Competition, Deposit Insurance and Bank Risk-taking

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Abstract

This paper presents a financial intermediation model integrating both loan and deposit markets to study the impacts of competition on bank risk-taking behavior under different coverage of deposit insurance. We find that the relationship between competition and bank risk-taking depends on the interactions of market structure between loan and deposit markets, deposit insurance, and depositors' risk aversion. With full deposit insurance coverage, an increase only in competition for deposit will trigger severe bank moral hazard problem and spill over to loan market because of the existence of bank's role on financial intermediation. Thus there exists a positive relationship between competition and bank risk-taking. In contrast, an increase only in competition for loan could lower bank risk. There exists a negative relationship between competition and bank risk-taking. Without deposit insurance, in general, bank risk will be contained due to depositors' risk internalization. The risk could be even lower in monopolistic deposit market and competitive loan market than other loan and deposit market structure combinations due to no existence of any moral hazard problem. In the other loan and deposit market structure combinations, risk will be higher due to moral hazard either in loan market or in deposit market. We also find that depositors' risk aversion under information disclosure could induce lower bank risk when deposits are competitive.

Keyword: competition, risk-taking, moral hazard, deposit insurance, information disclosure.

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1. Introduction

The actual relationship between banking competition and risk taking has long been the focus of debates among financial academics and monetary policy makers. Keeley(1990) postulates charted value hypothesis, which claims competition could erode bank's charter value and increase banks' incentives to take risk. Accordingly, there exists tradeoff between competition and financial stability. Charter value hypothesis has influential impacts on competition policy making since 1980s[1]. However, recent theoretical and empirical findings challenge this hypothesis. The relationship between banking competition and risk is mixed. Carletti and Hartmann (2002) claim the stability effects of change in market structures and competition are extremely case dependent[2]. The definitions of competition should be reconsidered. For most analysis on competition in banking issue, most papers put their focus on deposit market rather than loan market and assume banks could select their asset portfolio riskiness. This approach is referred as *portfolio allocation model*. In fact, most part of bank asset are loans instead of other securities. The moral hazard problems between banks and borrowers should be included in analyzing competition issues. Boyd and De Nicolo(2005) point out loan market and deposit market should be equally evaluated. They argue and show this *contracting model* will have different outcomes in comparing previous studies.

In this paper, we present a financial intermediation model integrating loan and deposit market to investigate the relationship between competition and bank risk-taking under different coverage of deposit insurance. Interactions between firms, banks and depositors are major characteristic in the model. Our main concept is whether competition could trigger more risk taking depends its impacts on agent's payoff structure and provides risk-taking incentives for agents in that market. We find that different definitions of competition have distinct impacts on moral hazard incentives. In a combinatorial analysis, we are able to derive more comprehensive answers for this issue.

In the model, market power as *exogenous factor* is defined as the pricing control right of some economic agent in that market[3], e.g. monopolistic bank has right in deciding loan rates for his own best interest. Risk-taking is defined as economic agent's pursuit high yields with low likelihood of success. According to above definitions, we could analytically combine loan and deposit market together. In *loan market*, competition could lower loan

[1] In Padoa-Schioppa(2001): In order to preserve the stability of the banking and financial industry, competition had to be constrained(p.14). His comments under that context reflect authority's viewpoints and attitude toward competition policy for banking industry.

[2] See their review, p.32.

[3] Different papers have different market power definitions, Keeley(1990) defined market power as monopoly power, p.1189; Repullo(2004), his market power definition is the ratio of traveling cost to number of banks. Our market power is close to Keeley's market power, but gives pricing control right in the market.

rates and reduce the extent of moral hazard problem between banks and firms. Because borrowers could benefit from competition in loan, they could choice proper project return and risk instead of excessive return. In *deposit market*, under deposit insurance and depositors' risk preference considerations, competition for deposit could let investors increase deposit rate and produce different risk taking incentives along with deposit insurance coverage. Flat premium deposit insurance is important determining factor for risk taking, because it changes agents' payoff structures in deposit market. Depositor's risk preference also plays important role in deposit market. In our model, we assume all investors could correctly project risk taken by observing pricing from banks.

With different market structure settings, various degrees of moral hazard problem interact between *loan market* and *deposit market* could produce different pricing in loan rates, deposit rates and equilibrium risk levels. Then, we could evaluate the joint effects of competition and deposit insurance on risk taking.

We find competition for deposit will induce risk-taking and competition for loan, in contrast, might reduce risk. According to our finding, degree of deposit insurance coverage will encourage risk taking for bank's risk shifting. Competition for deposit with full deposit insurance will result in excessive risk-taking no matter whether loan market is competition or monopolistic because of bank financial intermediation channel. Competition for loan market only will induce lower risk. With partial or no coverage, risky deposits will generally reduce risk levels because of risk internalization from depositors. However, competition for deposit will also induce higher risk. We find the lowest risk will be resulted in competitive loan market and monopolistic deposit because no moral hazard problem occurred. The ultimate relationships between market competition and risk taking will depend on where the competition taken place, deposit insurance coverage and investors' reaction on risk bearing.

