BANK OF FINLAND
DISCUSSION PAPERS

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Juha-Pekka Niinimäki

Research Department
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The Effects of Competition on Banks' Risk Taking with and without Deposit Insurance

SUOMEN PANKIN KESKUSTELUALOITTEITA • FINLANDS BANKS DISKUSSIONSUNDERLAG

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I am indebted to Juha Tarkka, Jouko Vilmunen and Matti Virén for several valuable comments and suggestions. I would also like to thank participants in seminar at the research department of the Bank of Finland for useful comments. Financial support from Yrjö Jahnsson Foundation and the Jenny and Antti Wihuri Foundation is gratefully acknowledged.

ISBN 951-686-691-3
ISSN 0785-3572
(print)

ISBN 951-686-692-1
ISSN 1456-6184
(online)

Suomen Pankin monistuskeskus
Helsinki 2000

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Abstract

We consider the joint effect of competition and deposit insurance on risk taking by banks when the riskiness of banks is unobservable to depositors. It turns out that the magnitude of risk taking depends on the type of bank competition. If the bank is a monopoly or banks compete only in the loan market, deposit insurance has no effect on risk taking. In that case the banks are too risky but extreme risk taking is avoided. In contrast, introducing deposit insurance increases risk taking if banks compete for deposits. Then, deposit rates become excessively high and force the banks to take extreme risks. Regarding the effects of increasing competition when there is deposit insurance, the results imply that deposit competition encourages risk taking but loan market competition does not. Our results can be extended more generally to insurance guaranty funds

Key words: Deposit insurance, Insurance guaranty funds, Bank and insurance regulation, Moral hazard, Credit rationing, Financial Fragility

JEL classification: G21, G22, G28

Pankkikilpailun ja talletusvakuutuksen yhteisvaikutus pankkien riskinottoon

Suomen Pankin keskustelualoitteita 21/2000

Juha-Pekka Niinimäki
Tutkimusosasto

Tiivistelmä

Tutkimuksessa tarkastellaan kilpailun ja talletusvakuutuksen vaikutuksia pankkien riskinottoon, kun tallettajat eivät kykene havaitsemaan pankkien riskejä. Osoittautuu, että riskinoton laajuus riippuu kilpailutilanteesta. Jos pankilla on monopoliasema tai pankit kilpailevat luottoasiakkaista, talletusvakuutus ei vaikuta riskinottoon – pankit ottavat liikaa riskejä, mutta välttävät äärimmäistä riskinottoa. Jos pankit kilpailevat talletuksista, talletusvakuutusjärjestelmä lisää riskinottoa, koska korkeat talletuskorot pakottavat pankit sjoittamaan äärimmäisen suurituottoisiin – ja riskialttiisiin – kohteisiin. Jos talletukset ovat vakuutettuja, kilpailuasetelman muutokset vaikuttavat riskinoton laajuuteen: talletuskilpailun kiristyminen lisää riskinottoa, mutta luottomarkkinakilpailun lisääntymisellä ei ole vaikutusta. Tulokset ovat yleistettävissä vakuutuslaitosten takuurahastoihin.

Asiasanat: talletusvakuutus, vakuutuslaitosten takuurahastot, pankki- ja vakuutustoiminnan sääntely, luotonsäännöstely

JEL-luokitus: G21, G22, G28

Contents

1 Introduction

Deposit insurance usefully prevents bank runs (e.g. Diamond & Dybvig 1983) and improves risk sharing (e.g. Park 1996). Unfortunately, it may also generate an asset substitution moral hazard problem. Viewing deposit insurance as a put option, Merton (1977) shows that deposit insurance encourages a bank to take excessive risks: if risky loans succeed a bank earns high profits whereas as in the reserve case the insurer bears the costs of risk taking.[1] John et al. (1991), however, show that the same risk taking incentives exist even without deposit insurance when bank risk is unobservable to depositors. The risk-taking problem is fundamentally attributable to the convexity of the levered equity payoff from the limited liability option that exists in full force in a deposit market even without deposit insurance.[2] In our paper, we extend their analysis by showing that deposit insurance may increase risk taking even when bank risk is unobservable if the banks compete for deposits. In the absence of deposit insurance, a credit rationing equilibrium occurs (see Stiglitz & Weiss 1981).[3] Uninformed depositors rationally anticipate that bank's risk taking is increasing in deposit interest rate. This increase of risk may be so extensive that depositors' expected return drop by the rise in the deposit rate. Hence, depositors optimally avoid banks that offer suspiciously high interest on deposits. In contrast, with deposit insurance depositors optimally accept only the highest interest offers. Consequently, deposit insurance may drive up deposit rates increasing risk taking even when bank risk is unobservable.

