\lambda_2(1-\lambda_2) \tag{3.9}$$

As is typically the case in two-stage models of horizontal differentiation, it is analytically intractable to present closed-form characterizations of the subgame perfect diversification equilibrium. Nevertheless, we are able to acquire important insights from allowing a slight relaxation of our research task.

3.2.1 Symmetric diversification equilibrium

Initially, we will restrict our analysis to symmetric subgame perfect diversification equilibria ($\lambda = \lambda_1 = \lambda_2$). A necessary condition[2] for such an equilibrium to exist is $\sigma_A+\sigma_B-\gamma\rho\sqrt{\sigma_A\sigma_B}-3c>0$, which means that the monitoring cost must not exceed a certain level compared with the risk of the two assets. Then, if a symmetric equilibrium, where both firms diversify their asset portfolios by choosing to invest in both projects, exists, it has to satisfy

$$\lambda=\frac{\beta-\alpha+3c+\gamma(\rho\sqrt{\sigma_A\sigma_B}-\sigma_B)}{6c+\gamma(2\rho\sqrt{\sigma_A\sigma_B}-\sigma_A-\sigma_B)}. \tag{3.10}$$

Differentiating (3.10) with respect to the parameter capturing the consumers' risk aversion, γ, yields

[2] This condition is required to guarantee that the portfolio proportion is feasible, i.e. $0 < \lambda < 1$.

$$\left.\frac{d\lambda}{d\gamma}\right|_{\alpha=\beta} = \frac{3c(\sigma_A - \sigma_B)}{\left[6c + \gamma(2\rho\sqrt{\sigma_A\sigma_B} - \sigma_A - \sigma_B)\right]^2}, \text{ and}$$

$$\left.\frac{d\lambda}{d\gamma}\right|_{\sigma_A=\sigma_B=\sigma} = \frac{(1-\rho)\sigma(\beta-\alpha)}{2[3c + \gamma\sigma(\rho-1)]^2}. \quad (3.11)$$

Differentiating (3.10) with respect to the monitoring cost parameter, c, yields

$$\left.\frac{d\lambda}{dc}\right|_{\alpha=\beta} = \frac{3\gamma(\sigma_B - \sigma_A)}{\left[6c + \gamma(2\rho\sqrt{\sigma_A\sigma_B} - \sigma_A - \sigma_B)\right]^2}, \text{ and}$$

$$\left.\frac{d\lambda}{dc}\right|_{\sigma_A=\sigma_B=\sigma} = \frac{3(\alpha-\beta)}{2[3c + \gamma\sigma(\rho-1)]^2}. \quad (3.12)$$

Differentiating (3.10) with respect to the correlation coefficient, ρ, between the returns of the two types of projects yields

$$\left.\frac{d\lambda}{d\rho}\right|_{\alpha=\beta} = \frac{\gamma^2\sqrt{\sigma_A\sigma_B}(\sigma_B - \sigma_A)}{\left[6c + \gamma(2\rho\sqrt{\sigma_A\sigma_B} - \sigma_A - \sigma_B)\right]^2}, \text{ and}$$

$$\left.\frac{d\lambda}{d\rho}\right|_{\sigma_A=\sigma_B=\sigma} = \frac{\gamma\sigma(\alpha-\beta)}{2[3c + \gamma\sigma(\rho-1)]^2}. \quad (3.13)$$

Finally, differentiating (3.10) with respect to the risk parameter associated with project A yields

$$\left.\frac{d\lambda}{d\sigma_A}\right|_{\substack{\alpha=\beta \\ \sigma_A=\sigma_B=\sigma}} = \frac{\gamma}{4[3c - (1-\rho)\gamma\sigma]} < 0. \quad (3.14)$$

Equations (3.10)–(3.14) describe how changes in the parameters of the model affect banks' investment portfolios.

Proposition 3. *Consider a symmetric equilibrium where the two banks both invest a strictly positive amount in each of the two types of projects A and B (i.e., $0 < \lambda = \lambda_1 = \lambda_2 < 1$). In such a symmetric equilibrium*

(a) an increase in the return on project A(B) will increase the portfolio proportion of project A(B), respectively.

(b) with equal expected return on the projects (α=β), an increase in the parameter capturing risk aversion, γ, will increase the portfolio proportion of the high risk project; that is, λ increases if $\sigma_A > \sigma_B$, and decreases if $\sigma_B > \sigma_A$. Also, given equal risk ($\sigma_A = \sigma_A$), an increase in γ will increase the portfolio

proportion of the project with the lower return; that is λ increases if $\beta > \alpha$ and decreases if $\alpha > \beta$.