The remainder of this paper is organized as follow: in section 2, we review recent literature to demonstrate our research motives. Then, model is introduced in section 3, the three different agents, banks, depositors and entrepreneurs will be presented in section 3.1. Then, we derive the equilibrium risk, loan rate and deposit rate in four different loan and deposit market structure combinations in section 3.2 after model settings. In section 4, we present conclusive remarks.

2. Literature Review

For widely studies involved this issue adopt single market approach where competition could happen either in loan or deposit market. Those studies assume competition happened in one of markets and combine with simplified assumptions in dealing with another market (Carletti and Hartmann (2002)). According to bank's asset/liability side, competition could happen in either loan or deposit side. When competition defines in deposit (liability) side, banks are regarded as agents and depositors

as principles. Most studies related to this issue often explore how governmental regulations affect bank risk-taking incentives when agency problems are concerned. In Keeley(1990)'s seminal paper, he introduces charter value as regulatory bankruptcy opportunity costs to explain why deposit insurance did not trigger risk-taking until 1980's banking deregulations. In short, competition reduces charter value with rising deposit rate and restores risk-taking incentive. By assuming banks select asset portfolio risk, Allen and Gale (2000) use deposit-competition model to manifest bank's moral hazard problem as number of banks increases, banks could select extreme asset risk[4]. These kinds of studies are related to whether bank regulations could remedy such bank risk-taking problem. Matutes and Vives(2000) study alternative deposit insurance schemes under deposit imperfect competition, and conclude when competition is intense, deposit rate is excessive high and results in higher bank portfolio risk in a uninsured market or market with flat-premium deposit insurance. By adopting charter value hypothesis in a dynamic model, Hellman, Murdock and Stiglitz (2000) and Repullo(2004) both of them evaluate effectiveness of capital requirements on bank moral hazard problem. Hellman et al.(2000) find ambiguous effects of capital requirements on reducing risk taking for two opposite effects: capital-at-risk effect and charter value effect. Capital requirements could totally inefficiency in containing bank risk-shifting incentives. They claim deposit rate ceiling policy could be more Pareto efficient in retaining prudential banking. Repullo(2004) addresses in solving Hellman et al.(2000) ambiguous effects of capital requirements and conclude that capital requirements could reduce bank's asset-shifting incentives. Shy and Stentbacka(2004) propose competing for deposits might not induce banks to take risk in the environment where homogenous loss averse depositors will base their knowledge about bank's asset portfolios to select banks for their benefit. With this context, banks use asset quality as a strategic instrument and end up with safer assets. In similar spirit, Cordella and Yeyati(2002) conclude informational observability will mitigate risk taking caused by competition. Above studies share one common property, banking moral hazard, that banks as agents could select prudential or gambling asset. Competition for deposits could exacerbate or ameliorate this moral hazard through different model settings and assumptions.

The competition in loan market related to risk-taking is based on moral hazard problem between banks (principle) and entrepreneurs (agents). Caminal and Matutes(2002) consider banks face borrower's moral hazard problem in loan market and consider two alternative bank strategies, monitoring or credit rationing. Market power provides sufficient incentives for bank to reduce agency problems through monitoring. Intermediate monitoring cost induces banks to adopt monitoring strategy and grant more loans to borrowers. In present of non-diversifiable risks and decreasing return to scale, it makes

[4] However, Grouchulski and Kareken(2004) prove that Allen and Gale(2000)'s results are not robust. They prove number of banks is independent of risk taking in another model with different constraint setting.

negative relationship between risk and banking competition. However, they conclude with no definite relationship between competition and risk for various monitoring costs. Koskela and Stenbacka(2000) combine mean-shifting investment technology and limited liability debt contract in loan market. They find competition in lending market will reducing loan rate and increase investments, which will not increase probability of default because of mean-shifting investment technology. They claim *no* trade-off between competition and financial fragility. Besanko and Thakor(1993) from relationship lending perspective claim more competition in loan will reduce their investment in informational acquirement and result in higher chance of being default. The effects of competition for loan are mainly based on extent of moral hazard problem between borrowers and banks and other considerations.

Most studies about competition in deposit belong to bank *portfolio allocation* model (Keeley(1990), Hellman et al.(2000), Matutes and Vives(2000)). Banks will select the risk and return combinations for their asset portfolio. Boyd and De Nicolo(2005) propose *optimal contracting* model incorporating deposit market with loan market, in which moral hazard problem works oppositely in different markets, will be more properly in analysis this issue. They emphasize loan market channel and deposit market channel should be equally evaluated, when competition in banking influence risk taking incentives. There are two price-mechanisms work in opposite directions for risk-taking. Their paper shows, as more concentrated banking markets are, the risk of default increases. Our paper is inspired and closely related their concepts. As we know bank's assets are mostly composed of entrepreneurial loans. Firms, instead of banks, determine the risk of bank assets. In contrast, *portfolio allocation* model focus only on moral hazard problem in deposit market. Another similar study is Niinimaki(2004). In his paper, with four different market situations and different degrees of deposit insurance coverage, he studies how competition brings out different risk levels under full and no deposit insurance situations. He finds competition in loan market only results in mild risk taking and deposit insurance is nothing to do with loan market competition. But, competition in deposit could induce extreme high risk with full covered deposit and deposit credit rationing with no deposit insurance. However, same as traditional competition analysis, Niinimaki(2004) in his modeling ignore moral hazard problem in loan market in his modeling.