The magnitude of the moral hazard problem associated with deposit insurance crucially depends on the type of bank competition. When a bank is a monopoly (or bank competition takes place in loan markets), risk taking is socially excessive but the most risky assets are avoided. Even if the extreme assets yield a very high success output, their success probability is so small that the bank (the entrepreneur) earns a higher expected profit by choosing safer assets. When the banks compete for deposits, the funds are invested in the most risky assets available. Depositors optimally favour extreme risk taking since they receive the

[1] Empirical evidence mostly supports the moral hazard hypothesis. Evidence on both moral hazard and adverse selection is found by Calomiris (1989) on voluntary deposit insurance schemes in 1800s and by Wheelock & Kumbhakar (1995) on such systems in Kansas during 1909–1929. Grossman (1992) finds that the creation of the Federal Deposit Insurance System in 1934 increased risk taking. Hovakmian & Kane (2000) present evidence on excessive risk taking by U.S. commercial banks during 1985 to 1994. Keeley (1990) and Brewer (1995) also present evidence on moral hazard, but Karels & McClatchey (1999) find no such evidence within the credit union industry.

[2] John et al. (1991) suggest that risk taking could be prevented by adopting a tax system in which a higher tax rate is imposed on high levels of profits compared to the tax rate on low level of profits. Alternatively, risk taking could be prevented by collecting the insurance premium in the form of upfront fee plus a specified number of warrants. In their another paper, John et al. (1994), they examine how bank risk is effected by bank's equity ownership. Interestingly, the efficiency of borrowers' investments may increase and the bank risk decrease with increased equity ownership.

[3] In the Stiglitz & Weiss (1981), a credit rationing equilibrium occurs in a loan market. Banks understand that the interest rate a bank charges may itself affect the riskness of the pool of loans by either sorting potential borrowers (the adverse selection effect) or by affecting the actions of borrowers (the incentive effect). As the loan interest rate rises, the riskness of those who borrow increases, possibly lowering the bank's profits. Hence, there exist an interest rate which maximizes the expected returns to a bank. Clementz (1986), Clementz & Ritthaler (1992) and Jaffee & Stiglitz (1990) survey the literature of credit rationing.

same payment whether the assets succeed or not. If assets succeed, the bank can pay very high interest on deposits, whereas in the reserve case the bank fails and the insurer pays an equal indemnity to fully insured depositors. Competition for deposits may thus drive the bank sector into instability.[4]

Variety of theoretical models have been put forth to examine deposit insurance, bank competition and financial fragility. In Chan et al. (1992), Keeley (1991) and Hyytinen & Takalo (2000), bank's market power generates high future profits that may restrict risk taking today. Matutes & Vives (1996) focus on the economics of scale: a bank perceived to be safer obtains a higher margin and a larger market share, which tends to make the bank yet safer. Deposit insurance improves welfare by preventing systematic confidence crises and extending the deposit market, but it may also increase competition for deposits and bank failures. In contrast to our setting their bank cannot influence on the risk of its assets and bank risk is assumed to be observable to depositors. Matutes & Vives (2000) present a comprehensive model of imperfect bank competition with social bank failure costs. They find that in all market configurations (insured and uninsured) may yield too high deposit rates when social failure costs are high. Maximal risk-taking incentives occur with flat premium deposit insurance, and minimal incentives occur with risk-based insurance. Gorton & Rosen (1995) present a possibility that moral hazard associated with deposit insurance is not the most important reason for multiplied bank failures. They argue that a bank manager may keep their jobs only if a bank is profitable. In an 'unhealthy' banking industry the managers may obtain profits only by taking excessive risks.[5]

In the insurance theory, e.g. Holmström (1979), Shavell (1979), moral hazard problem is traditionally reduced by limiting insurance coverage. We show that partial coverage may be useful also in the context of deposit insurance, if bank competition takes place in deposit market. In contrast, it is useless if banks compete for borrowers or the bank is a monopoly.

Section 2 characterizes an economic environment. In the next sections, risk taking problem is analyzed in three extreme competition alternatives: first, a bank is a monopoly (section 3), then several banks compete for borrowers (section 4), and finally the banks compete for deposits (section 5). Regulatory implications for both bank sector and insurance industry are discussed in section 6.