(c) *given equal expected return on the projects, an increase in the monitoring cost parameter, c, will increase the portfolio proportion of the less risky project, that is, λ increases if $\sigma_B > \sigma_A$, and decreases if $\sigma_A > \sigma_B$. Also, given equal risk, an increase in c will increase the portfolio proportion of the higher return project; that is, as c increases, λ increases if $\alpha > \beta$, and decreases if $\beta > \alpha$.*

(d) *given equal expected return on the projects, an increase in the correlation coefficient, ρ, will increase the portfolio proportion of the less risky project, that is, λ increases if $\sigma_B > \sigma_A$, and decreases if $\sigma_A > \sigma_B$. Also, given equal risk, an increase in ρ will increase the portfolio proportion of the higher return project; that is, as ρ increases, λ increases if $\alpha > \beta$, and decreases if $\beta > \alpha$.*

(e) *given equal return and equal risk on both projects, an increase in the risk of one of the projects will increase the portfolio proportion of the other project, that is, λ decreases as σ_A increases.*

Part (b) of the proposition requires some explanation, since at first glance it may seem unreasonable for banks to increase their investment share of the risky asset when depositors become more risk averse. However, a closer look reveals why this is indeed the case. Given equal return, in equilibrium banks invest a majority share of their portfolios in the less risky asset. Now, with an increase in investors' degree of risk aversion, the return from diversification increases and, consequently, competition drives the banks towards more diversification. Hence, since the larger part of the banks' investment is in the less risky asset, a higher degree of diversification implies increasing the investment in the risky asset. Part (c) of the proposition has the reversed logic. When monitoring becomes more expensive, the gains from specialization increase meaning that the banks will have incentives to decrease their diversification; thereby more concentrating their investment in either the higher return asset or the asset with the lower risk. Part (d) follows from the fact that an increase in the correlation coefficient will increase the risk of a diversified portfolio, therefore will induce the bank to increase its specialization in the asset with the lower risk (or with the higher return, given equal risk).

From this characterization of the symmetric diversification equilibrium we now shift our attention from symmetric to asymmetric equilibria.

3.2.2 The generalized game: Allowing for asymmetric equilibria

We now solve for the equilibrium portfolio selection allowing for asymmetric equilibria, that is, equilibria where it is possible that banks choose to diversify their portfolios to a different degree. For reasons of tractability, and in order to highlight how asymmetric diversification equilibria may emerge in an otherwise symmetric setting, we simplify the model by assuming that the two available investment projects bear the same risk and the same expected return. Formally, we let $\beta = \alpha$ and $\sigma_A = \sigma_B = \sigma$. Also, given the possibility of multiple equilibria, we restrict the diversification choice of each bank to $\lambda_i \in \{0, 1/2, 1\}$, $i = 1, 2$. This means that each bank has to choose among three possible investment portfolios:

project A only ($\lambda_i = 1$), project B only ($\lambda_i = 0$), or the fully diversified loan portfolio with equal weights on the two projects ($\lambda_i = ½$).

Throughout our analysis we assume that $2\tau \geq c$. Table 1 exhibits the profit of each bank for all the four[3] possible combinations of portfolio choices, constructed by substituting the available portfolio shares into the banks' profit functions (3.8) and (3.9).

Table 1. **The banks' profit levels (π_1, π_2) as functions of their decisions (λ_1, λ_2) whether to specialize or diversify their loan portfolios**

	$\lambda_2 = 0$ or $\lambda_2 = 1$	$\lambda_2 = ½$
$\lambda_1 \in \{0, 1\}$	$\frac{\tau}{2}$; $\frac{\tau}{2}$	$\frac{[\gamma\sigma(\rho-1)+12\tau]^2}{288\tau}$; $\frac{[\gamma\sigma(\rho-1)+12\tau]^2}{288\tau} - \frac{c}{4}$
$\lambda_1 = ½$	$\frac{[\gamma\sigma(\rho-1)+12\tau]^2}{288\tau} - \frac{c}{4}$; $\frac{[\gamma\sigma(\rho-1)+12\tau]^2}{288\tau}$	$\frac{\tau}{2} - \frac{c}{4}$; $\frac{\tau}{2} - \frac{c}{4}$

Our equilibrium concept with respect to the portfolio decisions is the simple Nash equilibrium with respect to the strategic interaction exhibited in Table 1.