We intend to combine Byod and De Nicolo(2005)'s concepts about loan market' moral hazard with Niinimaki(2004)'s model treatments on market structure modeling and deposit insurance setting. The reason why we adopt Niinimaki(2004)'s analytic framework is it enable us to integrating both markets together so we could see moral hazard problems interact between different markets. Deposit insurance provides important source of moral hazard in deposit market. There several points make ours different from them. First, we use

principle-agent analysis[5] in dealing how competition affects risk-taking in a model combining two markets. There are different objective and constraint settings along with different market structures. The loan market risk taking channel and deposit market risk-taking channel will be considered simultaneously under certain market competition conditions. Second, we consider investor's risk preference and different degree of deposit insurance coverage in our deposit market. Different degree of insurance coverage will render different extent risk taking incentive for banks. Our paper's analysis will be more comprehensive than Byod and De Nicolo(2005)'s results. Finally, we allow information disclosure in deposit market for depositors could observe potential risk through bank's pricing[6]. This could affect the risk taking incentives for banks, firms and depositors, especially in competitive deposit market. We present an analytical framework and hope to find more comprehensive explanations for relationship between competition and risk-taking in banking industry, especially when policymakers are design proper regulatory measurements.

3. The model

In this model, we consider a financial intermediation system with three kinds of agent, entrepreneur, bank, and depositor. All of them are risk neutral except for depositors. In this model, two markets, loan and deposit will be included and considered simultaneously. On bank's liability side, banks collect depositors from investors. On bank's asset side, banks grant loans to entrepreneurs. For asset or liability side, banks face different market structures. We use different market power settings representing different market structures. Market power is defined as previous section. With market power over the market, banks could decide the rates and the market is monopolistic; otherwise, it is competitive. By varying different market power settings, we could analyze the different competition effects on market rate pricing and risk. Before that, we proceed with agent's behavior and objection function settings.

3.1 Agents and their behavior settings

3.1.1 Entrepreneur

Entrepreneurs have special knowledge about risky investment project and need $1 funding. They get funding from banks or give up investment project. In order to simplify analysis, we assume all investment have only systemic risk and ignore idiosyncratic risk of

[5] Our model is also similar to Byod and De Nicolo(2005)'s model, which is also modified from Allen and Gale(2000)'s model. They use a simple model and Nash game to demonstrate a risk taking equilibrium could reach when number of banks increases. Competition is increasing with number of banks. We approach competition issue is same as Niinimaki(2004) with agent's problem solving in different constraints, which represent different market competition condition.

[6] The information observability is main from the concepts of Cordella and Yeyati(2002). They claim bank asset portfolio information disclosure will let depositors optimally respond to bank asset allocation decision. In similar fashion, we consider depositors will optimally adjust required deposit rates in response to bank's loan rate pricing and risk taken. This will have influences on bank's pricing and risk taken decisions.

each investment. All investment projects have closely related returns. The investment in good state will produce return y with probability p(y); otherwise, will produce zero return with probability (1-p(y)). Investment return y is with continuum support $y \in [0,\overline{y}]$; the higher project return, the lower is its success probability: p(0) =1 and $p(\overline{y}) = 0$. Therefore, y could also be seen as risk index. Higher y also means higher default likelihood (risk). If the highest output $\overline{y}$ were chosen, we assume it will have negative net present value ($p(\overline{y})\overline{y}$ <1). This makes the investment project invalid. p(y) is a strictly decreasing function of y and exhibits concave to origin, $p'(y) < 0,\ p''(y) < 0$. This condition also implies the expected return of the project is concave function of y, $\frac{\partial^2 (p(y)y)}{\partial y^2} < 0$.

According to above descriptions, we define firm's object function as:

$$\pi_f = p(y)\max[y - R_L, 0] \qquad (1)$$

R_L is loan rate offered by bank. The loan is standard debt with limited liability. The limited liability debt contract provides sufficient incentive for firms to take risk. In the appendix, we provide simple proof that under such debt contract firm will take social undesirable (higher) risk levels. In any given loan rate, firm picks up project return y to maximize his objective function.

$$p'(y)(y - R_L) + p(y) = 0 \qquad (2)$$

From (2), higher loan rate means higher project return and risk. There exists moral hazard problem between firm and bank. After granted loans, firms may ask for higher investment return in selecting more risky project and share risk with banks. This is because of limit liability of debt contract. In order to ensure the existence of equilibrium project return, we assume $R_L''(y) < 0$.