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[4] Insurance guaranty funds – which ex post pool the resources of solvent insurers to pay covered claims against an insolvent insurer – create the very same moral hazard problem as deposit insurance. For example, Bohn & Hall (1997) and Lee et al. (1997) find evidence of moral hazard in insurance guaranty funds. Our results can be generalized to these funds.

[5] In the banking literature, several methods to restrict the moral hazard problem has been suggested: for example, capital requirements (e.g. Rochet 1992), risk-based deposit insurance premiums (Pennacchi 1987, Chan et al. 1992, Nagarajan & Sealey 1998, Matutes & Vives 2000), deposit rate regulation (Chan & Mak 1985, Matutes & Vives 2000), direct lending restrictions (Chan & Mak 1985, Matutes & Vives 2000), warrants and taxes (John et al. 1991), optimal bank closure policy (Mailath & Mester 1994) and bank transparency/market discipline (e.g. Berlin et al. 1991, Hyytinen & Takalo 2000). Berlin et al. (1991) and Bhattacharya et al. (1998) survey this literature. Garcia (1999) reviews the characteristics of explicit systems of deposit insurance in 68 countries.

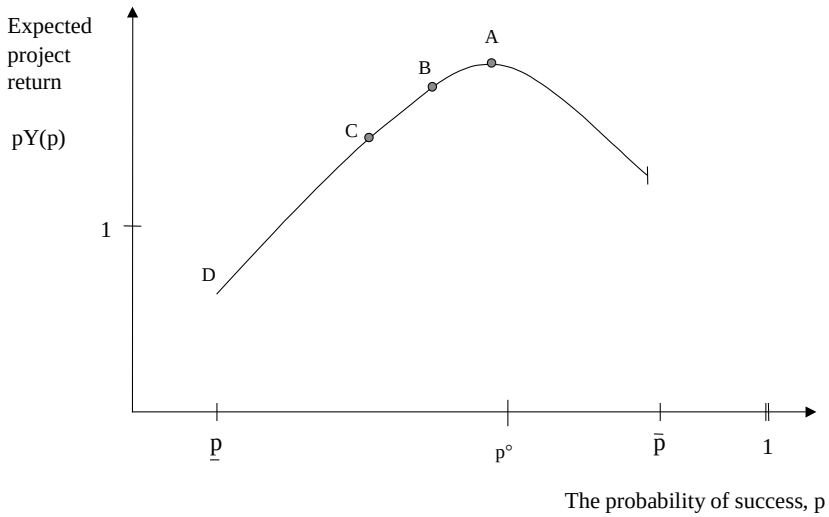
2 The economic environment

The economy consists of four groups of agents, namely depositors, banks, entrepreneurs and a deposit insurer.[6] *Entrepreneurs* are risk-neutral and have alternative investment projects. Each project lasts for a period, requires one unit of investment and yields output Y(p) with probability p, $p \in [\underline{p}, \bar{p}]$, and no output otherwise. It is assumed that Y'(p) < 0 and that pY(p) is concave in p with a unique optimal value p°, $\underline{p} < p° < \bar{p}$. This socially optimal project choice satisfies

$$\left.\frac{d[pY(p)]}{dp}\right|_{p=p°} = 0, \tag{2.1}$$

and it is always achieved when bank risk is observable and deposits are uninsured.

Figure 1. **The risk-return function**



Point A: The optimal risk of the society
Point B: The chosen risk level when a bank is a monopoly or banks compete for borrowers with or without deposit insurance.
Point C: The chosen risk level in the absence of deposit insurance when the banks compete for deposits.
Point D: The chosen risk level when deposits are insured and banks compete for deposits.

The risk-return function.
1) Deposit insurance does not effect on risk taking when a bank is a monopoly or banks compete for borrowers (point B).
2) Deposit insurance increases risk taking when banks compete for deposits (a move from Point C to Point D).

[6] Even if we have attempted to follow the assumptions of John et al. (1991), some changes have been made to simplify the analysis. For example, we utilize a different risk-return function, which is rather similar than in Stiglitz & Weiss (1981) and Chan et al. (1992).

An entrepreneur has no wealth of his own and he must search credit for his project. Banks are willing to finance the project at a loan interest R. Thus, an entrepreneur earns expected return

$$\pi_E = p[Y(p) - R], \quad \pi_E \geq 0. \tag{2.2}$$

A bank is risk neutral and it has no equity. It grants loans at an interest rate R and pays interest r on deposits. A bank raises enough deposits to cover both the insurance premium $\alpha\phi$ and the needs of the project 1, $1+\alpha\phi$ in total.[7] The bank's expected profit is

$$\pi_B = p[R - r(1+\alpha\phi)], \quad \pi_B \geq 0. \tag{2.3}$$

Notice that the bank's loan returns are perfectly correlated.[8] The bank is assumed to be able to monitor entrepreneurs' project choices.