DEFINITION 1.

(a) We say that a pair of investment weights $(\lambda_1^*,\ \lambda_2^*) \in \{0,1/2,1\} \times \{0,1/2,1\}$ *consitutes a* ***portfolio equilibrium*** *if for each bank i = 1, 2* ($i \neq j$) *it holds that* $\pi_i(\lambda_i^*, \lambda_j^*) \geq \pi_i(\lambda_i, \lambda_j^*)$ *for all* $\lambda_i \in \{0,1/2,1\}$.

(b) We say that a portfolio equilibrium exhibits ***pure diversification*** *if both banks diversify their portfolios, that is,* $\lambda_1^* = \lambda_2^* = 1/2$.

(c) We say that a portfolio equilibrium exhibits ***pure specialization*** *if neither bank diversifies its portfolio, that is,* $\lambda_1^* \neq 1/2 \neq \lambda_2^*$.

(d) We say that a portfolio equilibrium is ***mixed*** *if one bank diversifies and the other specializes, that is, either* $\lambda_1^* = 1/2$ *and* $\lambda_2^* \neq 1/2$, *or* $\lambda_1^* \neq 1/2$ *and* $\lambda_2^* = 1/2$, *but not both.*

Table 1 reveals that a necessary condition for a pure specialization equilibrium to exist is

$$\frac{\tau}{2} \geq \frac{[\gamma\sigma(\rho-1)-12\tau]^2}{288\tau} - \frac{c}{4}, \quad \text{or} \quad \gamma\sigma \leq \frac{6\sqrt{2\tau(2\tau+c)} - 12\tau}{1-\rho}. \tag{3.15}$$

Similarly, a necessary condition for a pure diversification equilibrium to exist is

[3] Note that the symmetric return structures of the two projects means that we can capture all the possible combinations by restricting the choice of each bank to that of either diversify or specialize irrespectively of whether the bank specializes in project A or B.

$$\frac{\tau}{2}-\frac{c}{4}\geq\frac{[\gamma\sigma(\rho-1)+12\tau]^2}{288\tau},\quad\text{or}\quad\gamma\sigma\geq\frac{12\tau-6\sqrt{2\tau(2\tau-c)}}{1-\rho}.\tag{3.16}$$

Figure 2 illustrates the portfolio equilibrium outcomes as functions of $\gamma\sigma$, which is the product of the consumer's degree of risk aversion and the variance on the returns of the projects. We will refer to this product as the *risk burden*, $\Psi\equiv\gamma\sigma$, imposed on the risk averse depositor.

Figure 2. **Equilibrium portfolios as functions of project risk and risk aversion**

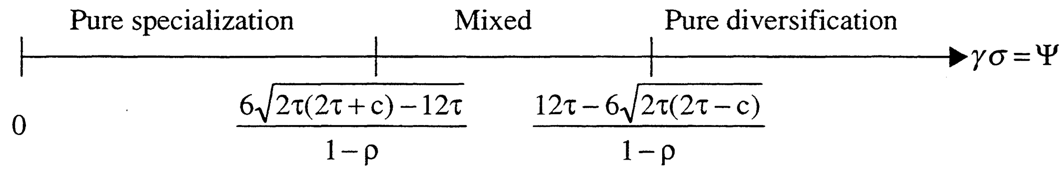


Figure 2 illustrates the following proposition.

Proposition 4.

(a) When the risk burden is high, i.e. $(1-\rho)\psi\geq 12\tau-6\sqrt{2\tau(2\tau-c)}$, *both banks diversify their portfolios. In this equilibrium risk is minimized whereas monitoring costs are maximized.*

(b) When the risk burden is low, i.e. $(1-\rho)\psi\leq 6\sqrt{2\tau(2\tau+c)}-12\tau$, *both banks specialize their investment in one project. In this equilibrium risk is mazimized whereas monitoring costs are minimized.*

(c) When the risk burden is at an intermediate level, one bank diversifies whereas the other specializes its investment. In this equilibrium one bank minizmizes risk (thereby maximizes monitoring costs) whereas the competing bank minimizes monitoring cost (thereby maximizing its portfolio's risk).