3.1.2 Bank

As a financial intermediary, typical bank collects deposits \$1, lends it to firms and shares risk with them. We assume banks have no capital. Bank' profit is composed by the difference between loan rate and deposit rate and operation costs. His object function is:

$$\pi_B = p(y)\max\{(R_L - R_D),\ 0\} - c \qquad (3)$$

where c is operation cost, including flat deposit insurance premium paid to regulator ex ante[7].

With flat premium, we could assume deposit insurance provides different insurance coverage in our model settings. There exists a moral hazard problem between banks and insurance agency (Merton (1977)) under fully coverage deposit insurance. With deposit guarantee from insurer, banks may risk their asset portfolio in pursuit high return with lower successful likelihood and investors with such guarantee will not care about bank's

[7] As traditional deposit insurance setting, the flat premium is under pricing, referred as deposit insurance premium subsidy.

risky behaviors. This is risk-shift effect in deposit insurance.

In order to comply with economic meaning, we assume bank's low operation costs, c, that $c < \frac{R_L'(y)(p(y))^2}{-p'(y)}$. With this assumption, it allows positive relationship between project return, y, and deposit rate[8].

3.1.3 Depositors

Investors with endowment \$1 in total could invest in safety assets with return r_f or in bank deposits with *contingent return*, $R_D(\geq 1)$, with probability p(y). Deposits are different from bonds for different degree of coverage provided by deposit regulator. Under fully protection, depositors could get deposit return with regulator's guarantee. In this situation, depositors were well protected and it cuts off the concerns of depositors about the deposit's potential default risk. Under partial coverage, depositors will get partial redemption according to coverage parameter setting, $0 \leq \lambda < 1$. In partial deposit coverage, investors will have incentives to adjust required deposit rate according to the risk accompanying with deposits. With bank information disclosure to depositor, e.g. loan rate, depositors could know probability of get paid, p(y) in equilibrium. We model representative depositor's interest as expected utility:

$$U^D = (\lambda + (1-\lambda)p(y))R_D \qquad (4)$$

If $-\frac{p(y)}{1-p(y)} < \lambda < 0$[9], it means depositors have strong risk aversion because of suffering more in case of project failure. It notes deposit rate is independent of amount of deposits and positively related to risk along with it. By taking total differentiation to depositor's utility, there exists positive relationship between R_D and y:

$$\frac{\partial R_D}{\partial y} = -\frac{(1-\lambda)p'(y)R_D}{\lambda + (1-\lambda)p(y)} > 0$$

With $p'(y) < 0$, it means higher risk will result in higher return including risk premium to compensate investors.

With different market power settings in loan and deposit markets, we could emulate various market structures and analyze the effects of competitive on risk taking in banking under different insurance coverage. In our static model with two-period, the sequence of events can be described as follows:

I. In first period, entrepreneurs have an investment project. Entrepreneurs without

[8] If the assumption does not hold, there exists negative relationship between deposit rate, R_D, and project return, y. The negative relationships imply higher project return(riskiness) will cause lower deposit rate because of high operation costs.

[9] We adopt risk aversion follow Shy and Stenbacka(2004) p256~257. In their model, they set parameter to descript different kinds of depositor's risk preferences.

endowments need external finance. All projects are closely related in their returns. The risk-return relationship is common known. Investors with endowments \$1 in total could invest in bank's risky deposits or in safety assets. In order to let investors transact with banks, banks preserve minimum reservation return same as safety asset return. Banks collect deposits and grant loans to firms. Regulator protects deposits with regulator guarantee.

II. In the second date, the project's returns accrue. If it is success, entrepreneurs could repay his debt and banks could repay deposit's required return; otherwise, both of them will be default and deposit insurer will pay depositors according to the extent of coverage.

Now, we divide into four different sections, according to different market structures, to present our analysis.

3.2 Different market structures and equilibrium risk determination

A. Suppose bank has market power in both loan and deposit market.

With market power in both markets, representative bank has the right in pricing loan rate and deposit rate. In loan market, bank price loan rate to maximize his profit. It notes that, with moral hazard between bank and firm, firms will choose y in response to bank's loan rate pricing (Boyd and De Nicolo(2005))[10]. In deposit market, bank with market power will lower deposit rate as low as possible, but have to keep investors transacting with him by providing participation incentives at reservation utility levels, r_f.