A deposit insurer, a risk neutral agent of the government, collects an insurance premium $\alpha\phi$ at the beginning of the period (The full insurance premium is denoted by ϕ. The insurer selects coverage α, $0 \leq \alpha \leq 1$. When $\alpha = 1$ deposits are fully insured and when $\alpha = 0$ there is no insurance). At the end of the period he indemnifies a fraction α of deposits if the bank fails. The chosen project risk and the project outputs are unobservable to the insurer, who can only observe whether the projects succeed or not. The insurer, however, anticipates risk taking correctly and charges such a premium that expected indemnities to depositors can be covered, $\alpha\phi = \alpha(1-p)(1+\alpha\phi)r$, from which a zero profit insurance premium can be solved

$$\phi = \frac{(1-p^*)r}{1-\alpha(1-p^*)r}. \tag{2.4}$$

Here the anticipated success probability is denoted by p*. Given (2.4), we can rewrite $r(1+\alpha\phi)$ in the more useful form as

$$\frac{r}{1-\alpha(1-p)r}. \tag{2.5}$$

As in John et al. (1991), *depositors* are assumed to be risk neutral. They save in a bank, which pays interest r on deposit with probability p and fails with probability 1 – p. In the latter case the insurer pays an indemnity αr to depositors. Depositors are unable to observe the bank risk but they anticipate the future risk correctly, p*. Hence, depositors' expected utility is

[7] This assumption is similar to John et al. (1991), when their bank has no equity. The formulation is almost identical, if the banks form a mutual deposit insurance system, in which solvent banks ex post cover the deposit claims against insolvent members.

[8] Perfect correlation is bank's optimal choice. Besides, sectorally and geographically specialized loan portfolios or macroeconomic shocks may make the project returns correlated. The assumption of perfect correlation is rather standard in bank regulation models, e.g. John et al. (1991), Chan et al. (1992) and Mailath & Mester (1994).

$$U(r, p^*) = p^* r + \alpha(1 - p^*)r. \tag{2.6}$$

The risk-free interest of the economy, 1, determines depositors' reservation utility. The following assumption ensures a bank formation in our setting.

Assumption 1. *The bank can pay such interest on deposits that depositors obtain their reservation utility. The lowest sufficient deposit rate is denoted by r*, U(r*,p*)=1.*

In summary, the time line is the following.

1. The deposit insurer announces a deposit insurance policy (premium, coverage).
2. Banks set deposit rates and raise deposits.
3. Banks pay insurance premiums.
4. Banks grant loans to borrowers.
5. At the end of the period project returns come true. If a bank succeeds, it can pay interest on deposits and the rest of the returns are devided by bank's shareholders. If the bank fails, its shareholders do not get anything. The insurer indemnifies a respecified fraction of deposits.

3 A monopoly bank

In this section we present the results of John et al. (1991) in our framework: deposit insurance has no effect on risk taking.

A bank has market power both in deposit and loan markets. In the deposit markets, it pushes deposit interest rate down to the minimum level r* such that depositors obtain their reservation utility, U(r*, p*) = 1. In the loan markets, it raises loan interest to the upper limit, R = Y(p). Hence, the bank maximizes its expected profits subject to the depositors' and entrepreneurs' participation constraints. Given R = Y(p) and r = r*, bank's expected profit (2.3) can be rewritten as

$$\pi_B = p[Y(p) - r^*(1 + \alpha\phi)]. \tag{3.1}$$

Notice that since the insurer and depositors are unable to observe bank risk, both the deposit rate and the insurance premium are independent of the risk. Because the bank can completely control entrepreneurs, it will choose the risk that maximizes its expected profits. The bank chooses the probability of success so that

$$\frac{d}{dp}[pY(p)] = r^*(1 + \alpha\phi), \tag{3.2}$$

which is satisfied when p = p*: the choice corresponds with anticipations. Since the right hand-side of (3.2) exceeds zero, the choice is socially too risky, p* < p°. Given U(r*, p*) = 1, deposit rate can solved from (2.6) as

$$r^* = \frac{1}{p^* + \alpha(1 - p^*)}.$$

By inserting this deposit rate into (2.5) we obtain $r^*(1+\alpha\phi) = 1/p^*$. Now bank's optimal risk choice (3.2) can be rewritten as

$$\frac{d}{dp}\left[pY(p)\right] = \frac{1}{p^*}. \tag{3.3}$$

Thus, the chosen project risk is independent of deposit insurance coverage, α, as in John et al. (1991). Let us examine two extreme cases in more detail.