Proposition 4 highlights a main message of this paper. When consumers are sensitive to the risk taken by the bank in which they deposit their money and/or when investment projects are risky, i.e. when either γ and/or σ are high, competition for customers leads banks operating in the absence of deposit insurance to diversify their investment portfolios thereby reducing the risk of failure. Conversely, when the risk burden is low the portfolio equilibrium will be characterized by both banks exploiting the monitoring gains from specialization.

For an intermediate range of the risk burden Proposition 4 (c) shows that the nature of the portfolio equilibrium is such that competition leads banks to 'split' the market not only with respect to location, but also with respect to the risk dimension. To see this, substituting $\lambda_1 = 0$ and $\lambda_2 = ½$ into the equilibrium interest rates the of second-stage as well as into the equilibrium market shares given in (3.5) and (3.6) yield

$$r_1^*=\alpha-\tau+\frac{\psi(1-\rho)}{12}>\alpha-\tau-\frac{\psi(1-\rho)}{12}=r_2^*\quad\text{and}\quad\bar{x}^*=\frac{1}{2}-\frac{\psi(1-\rho)}{24\tau}.$$

Hence, when the risk burden is at an intermediate level, bank 1 takes a maximum risk, pays a higher interest rate and maintains a smaller market share compared with bank 2 which attracts more depositors by minimizing its risk thereby enabling it to pay a lower interest rate.

3.2.3 Institutions for joint project monitoring

In many countries creditors share information about the credit history of borrowers and such information exchange is often intermediated by, for example, credit bureaus or credit rating agencies. Government policy in many countries, in particular in Europe, has actively supported such arrangements for information exchange between lenders. This has taken place, for example, in the form of credit registers under central bank supervision. Various aspects of such information exchange between banks have been analyzed by Pagano and Jappelli (1993) or Padilla and Pagano (1997).

We now ask what are the effects on the portfolio equilibrium of allowing competing banks to form an industry-wide institution monitoring all the projects financed by the banking industry and disseminating the acquired information to all banks. We assume that the two competing banks share the costs of the monitoring taking place within the framework of the jointly operated institution on an equal basis.[4]

We restrict our attention to the environment analyzed in Section 3.2.2 and ask how interbank sharing of the monitoring costs will impact on the resulting portfolio equilibrium. Figure 2 shows that a reduction in the monitoring cost parameter, c, will increase the parameter range where pure diversification is the unique equilibrium. Thus information sharing between the banks would make the pure diversification equilibrium a more likely outcome. Hence,

Proposition 5. *Hence information sharing between the banks will increase the parameter range in which pure diversification is the unique equilibrium.*

In an extreme case, say when monitoring is provided to banks without any cost or when the number of banks would increase without bound, i.e. when $c \rightarrow 0$, pure diversification would be the unique equilibrium for any degree of the risk burden.

[4] It should be pointed out that such a hypothetical institution may facilitate collusion among banks and that it could be challenged by the regulators for antitrust reasons. Therefore, the conclusions we draw from this section may not be implementable, unless the monitoring is carried out by the regulator itself in such a way that the regulator charges the monitoring costs to the participating banks. However, we consider an analysis of this important issue to be outside the scope of the present analysis.

4 Monopoly and deposit insurance

Our main purpose in this paper is to analyze the effect of competition on banks' incentive to diversify their portfolios. Therefore, as a benchmark for comparison we now analyze how a monopoly bank diversifies its portfolio. Then, the section concludes with a short analysis on the effects of deposit insurance systems.

4.1 Monopoly bank

In order to focus exclusively on the relationship between market structure and the market-determined diversification incentives we now suppose that the two banks merge into a single bank that runs the two branches (branch 1 and branch 2) located at the two endpoints of the unit interval. We initially consider the case where the customers do not have any option to withdraw from the services offered.[5] Thus, we initially analyze the case where the banking monopoly will capture a market share consisting of all investors.

The objective function of the merged bank is that of maximizing expected profits

$$\pi_m = [\lambda\alpha + (1-\lambda)\beta - r] - c\lambda(1-\lambda)$$

by making use of the two instruments r and λ for each of the two identical branches. It can directly be seen that this profit function is convex with respect to λ and that the optimal portfolio choice will be pure specialization into industry A ($\lambda = 1$), assuming that $\alpha \geq \beta$. Furthermore, the objective function is strictly decreasing with respect to the interest rate and for that reason a monopoly bank serving all investors would decide on the deposit rate so as to make the investor located at $x = ½$ indifferent between accepting the service or not, hence paying no interest in the present case.