We formulize the problem as following:

$$\begin{aligned} &\max_{\{R_L, R_D, y\}} \pi_B = p(y)[R_L - R_D] - c \\ &s.t.\ \ \mathrm{U}^{\mathrm{D}} \geq r_f \\ &\quad \pi_f(y) \geq \pi_f(y'), \forall y' \end{aligned} \tag{5}$$

The first constraint is depositor individual rationality condition (or participation constraint), which keeps investors depositing their endowments in banks. The depositor participation constraint could turn into lower bound for deposit rate, $R_D \geq \frac{r_f}{(\lambda + (1-\lambda)p(y))}$. The second constraint is incentive compatible condition for firms. Firms will choose optimal project return y in response to bank loan rate pricing. Mathematically, with this incentive compatible condition, this problem could be viewed

[10] In pricing loan rates, banks will taking firm's reactions toward loan rate settings. The reaction is derived from $\max_{\{y\}} \pi_f = p(y)[y - R_L]$ for any given R_L. Bank will choose the R_L, so that firm will choose the y to maximize his profit. This is known as incentive compatible condition.

as double maximization problem and only second best solution could exists (Grossman and Hart(1983), Rogerson(1985)). By using first order approach, incentive compatible condition is equivalent to $p'(y)(y-R_L)+p(y)=0$ [11] for $\forall$ y in replacing $\pi_f(y) \geq \pi_f(y'), \forall y'$. In order to valid the problem, we need to check convexity of firm's object function with second order condition, $\pi''_f < 0,$ for $\forall y \in [0, \bar{y}]$. It is worth to note that depositors will ask for higher required deposit rate in observing higher loan rate means higher risk bank allow firm to take. With these binding constraints, the objective function's first order condition could be:

$$p'(y)y + p(y) + p(y)R'_L(y) = \frac{\lambda p'(y)R_D}{(\lambda + (1-\lambda)p(y))} \qquad (6)$$

On the right hand side of (6) is marginal return of increase in project return(risk) in loan market and on the left hand side of (6) is marginal costs of increase in project return in deposit market. $p(y)R'_L(y)$ is the agency cost for moral hazard problem between bank and borrowers. Banks will charge higher loan rate for agency costs. With assumption of $R''_L(y) < 0$, we find marginal return of increase in risk is decreasing. And with higher project return, depositors will ask for higher required deposit rate for compensating risk bearing.

In order to simplify deposit market situation, we outline the results according to coverage parameter, λ.

（1） When deposits are fully protected（λ = 1）

Deposit lower bound could be lower as risk-free interest rate, r_f. There exists moral hazard between banks and regulator: bank will risk more in pursuit higher project risk and shift it to deposit insurer. With this asset-shifting effect, the first order condition is:

$$p'(y)y + p(y) + p(y)R'_L(y) = p'(y)r_f \qquad (7)$$

There are two moral hazards working separately in loan and deposit markets shown in both side of （7）. On left hand side, there exist agency problem between banks and borrowers. On the right hand side, bank could shift risk to regulator because of fully coverage insurance. Both of them allow higher project return and risk. The optimal risk

[11] According to Mirrlees(1975), we take firm's objective function first derivative with respect to y and get $p'(y)(y-R_L)+p(y)=0$. It could turn into $R_L = \frac{p(y)}{p'(y)} + y$. On the left hand side is firm's marginal costs and right hand side is firm's marginal benefits. Basing on this first order condition, principle could provide optimal contract for best his own interest.

choice is y^{MLMDC}. It is determined by the interactions between loan and deposit market.

（2） When deposits are no protected（$\lambda = 0$）

With bank financial information, e.g. loan rate pricing, exposed to investors, them will ask higher risk premium for compensation. Therefore, with deposit rates auto adjustment, there is no moral hazard in deposit market. Only moral hazard problem exists in loan market. The first order condition is:

$$p'(y)y + p(y) + p(y)R_L'(y) = 0 \qquad (8)$$

The project return is solely determined in loan market rather than interact with deposit market. Optimal return is y^{MLMDUC}. It is lower than project return in (1) and less risky.

（3） When deposits are no protected and depositors are risk averse（$\lambda < 0$）

With risk averse investors will ask for higher risk compensation from higher required deposit rate. From（6）, because of negative value of λ and $p'(y)$, optimal y is y^{MLMDRA}. Reflecting depositors' risk averse and required higher deposit rate, the interaction result in lower optimal project return as we expected.

In ranking optimal project return and risk, we find $\mathbf{y^{MLMDRA} < y^{MLMDUC} < y^{MLMDC}}$ from （6)、（7）and （8）. The ranking is joint results of deposit insurance and moral hazard under monopolistic loan and deposit markets. Of course, without bank information disclosure to investors, the situation will be close to deposits with fully insurance coverage and higher optimal risk levels.

B. <u>When banks compete for loan, but they have market power over deposit</u>.

In competitive loan market, loan rate offered to borrowers will be as low as possible and bank's profit will be squeezed. Under this situation, entrepreneurs have right in choosing project return and risk. Having much more profit margin from investment project in case of success, firms have no need to select higher project return in low likelihood of success. If they choose to jeopardy in taking excessive risk, this attempt may lower their expected return in stead. According to above argument, we claim there is no moral hazard problem between firm and bank in competitive loan market. In deposit market, same as previous part, banks have market power in lower deposit rate at minimum reservation utility levels, r_f.