– When deposits are fully insured: $\alpha = 1$, $r^* = 1$ and $\phi = (1-p^*)/p^*$. We see that $r^*(1+\alpha\phi) = (1 + (1-p^*)/p^*) = 1/p^*$. Since deposits are insured, deposit interest rate is independent of the bank risk. Hence, the bank can increase project risk – and the success output of the project – without a rise in the deposit rate. This makes risk taking profitable: if risky projects succeed, the bank earns high lending returns, while in the reserve case the bank fails and the insurer bears the costs of risk taking. Risk taking could be avoided by adopting risk based insurance premiums if the insurer observed bank risk.
– When no deposit insurance exist: $\alpha = 0$, $r^* = 1/p^*$ and $r^*(1+\alpha\phi) = 1/p^*$. Since bank risk is unobservable to depositors, deposit rate is independent of the bank risk even in the absence of deposit insurance. Hence, the bank can again increase project risk without a rise in the deposit rate. If risky projects succeed, the bank earns high returns, whereas in the reserve case the bank fails and depositors bear the costs of risk taking. Market discipline would prevent risk taking if depositors observed bank risk.

This section can be summarized as follows.

Proposition 1. *A monopoly bank takes too much risk, but avoids extreme risk taking. Under monopoly, deposit insurance has no effect on risk taking.*

4 Competition for borrowers

In this section we show that when bank competition takes place in loan markets deposit insurance has no effect on risk taking.

There exist several banks having market power in deposit markets but not in loan markets. The banks pay the minimum interest r^* on deposits such that depositors are pushed down to their reservation utility level, $U(r^*, p^*) = 1$. Competition in a loan market decreases loan interest to $R = r^*(1+\alpha\phi)$ so that banks earn zero profits. Hence, entrepreneurs' expected earnings (2.2) are now maximized subject to the depositors' and banks' participation constraints. Given the loan interest $R = r^*(1+\alpha\phi)$, the entrepreneur's expected earnings (2.2) can be rewritten as

$$\pi_E = p\left[Y(p) - r^*(1+\alpha\phi)\right],$$

which is exactly the same as the monopoly bank's expected profit (3.1), and thus (3.3) shows the entrepreneurs' optimal project choice. The chosen projects are again socially too risky and the magnitude of excessive risk taking is the same as when the bank is a monopoly. The project choices are not effected by deposit insurance. Let us again examine both extreme cases in more detail.

– When deposits are insured, deposit rate is independent of the bank risk. Since banks compete for borrowers, this benefit transfers through the bank system to borrowers: loan interest rate is independent of the project risk. The fixed loan interest encourages entrepreneurs to take risks. If risky projects succeed, entrepreneurs earn high returns. If projects are unsuccessful, entrepreneurs cannot repay their loans, the banks suffer from credit losses and fail. The deposit insurer then bears the costs of risk taking.
– The case is very similar when deposit are uninsured. Now deposit rate is independent of the bank risk, since the risk is unobservable to depositors. Moreover, when the bank fails the cost of risk taking are bore by depositors.

We can summarize our findings as follows:

Proposition 2. *When banks compete only for borrowers, the chosen projects are too risky, but extreme risk taking is avoided. In this case, deposit insurance has no effect on risk taking.*

5 Competition for deposits

In this section we show that deposit insurance increases risk taking when banks compete for deposits.

There exist several banks having market power in loan markets but not in deposit markets. The banks can raise the loan interest to the borrowers' zero profit level, R = Y(p). Since the banks compete for deposits, depositors' expected utility is maximized subject to the *bank's participation constrain* (2.3), $p[Y(p) - r(1+\alpha\phi)] \geq 0$, and *bank's incentive constraint* (3.2),

$$\frac{d}{dp}\left[pY(p)\right] - r(1+\alpha\phi) \leq 0, \tag{5.1}$$

which can be rewritten as

$$p\left[Y(p) - r(1+\alpha\phi)\right] + p^2 Y'(p) \leq 0. \tag{5.2}$$

That is, the incentive constraint (5.2) can be obtained by summing the participation constraint and $p^2Y'(p) < 0$. It is easy to see that when the intensive constraint is binding, the participation constraint cannot bind. In contrast, when the participation constraint is binding, the incentive constraint cannot bind. The bank optimally attempts to choose such a probability of success that the incentive constraint is binding: when a deposit rate rises, the bank decreases the probability