We can summarize our result concerning the optimal diversification of a monopoly bank in

Proposition 6. *A monopoly bank will find it optimal to choose pure specialization into the industry with higher expected return.*

The intuition behind Proposition 6 seems clear. In the absence of competition there is no need for the bank to diversify its loan portfolio and thereby sacrifice the monitoring gains from industry-specific specialization in order to attract risk averse investors.

[5] In Section 6 we explicitly make clear how this assumption affects our analysis.

4.2 Deposit insurance

So far we have restricted our attention to a banking industry operating in an unregulated environment. In an assessment of the impact of competition between banks this is a serious restriction insofar as the consequences of competition exhibit important interaction effects with the prevailing regulatory environment. In the case of deposit insurance policies these interaction effects are actually not very difficult to outline.

Clearly, governments that explicitly (or implicitly) commit themselves to guarantee bank deposits reduce the incentives of depositors and, in turn, of banks, to monitor the lending activities. In particular, the presence of a deposit insurance system will undermine the returns to banks from investing into diversification. Consequently, deposit insurance would eliminate the beneficial effects from banks competing with asset quality as a strategic instrument.

Of course, one could argue that market participants will be able to monitor banks only with public disclosure regarding the asset portfolios of banks as a necessary condition for the risk assessments[6]. Also, the deposit insurance institution could be designed with incentives to accurately evaluate the risk exposure of banks' lending portfolios. However, quite severe requirements need to be satisfied for such an institution to be able to substitute for the market discipline introduced by competition in the absence of deposit insurance. For example, the deposit insurance system has to be perfect in the sense that the banks covered are charged an insurance premium reflecting precisely the risk exposure of their asset portfolios.

5 Welfare analysis

As we have seen the introduction of deposit insurance eliminates the incentives for competing banks to diversify their lending portfolios. Consequently, a natural question to ask is whether deposit insurance is socially desirable. For this purpose, we define a criterion against which to evaluate the social consequences of introducing a deposit insurance policy.

We define total welfare as the sum of banking industry profits and consumer surplus in accordance with

$$W(\lambda_1,\lambda_2) = \pi_1(\lambda_1,\lambda_2) + \pi_2(\lambda_2,\lambda_1) + \int_0^1 U(x)dx. \tag{5.1}$$

Obviously, the interest rate payments represent a transfer between the banking industry and the depositors and this transfer will play no role from the point of view of the overall welfare evaluation. Further, since the consumers are symmetrically distributed total disutility caused by the transportation costs can be calculated as $T = 2\int_0^{1/2} \tau x dx = \frac{\tau}{4}$ as long as the banking industry serves all the

[6] For an analysis of the impact of public disclosure of banks' risk exposure on the risk taking incentives of banks we refer to Cordella and Levy Yeyati (1998).

consumers and as long as banks choose portfolios that bear identical risk. Thus, in our model the welfare implications from changes in the market structure of the banking industry or from changes in the regulatory environment are dependent on the risks incorporated in the loan portfolios of the banks. We therefore turn to compare an equilibrium with diversification with one exhibiting specialization.

We start by exploring the welfare associated with a specialization equilibrium such that the banks concentrate their lending activities into industry A. Such a specialization will generate the social welfare

$$W(0,0) = 2\alpha - \frac{\gamma\sigma}{2} - \frac{\tau}{4}. \tag{5.2}$$

A diversification equilibrium on the other hand will be associated with a total welfare of

$$W\left(\frac{1}{2},\frac{1}{2}\right) = 2\alpha - \frac{c}{2} - \frac{\gamma\sigma}{4}(1+\rho) - \frac{\tau}{4}. \tag{5.3}$$

Comparing (5.3) with (5.2) we find the following proposition to hold.