Accordingly, we formulate the problem as:

$$\max_{\{y\}} \pi_f = p(y)(y - R_L)$$
$$s.t.\ \pi_B \geq 0 \qquad (9)$$
$$U^D \geq r_f$$

In part B, we find object function is firm's profit function instead of bank's. This

reflects market competitiveness in loan. Firm with market power could determine project returns for his best interest and select lower loan rate offered by banks. For these constraints, the first constraint is bank's participation constraint to represent competitive loan market. From this constraint, loan rate could be lower according to bank's participation constraint at $R_D + \frac{c}{p(y)}$. The second constraint is depositor participation constraint to present monopolistic deposit market situation. With these binding constraints, the object's first order condition is:

$$p'(y)y + p(y) = \frac{\lambda p'(y) R_D}{(\lambda + p(y)(1-\lambda))} \qquad (10)$$

On the right hand side of （10）, there is no agency cost in loan market. The term in the third item of （6）vanished in the right hand side of（10）. On the left hand side of（10）is same as equation（6）. We discuss deposit market situations according to various λ settings.

（1）When deposits are fully protected（λ = 1）

Under fully deposit insurance, deposit rate could equal to risk-free interest rate, r_f.

There exists moral hazard problem between banks and regulator in deposit market. With deposit payoff guarantee, bank could pursuit higher project return in low likelihood and shift risk to deposit insurer. Therefore, it turn first-order condition into

$$p'(y)y + p(y) = p'(y)r_f \qquad (11)$$

The optimal y is y^{CLMDC}. With rearrangement, (11) could turn into $p(y) = -p'(y)(y - r_f)$. On the left-hand side is firm's marginal benefit of increasing risk and on the right hand side is marginal cost of increasing risk. Firm with market power will balance benefit and cost and find optimal project return and risk.

（2）When deposits are no protected（λ = 0）

Without deposit insurance protection, investors will more concern about the default likelihood. Under bank financial information disclosure, investors will ask for higher deposit rate to compensate risk them may bear. Therefore, there is no moral hazard problem in deposit market.

$$p'(y)y + p(y) = 0 \qquad (12)$$

In competitive loan market and monopolistic deposit market without deposit insurance, we expect lower project return and risk. The optimal is y^{CLMDUC}. In fact, this is social desirable outcome at y^{CLMDUC} for it is also the optimal project return obtained in unlimited liability debt contract. Please see the appendix for comparison.

（3）When deposits are no protected and depositors are risk averse（λ < 0）

Risk averse will ask for higher deposit rate to compensate their loss in case of default. In this case, we expect lower project return could be determined. We note that on the right hand side of（10）is positive for negative λ and $p'(y)$. The optimal project return is y^{CLMDRA}, which is lower because of depositors' request and no moral hazard problem in both markets.

The ordering these project returns is $\mathbf{y^{CLMDRA} < y^{CLMDUC} < y^{CLMDC}}$**.** The overall risk is lower than these in part A. The major finding in this part is competition in loan market could eliminate moral hazard problem in loan market. Our result is similar to Boyd and De Nicolo(2005). In their paper, they claim higher concentrated market could produce higher loan rate and this in turn increase borrower's incentive to take risk. Our argument is different from theirs and stems from borrower's perspective. Because borrowers could exploit this market advantage to increase profit margin in transacting with banks, there is no motivation for them to jeopardize their own interests by take risky investment. In contrast with traditional perspectives that competition encourages on risk taking in loan market, we think firm will not take extreme risk in a competitive loan market with lower loan rates.

On the right hand of（10）, we have same situation as in part A. In monopolistic deposit market, it will depend on whether investors will adjust required deposit rate properly to match the risk carried with deposits. If it does, no moral hazard problem happened; otherwise, fully deposit insurance could cut off such incentives and produce moral hazard problem in deposit market.

C. <u>When banks have market power in loan market, but compete for deposits</u>

In competitive deposit market, depositors could ask for higher deposit rate to maximize their expected utility and bank profit could be eroded. In monopolistic loan market, banks price loan rate and face with moral hazard problem in which firm will choose project return according to charged loan rate. With these conditions combined together, we formulate the problem as:

$$\max_{\{R_D, y\}} U^D = [\lambda + (1-\lambda)p(y)]R_D \qquad (13)$$

$$s.t.\ \pi_B \geq 0$$
$$\pi_f(y) \geq \pi_f(y'), \forall y'$$

In order to present the character of competitive deposit market, we follow Niinimaki(2004)'s treatment and replace object function with depositors' expected utility function. With market power, depositors could ask for deposit rate that banks are willing to offer. The deposit rate is constrained by first constraint, bank's participation constraint. It could derive the upper bound of deposit rate: $R_L - \frac{c}{p(y)}$. The second constraint shows monopolistic loan market, there exists moral hazard problem: firms will select project

return according to bank's loan rate pricing. So, under this situation, if depositors ask for higher deposit rate which could push up loan rate in order to maintain bank's participation incentive. In turn, the higher loan rate could trigger moral hazard in loan market[12]. For depositors, he has to take the moral hazard problem of loan market into consideration. Therefore, the first order condition in part C. is:

$$p'(y)y + p(y) + p(y)R_L'(y) = -\frac{\lambda}{1-\lambda}[R_L'(y) + \frac{cp'(y)}{(p(y))^2}] \qquad (14)$$