of success. However, since the probability of success has a lower limit $\underline{p}$, the incentive constraint cannot bind when the deposit rate is very high. Let us denote by $\hat{r}$ the highest deposit rate by which the incentive constraint is still binding, that is

$$\underline{p}\left[Y(\underline{p}) - \hat{r}(1+\alpha\phi)\right] + \underline{p}^2 Y'(\underline{p}) = 0. \tag{5.3}$$

Thus, the incentive constraint binds when $1 \le r \le \hat{r}$ and it does not bind when $r > \hat{r}$.

Lemma 1. *When $1 \le r \le \hat{r}$, depositors' expected utility is maximized subject to the banks' incentive constraint, since bank's participation constraint is not binding. When $r > \hat{r}$, depositors' expected utility is maximized subject to the participation constraint, since the incentive constraint is not binding. In this case, the probability of success is at the minimum level, $\underline{p}$.*

Let us study the case $1 \le r \le \hat{r}$; depositors' utility is maximized subject to the bank's incentive constraint. We see from the binding incentive constraint, how the probability of success changes when deposit rate increases

$$\frac{dp(r)}{dr} = (1+\alpha\phi)\left\{\frac{d^2\left[pY(p)\right]}{dp^2}\right\}^{-1} < 0. \tag{5.4}$$

Because pY(p) is concave, dp/dr is negative: when deposit rate rises, the bank increases risk taking and its probability of success decreases. This is realized by depositors who maximize their expected utility (2.6),

$$U(r, p(r)) = p(r)r + \alpha(1 - p(r))r. \tag{5.5}$$

The deposit rate that maximizes depositors' expected utility satisfies

$$\frac{dU(r,p(r))}{dr} = \alpha + (1-\alpha)\left[p + r\frac{dp}{dr}\right] = 0, \quad 1 \le r \le \hat{r}, \tag{5.6}$$

in which dp/dr is solved in (5.4). Next we will examine three cases in more detail: no deposit insurance, full deposit insurance and partial insurance coverage.

5.1 No deposit insurance – rationing equilibrium

When $\alpha = 0$, the optimal deposit rate (5.6) satisfies

$$\frac{dU(r,p(r))}{dr} = p + r\frac{dp}{dr} = 0, \quad 1 \le r \le \hat{r}. \tag{5.7}$$

The first term is positive and it shows that depositors' income increases when the bank is successful. The second term is negative and it shows that depositors' income decreases due to the lowered probability of success. Let us study the conditions such that the optimal deposit rate in (5.7) exist. If $p + r\, dp/dr$ was positive everywhere, depositors would favour maximal deposit rate and maximal risk taking. Even possible, this alternative contradicts a common assumption of deposit insurance models that the most risky assets of the economy are socially unproductive.

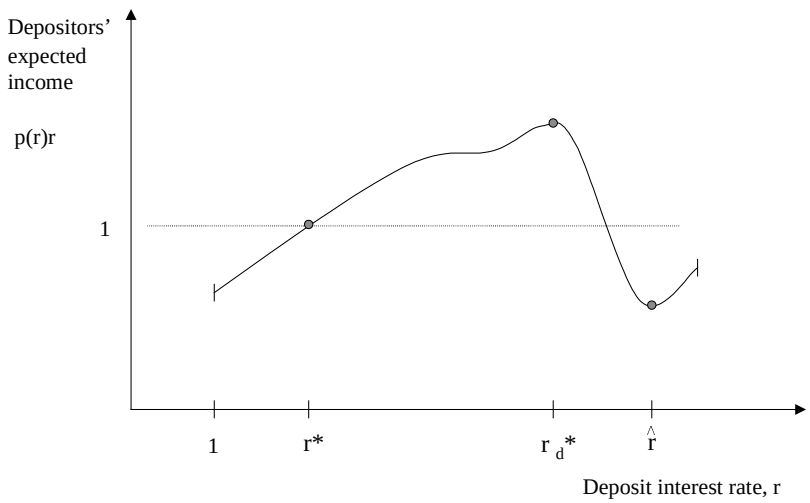
Assumption 2. *$\underline{p}Y(\underline{p}) < 1$, the most risky assets of the economy have negative NPV.*

This assumption ensures that the depositors will never raise deposit rate to the level $\hat{r}$, which provides negative expected income to them, $\underline{p}\hat{r} < \underline{p}Y(\underline{p}) < 1$. Let us denote by r_d^* the deposit interest rate which maximizes depositors' expected income. Given assumption 2, we know that $r_d^* < \hat{r}$. In contrast, if $p + r\, dp/dr$ was negative everywhere, depositors would wish to minimize the deposit rate, $r = 1$. However, when $r = 1$, a bank fails with a positive probability, $p^*(1) < 1$, and depositors' expected income is negative.