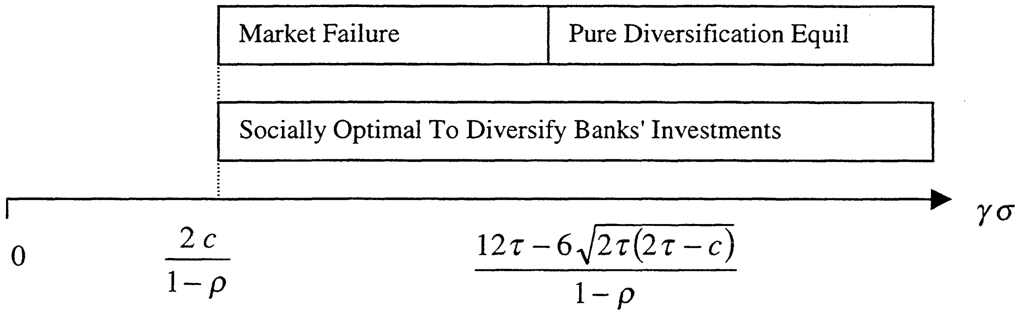
Proposition 7. *Society is better off in a pure diversification equilibrium than in a pure specialization equilibrium if and only if*

$$\Psi = \gamma\sigma > \frac{2c}{1-\rho}. \tag{5.4}$$

From Proposition 7 we can conclude that society tends to benefit from diversification when the risk burden, $\Psi = \gamma\sigma$, is high relative to the parameter capturing the monitoring costs, which serves as a measure of the gains from specialization. Furthermore, condition (5.4) states that the welfare preference for a diversification equilibrium is related to the correlation between the two available types of projects (industries). Namely, the diversification equilibrium is socially more desirable the lower is the correlation between the two available assets.

How will the diversification decisions of imperfectly competitive banks perform relative to the benchmark of social efficiency? By comparing the right hand side of (3.16) with that of (5.4) we can directly conclude that it will always be socially optimal to fully diversify the lending portfolio in all those cases when the banking duopolists would choose pure diversification. However, the strategic interaction between the competing banks will not generate the pure diversification equilibrium under all those circumstance when it would be socially justified. Thus, despite representing a welfare improvement duopoly competition will not eliminate the market failure for all such levels of the risk burden that full diversification would be socially beneficial. We illustrate this relationship between the diversification equilibrium and the social optimum in Figure 3.

Figure 3. **The relationship between pure diversification equilibrium and social optimum**



Keeping in mind that the monopoly bank would not have any incentives to diversify its asset portfolio we can make the following welfare evaluation regarding the impact of competition on diversification by the banking industry.

Proposition 8. *Introdution of competition into the banking industry can only improve social welfare. However, competition cannot always guarantee that diversification will occur under all those circumstances when it is socially optimal to diversify.*

6 Competition from outside investment opportunities

Our analysis, so far, has been conducted under the assumption that depositors do not have any saving opportunities other than those offered by the banking industry under consideration. Therefore, since depositors were assumed to have no outside saving or investment options, the analysis was conducted under the assumption that consumers do not have a reservation utility (or formally their reservation utility was assumed to be minus infinity). Consequently, so far the entire market was served.

In this section, we introduce an outside saving opportunity which yields each consumer a certain utility level, which, with no loss of generality, is normalized to equal zero. For a sufficiently high differentiation parameter, τ, consumers 'located' close to the center are not served by any of the two banks. In this case, the two banks act as local monopolies implying that a two-bank market structure generates the same outcome as a monopoly (two branch) market structure. This implies that the analysis conducted in the previous sections comparing banks' investment portfolios cannot (and should not) be repeated. Instead, we wish to ask whether the introduction of outside saving opportunities affects a monopoly bank's incentives to diversify its investment portfolio.

Not surprisingly, we demonstrate that, depending on the degree of risk burden, a monopoly bank facing the threat created by "outside" investment opportunities may or may not diversify its portfolio. Such a result is to be expected considering the fact that the introduction of a reservation utility can be interpreted as the introduction of out-of-industry competition as consumers are allowed to switch to the outside opportunity. A good example of an outside saving opportunity is the cash-management accounts introduced in the early 1980s by US brokerage firms which issued almost perfectly liquid deposit accounts which were diversfied in a wide variety of bonds whereas the consumers were provided with check books and credit cards in which they were able to make withdrawals at their convinience.