On the left hand side reflects moral hazard in loan market. There exists agency costs in loan market, $p(y)R_L'(y)$. On the right hand side, it shows higher project return's effects on deposit rate[13]. The equilibrium project return will depend on how depositors balance marginal benefit of increase deposit and marginal cost of rising deposit rate. The coverage of deposit insurance plays important role in depositor's decision for λ is also the weigh for marginal benefit of increase deposit rates.

（1） When deposits are fully protected（$\lambda = 1$）

The first order condition turns to

$$[R_L'(y) + \frac{cp'(y)}{(p(y))^2}] > 0 \qquad (15)$$

Under fully deposit guarantee, deposit market's moral hazard could be at it fully strength. With insurance's protection, depositors will ask for higher deposit rate and push loan rate along with it. This could also imply depositors with market power put total weigh on marginal benefit of rising deposit rates. Banks under depositors' request will adjust loan rate along with his participation constraint. In loan market, ultimate project return chosen by firms will be highest. We assume there exists a project return such as $y^{MLCDC} = \hat{y} < \overline{y}$ in order to avoid invalid investment situation[14]. In competitive deposit market and monopolistic loan market, fully coverage deposit insurance could let moral hazard problems exacerbated in both markets. So, competitive deposit market with fully deposit insurance could cause excessive risk taking incentives.

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[12] We take different analytic approach from Niinimaki(2004), who takes $R_L = y$. Instead, we adopt Boyd and De Nicolo(2005)'s concept: firm will respond optimally toward bank's loan rate pricing. Therefore, firm's incentive compatible condition is $R_L = y + \frac{p(y)}{p'(y)}$. It also is Mirrless(1975)'s first-order condition, see footnote 18.

[13] Note on the right hand of (14) $[R_L'(y) + \frac{cp'(y)}{(p(y))^2}] = R_D'(y)$; by assumption about bank low operation cost, $c < \frac{R_L'(y)(p(y))^2}{-p'(y)}$, which implies $R_D'(y) > 0$ represents increase in y could increase deposit rate. Note that $R_D'(y) < R_L'(y)$.

[14] If $y = \overline{y}$, the investment project could be infeasible because of the assumption, $p(\overline{y})\overline{y} < 1$. The expected project return will be unable to repay loan. Therefore, firms will not take highest project return.

（2） When deposits are no protected（$\lambda = 0$）

The first order condition will be same as（8）.

$$p'(y)y + p(y) + p(y)R_L'(y) = 0$$

Because high deposit rate implies higher loan rate as well as higher risk taking, expected utility of depositors will be lower in asking for highest deposit rate, which induce lowest successful likelihood. With no deposit insurance and disclosure bank's information, moral hazard problem in deposit market will be vanished. No such incentives for depositors and banks to selection highest deposit rate and loan rate. In monopolistic loan market, agency costs and moral hazard problem will exist. In this situation, project return and risk will be mild at y^{MLCDUC}.

（3） When deposits are no protected and depositors are risk averse（$\lambda < 0$）

The right hand side of equation (14), $-\frac{\lambda}{1-\lambda}[R_L'(y) + \frac{cp'(y)}{(p(y))^2}]$, is positive. This implies risk averse depositors in considering increasing deposit rate, the effect of reducing the likelihood of success on deposit expected utility overpower the effect of increasing in deposit rate. Depositors will reduce required deposit rate further. In this situation, project return, y^{MLCDRA}, will be lower than in previous sections.

In this part, competition for deposit could induce extreme risk only under fully deposit insurance coverage. In this situation, double moral hazard problems in both deposit and loan markets interact with each other and result in serious risk taking. We get same results as Niinimaki(2004): in competitive deposit market and fully insurance protection, excessive risk taking could be seen.

Another moral hazard problem in loan market still exists, even without deposit insurance. This is mainly from monopolistic loan market. But, this moral hazard problem alone could only induce mild risk.

So, the major finding in this part is competition in deposit and full coverage deposit insurance are jointly major factors in inducing excessive risk taking. Without fully coverage, depositors will adjust deposit rate by observing bank's pricing. Under such circumstance, only competition in deposit could not induce depositors asking for excessive high deposit rate. Risk taking incentives will be contained as shown in (2) and (3). The main reason is no moral hazard problem for risky and unprotected deposits.