Lemma 2. *On the lower limit, r = 1, a deposit contract has a negative NPV.*

Therefore, $r = 1$ cannot be optimal. Given Assumption 1, the lowest deposit rate that provides the reservation level of utility to depositors is r^*. Hence, we know that $1 < r^* \leq r_d^*$. Lemma 2 and Assumptions 1, 2 ensure that an interior solution is optimal. That is, there exist a deposit rate r_d^*, $r^* \leq r_d^* < \hat{r}$, which satisfies (5.7) and maximizes depositors' expected utility.

Figure 2. **Rationing**



There exists a deposit interest rate which maximizes the expected return to depositors.

Consequently, a deposit market is characterized by rationing. As the deposit interest rate rises, banks undertake riskier projects. Hence, depositors' expected income increases less rapidly than deposit rate; and beyond a point, actually decreases. Deposit rate r_d^* maximizes depositors' expected income and no depositor will ever save in a bank which offers higher interest on deposits since such a bank would be too risky. Given $r^* < r_d^* < \hat{r}$, it is easy to see from (5.1) that banks invest in too risky projects but extreme risk taking is avoided.

Proposition 3. *When banks compete for deposits, but there is no deposit insurance, a rationing equilibrium occurs: the expected return to depositors decreases as the deposit rate increases over the optimal rate* r_d^*. *The banks are too risky, but extreme risk taking is avoided.*

5.2 Full deposit insurance – extreme risk taking

When $\alpha = 1$, the optimal deposit rate (5.6) satisfies

$$\frac{dU}{dr} = 1. \quad 1 \le r \le \hat{r}. \tag{5.8}$$

Hence, the optimal deposit rate exceeds $\hat{r}$ and the incentive constraint is not binding. Given Lemma 1, depositors' expected utility will be maximized subject to the bank's participation constraint, in which the probability of success is at the lower limit, $\underline{p}$. Depositors' utility is maximized by raising the deposit rate to the upper limit, $r = Y(\underline{p})/(1+\alpha\phi)$, so that each bank earns zero profits.

Proposition 4. *Under deposit insurance, depositors choose a bank that offers the highest interest on deposits. Banks invest in extremely risky projects.*

Recall that without deposit insurance a rationing equilibrium occurs. Depositors' expected income increases less rapidly than deposit rate; and beyond the point actually decreases. Deposit insurance removes the rationing equilibrium: now depositors' expected income increases in proportionally to the deposit rate. This excites competition for deposits since depositors optimally accept only the highest interest offers.

Notice that a monopoly bank benefits from deposit insurance through a risk-free deposit rate. The bank does not maximize its risk, since it gains by the risk-free deposit rate only when risky projects succeed. If the banks compete for borrowers, the case is almost identical. If the competition takes place in the deposit market, it drives deposit rates up so that depositors receive high deposit payments when the bank is successful. However, since deposits are fully insured, depositors receive the very same payment from the insurer when the bank fails. Hence, by rising the deposit rate a bank increases depositors' income whether the bank succeeds or not. This makes risk taking very attractive to depositors. If the bank didn't offer maximal interest on deposits, it could not raise deposits either.

Competition for deposits thus drives up deposit rates and forces the banks to take extreme risks.

However, if the most risky assets have negative NPV and if the deposit insurance is fairly priced, no bank is formed. A high deposit insurance payment makes bank formation unprofitable. Hence, banks will be formed only if the deposit insurance fund is subsidized by government or if Assumption 2 is replaced by such an assumption that the most risky assets produce low, positive returns.

5.3 Partial insurance reduces risk taking

In this section we will show that the insurer can reduce risk taking by limiting insurance coverage.