Since we analyze local monopolies, it is sufficient to concentrate the analysis on bank 1 only. Assuming that the investment projects A and B yield the same return and bear the same risk, i.e., $\alpha = \beta$ and $\sigma_A = \sigma_B = \sigma$, equation (2.1) implies that the risk of bank 1's portfolio is

$$\sigma_1 = \sigma\left[\lambda^2 + (1-\lambda)^2 + 2\rho\lambda(1-\lambda)\right],$$

where we drop the subscript 1 since only bank 1 is analyzed (due to the market segmentation bank 2 chooses an identical combination of interest rate and investment portfolio). The consumer who is indifferent between depositing in bank 1 and the outside opportunity, denoted by $\bar{x}$, is found by solving $0 = r_1 - \tau\bar{x} - \gamma\sigma_1/2$. Hence,

$$\bar{x}(\lambda, r) = \frac{2r - \gamma\sigma_1}{2\tau} = \frac{2r - \gamma\sigma\left[\lambda^2 + (1-\lambda)^2 + 2\rho\lambda(1-\lambda)\right]}{2\tau}.$$

Bank 1 chooses the diversification weight, λ, and interest rate, r, to maximize

$$\pi(\lambda, r) = (\alpha - r)\bar{x}(\lambda, r) - c\lambda(1-\lambda)$$

implying the two first order conditions given by the system of equations

$$\begin{aligned} -\bar{x} + (\alpha - r)\frac{\partial \bar{x}}{\partial r} &= -\bar{x} + \frac{\alpha - r}{\tau} = 0 \\ (\alpha - r)\frac{\partial \bar{x}}{\partial \lambda} &= (\alpha - r)\frac{\gamma\sigma(1-\rho)(1-2\lambda)}{\tau} \gtreqless c(1-2\lambda) \end{aligned} \tag{6.1}$$

Recalling that we defined $\psi \equiv \gamma\sigma$, the second condition in (6.1) implies that

$$\lambda = \begin{cases} 1/2 & \text{if } (\alpha - r)\psi \geq c \\ 0 & \text{if } (\alpha - r)\psi < c \end{cases}, \text{ hence, } \quad r = \begin{cases} \dfrac{\alpha}{2} + \dfrac{\psi(1+\rho)}{8} & \text{if } \lambda = \dfrac{1}{2} \\ \dfrac{\alpha}{2} + \dfrac{\psi}{4} & \text{if } \lambda = 0 \end{cases}. \tag{6.2}$$

Consequently, to find the profit maximizing investment weights for this monopoly, we only need to compare the profits when $\lambda = 0$ to the profit when $\lambda = ½$.

To simplify the algebra, we assume that the two investment projects are uncorrelated, that is $\rho = 0$. Hence, substituting (6.2) back into the objective function we obtain

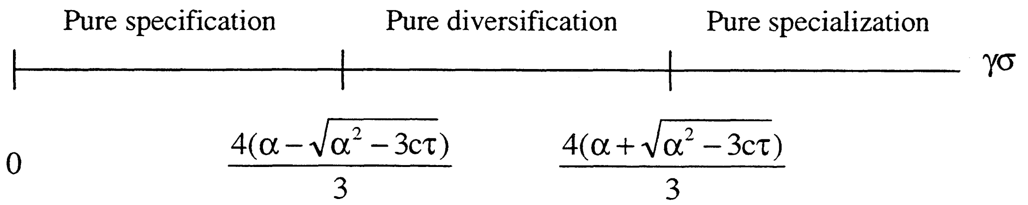
$$\pi = \begin{cases} \dfrac{16\alpha^2 - 8\alpha\psi - 16c\tau + \psi^2}{64\tau} & \text{if } \lambda = \dfrac{1}{2} \\ \dfrac{(2\alpha - \psi)^2}{16\tau} & \text{if } \lambda = 0. \end{cases} \tag{6.3}$$

Thus, the monopoly bank will diversify its portfolio ($\lambda = ½$) in the presence of an outside opportunity if and only if

$$\frac{4}{3}\left(\alpha - \sqrt{\alpha^2 - 3c\tau}\right) \le \Psi \le \frac{4}{3}\left(\alpha + \sqrt{\alpha^2 - 3c\tau}\right) \tag{6.4}$$

We illustrate the profit-maximizing diversification decision of a monopoly bank facing competition from sources outside the banking industry in Figure 4.

Figure 4. **The optimal diversification decision of a bank monopoly facing only out-of-industry competition**



We can thus summarize our findings according to

Proposition 9. *When faced with competition from investment opportunities outside of the banking industry, a monopoly bank will find it profitable to fully diversify its lending portfolio if and only if the risk burden belongs to the intermediate range determined by (6.4).*

7 Concluding comments

With only a few exceptions most countries in the world have selected to maintain a mandatory system of deposit insurance (New Zealand being one such exception). Given the distortions associated with explicit deposit insurance policies or implicit policies of the "Too Big To Fail" -type, it is impossible to infer from our observations of actual bank behavior how the banks' incentives to diversify their loan portfolios are related to the market structure of the banking industry. In particular, as our analysis has made clear, deposit insurance will prevent the economy from exploiting the social diversification gains from banks competing with the quality of their loan portfolios as a strategic instrument. For these reasons, and in light of the rapidly ongoing consolidation of the banking industry both in North America and in Europe, we feel that it is extremely important to investigate the effects of the market structure in the banking industry on the investment behavior of banks. Initially, such studies have to be carried out in the framework of banking industries operating in the absence of deposit insurance, because only such an intermediate step makes it possible to adequately address the fundamental policy issues associated with welfare evaluations of deposit insurance systems.

A major finding of our analysis consists of the demonstration of how banks competing for risk averse depositors will diversify their portfolios in the absence of deposit insurance. A trival implication of this finding is that competition in the banking industy can, at least partially, serve as a subsitute for deposit insurance, and what is important, as a substitute without the well known moral hazard-type of distortions associated with imperfect deposit insurance systems. By a partial substitute we mean that central banks will still have to maintain the role of providing the public with information concerning the riskiness incorporated in the banks' outstanding loan portfolios, or at least monitor the realiablity of the information transmitted to depositors.

Our analysis lends support for a policy of promoting competition between banks as an alternative to a policy based on deposit insurance where banks are offered no (or at most only partial) incentives to avoid risk taking. We have demonstrated that it will always be socially optimal to fully diversify the lending portfolio in all those cases when the banking duopolists would choose pure diversification. However, the strategic interaction between the competing banks will not generate the pure diversification equilibrium under all those circumstance when it would be socially justified. In particular, our result concerning the possiblity of asymmetric equilibria (see Proposition 4 (c)) highlights our vision concerning the possiblity of having socially efficient competition between banks offering differentiated services to consumers of different types. Such a competitive industry can offer a variety of differentiated risk taking with some banks representing higher risk than others, while paying higher interest rates, whereas some banks will serve as safe deposit boxes investing only in safe assets.

References

Bhattacharya, S. – Mookherjee, D. (1986) **Portfolio Choice in Research and Development.** Rand Journal of Economics, 17, 594–605.

Broecker, T. (1990) **Credit-Worthiness Tests and Interbank Competition.** Econometrica, 58, 429–452.

Caminal, R. – Matutes, C. (1997) **Can Competition in the Credit Market be Excessive?** Centre for Economic Policy Research, Discussion Paper No. 1725, October 1997.

Cerasi, V. – Daltung, S. (1996) **The Optimal Size of a Bank: Costs and Benefits of Diversification.** London School of Economics Financial Markets Group Discussion Paper No. 231.

Cordella, T. – Levy Yeyati, E. (1998) **Public Disclosure and Bank Failures.** Centre for Economic Policy Research Discussion Paper No. 1886.

Hellwig, M. (1998) **Allowing for Risk Choices in Diamond's "Financial Intermediation as Delegated Monitoring".** Mimeo, University of Mannheim.

Kanniainen, V. – Stenbacka, R. (1998) **Project Monitoring in Lending Markets with Adverse Selection.** Mimeo, Swedish School of Economics, Helsinki.

Klette, T. – de Meza, D. (1986) **Is the Market Biased against Risky R&D?** Rand Journal of Economics, 17, 133–139.

Koskela, E. – Stenbacka, R. (1998) **Is There a Tradeoff between Bank Competition and Financial Fragility?** Mimeo, University of Helsinki.

Matutes, C. – Vives, X. (1995) **Imperfect Competition, Risk-Taking, and Regulation in Banking.** Centre for Economic Policy Research, Discussion Paper No. 1177, 1995.

Matutes, C. – Vives, X. (1996) **Competition for Deposits, Fragility, and Insurance.** Journal of Financial Intermediation, 5, 184–216.

Padilla, J. – Pagano, M. (1997) **Sharing Default Information as a Borrower Discipline Device.** Mimeo.

Pagano, M. – Jappelli, T. (1993) **Information Sharing in Credit Markets.** Journal of Finance, 48, 1693–1718.

Riordan, M. (1993) **Competition and Bank Performance: A Theoretical Perspective.** In Meyer, C. and Vives, X. eds.: Capital Markets and Financial Intermediation. Cambridge: Cambridge University Press, 328–343.

Winton, A. (1997) Competition among Financial Intermediaries When Diversification Matters. Journal of Financial Intermediation, 6, 307–346.

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