First we will show that deposit rate is increasing in insurance coverage. Recall from (5.6) that the optimal deposit rate satisfies

$$\frac{dU(r,p(r))}{dr} = \alpha + (1-\alpha)\left[p + r\frac{dp}{dr}\right] = 0, \quad 1 \le r \le \hat{r}, \tag{5.6}$$

when the coverage is small enough. It is sufficient to show that deposit rate raises in this optimal point, when the coverage is extended. We see from (5.6) how deposit rate changes when the insurance coverage is extended

$$\frac{dr}{d\alpha} = -\frac{1-\left[p + r\frac{dp}{dr}\right]}{(1-\alpha)\frac{d}{dr}\left[p + r\frac{dp}{dr}\right]}. \tag{5.9}$$

It is possible to rewrite the denumerator as

$$1-\left[p + r\frac{dp}{dr}\right] = \frac{1}{1-\alpha}\left\{1-\left[\alpha + (1-\alpha)\left(p + r\frac{dp}{dr}\right)\right]\right\} = \frac{1}{1-\alpha} > 0. \tag{5.10}$$

Hence, the denumerator of (5.9) is certainly positive. The second order condition of (5.6) must be satisfied, that is

$$\frac{d}{dr}\left[p + r\frac{dp}{dr}\right] < 0. \tag{5.11}$$

Given (5.11), we see that the numerator in (5.9) is negative. Given (5.10) and (5.11) we see from (5.9) that $dr/d\alpha > 0$; deposit rate is increasing in insurance coverage. We know from (5.1) that risk taking is increasing in deposit rate. Therefore, risk taking increases when insurance coverage is extended. On the contrary, the insurer can reduce risk taking by limiting coverage. Hence, partial coverage can be used to reduce the moral hazard problem such as in the context of standard insurance, e.g. Holmström (1979), Shavell (1979). Notice, however, that this is possible only if bank competition takes place in deposit markets.

Proposition 5. *Under deposit competition, the insurer can reduce risk taking by limiting insurance coverage.*

6 Conclusions

The main objective of this paper is to examine how introducing deposit insurance influences banks' risk taking incentives when bank risk is unobservable to depositors. To this end, we construct a simple framework of financial intermediation in which both limited liability and deposit insurance play important roles. By studying three forms of bank competition – a monopoly bank, competition for borrowers and competition for deposits – we obtain the following results.

- When bank risk is unobservable to depositors, introducing deposit insurance may increase risk taking if banks compete for deposits. In contrast, if a bank is a monopoly or if banks compete for borrowers only, deposit insurance has no effect on risk taking.
- The magnitude of the risk taking problem depends on the type of bank competition. When a bank is a monopoly or when banks compete for borrowers, the chosen projects are too risky but extreme risk taking is avoided. In contrast, when competition takes place in a deposit market, the banks take extreme risks. Hence, deposit insurance and competition for deposits seem to form a destructive combination.

These results mean that under deposit insurance, inroducing lending market competition has no effect on risk taking. But introducing deposit market competition will increase risk taking. During the past decades deregulation, financial innovations and new information technology have increased financial competition narrowing banks' interest margins remarkably. On the asset side, the borrowers that previously relied on bank loans now favour capital markets, for example the commercial paper market. On the liability side, savers more often prefer bond or stock investments to bank deposits. Interbank competition for deposits has also increased. Deposit insurance schemes have traditionally included ceilings on deposit rates (e.g. Regulation Q) which have prevented deposit rate competition. The widespread deregulation in 1980s removed ceilings and liberalized interbank competition. Consequently, the threat of excessive competition for deposits may now be more topical than ever before. Therefore, given the large number of bank crises during 1980s and 1990s, considerable attention must be given on designing the bank regulation system in general and the deposit insurance scheme in particular.

Our results offer some implications for regulation. Most of all, regulators should focus on competition in input markets; that is, they should monitor deposit rates in the bank sector and benefit-to-premium ratios in the insurance industry. High deposit rates or high benefit-to-premium rations may provide a useful early warning signal of forthcoming financial difficulties. When insurance is complate and the input market is competative regulation of deposit rates and benefit-to-

premium ratios may be instrumental to discourage risk taking. Alternatively, risk taking can be restricted by setting high enough equity requirements to banks.[9]

Our simple analysis has some limitations. For example, only three extreme competition alternatives are examined. Moreover, the risk-return function is rather special and includes an assumption of fully correlated loan risks. In addition, adverse selection problem is excluded. Therefore, the results should be taken as preliminary, providing a useful point for a more general analysis that addressess these issues.

[9] It is possible to show that equity restricts risk taking in our framework whether deposits are insured or not. Extreme risk taking is then certainly avoided.

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