D. <u>When both loan and deposit markets are competitive</u>

In this situation, bank's profit will be squeezed in bid for loans and deposits. Entrepreneurs and depositors will share project's returns and risk together. The size of their share depends on their bargain power. In loan market, entrepreneurs with market power maximize their profit in selecting project return but subject to bank's participation constraint, which preserves bank's intermediation role in financial system. In competitive deposit market, depositors want to ask for optimal deposit rate to maximize their utility but

face with entrepreneurs asking for lower loan rate, which implies lower deposit rate. Their interests conflict with each other. In order to find equilibrium project return and risk, we proceed with following steps.

First, we solve for firm's optimal profit problem constrained by bank participation condition in selecting project return and deriving first-order condition. Then, we turn to deposit market; in depositor wants to maximize his expected utility but subjects to the first-order condition obtained from first step.

In loan market, firm decides project return to maximize his profit, subject to bank participation constraint, $\pi_B \geq 0$. Bank participation constraint could turn into

$$R_L = R_D + \frac{c}{p(y)}.$$

$$\max_{\{y\}} \pi_f = p(y)[y - R_L]$$

s.t. $R_L = R_D + \frac{c}{p(y)}$ for any given deposit rate, R_D.

With this binding constraint, we could rewrite firm's objective function and derive his first-order condition as:

$$p'(y)(y - R_D) + p(y) = 0 \qquad (16)$$

From (16), we note that higher deposit rate setting in deposit market will result in higher risk and project return chosen by firms. So, it implies in competitive loan and deposit market, moral hazard problem could exist between firms and depositors just as moral hazard problem between firms and banks in monopolistic loan market. It notes that from (16), $R_D'(y)$ is same as $R_L'(y)$ in Part C[15]. We will need this property to compare risk in Part C and Part D.

In checking second-order condition, we could know the firm's optimality problem is valid.

$$\pi_f'' = p''(y - R_D) + 2p' < 0.$$

Now we turn to deposit market. In competitive deposit market, representative depositor asks for required deposit rate to maximize their expected utility and subject to entrepreneur's first order condition in (16) gotten from first step. This is same as double maximization problem, according to Rogerson(1985), we could get second best solution. The problem is stated as:

$$\max_{\{R_D, y\}} U^D = [\lambda + (1-\lambda)p(y)]R_D$$
$$s.t.\ p'(y)(y - R_D) + p(y) = 0 \qquad (17)$$

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[15] $R_D'(y) = 2 - \frac{p(y)p''(y)}{(p'(y))^2}$ is same as $R_L'(y)$'s definition in footnote 12. This is key difference between Part C and Part D.

With assumption that constraint is binding, we could get first-order condition as:

$$(1-\lambda)(p'(y)y+p(y))+(\lambda+(1-\lambda)p(y))R_D'(y)=0 \qquad (18)$$

From（16）, higher deposit rate will induce higher project return and risk. From first step, in competitive loan, firm's payoff will be same as bank's payoff. When depositors ask for higher deposit, they will face moral hazard problem same as in monopolistic loan market described in Part A. On the left hand side of（18）, the first term is marginal costs of increasing risk. Increase in risk could lower likelihood of success. The second term is marginal benefit of increasing risk: taking more risk will also mean higher deposit rate, $R_D'>0$. The important factor in determining equilibrium project return and risk is deposit insurance coverage, λ.

（1） When deposits are fully protected（λ = 1）

With fully deposit insurance coverage, the first-order condition is $R_D'(y) > 0$ and with deposit guarantee, depositors will ask for highest deposit rate and firm will select highest project return, $\hat{y} = y^{CLCDC}$ in response. The moral hazard problems in both loan and deposit markets could be maximized for zero marginal costs of increasing risk toward depositors. Under this situation, the loan rate is $\hat{y}$ and deposit rate is $\hat{y}+\frac{p(\hat{y})}{p'(\hat{y})}$. Because of $\lim_{y\to\hat{y}} p(y)\approx 0$, deposit rate and loan rate is almost same. With this compelling deposit rate asking, firm's project share could be squeezed in fully zero, $\lim_{y\to\hat{y}} y-R_D=-\frac{p(\hat{y})}{p'(\hat{y})}\approx 0$. In order to access external finance, firms could face highest loan rate and have sufficient motivation to take excessive risk.

（2）When deposits are no protected（λ = 0）

Without deposit insurance, there is no moral hazard in deposit market because depositors have to take the consequences of failure investment. In the loan market, asking for higher deposit rate could induce firms to choose higher project return and risk. To depositors, with λ = 0, marginal benefit of increasing risk and marginal cost of increasing risk are equally weighted. Depositors have to balance pros and cons from taking more risk. Without deposit insurance, the incentives of risk-taking could be contained and risk will be mild. The first-order condition turns to:

$$p'(y)y+p(y)+p(y)R_D'(y)=0 \qquad (19)$$

The first two items of (19) are marginal costs of increase risk and the last item is marginal benefit of taking risk. The equilibrium risk is y^{CLCDUC}, which is higher but mild in risk. It is worth to note, because of equality of $R_D'(y)$ and $R_L'(y)$, (19) is same as (8) and y^{CLCDUC} is equal to y^{MLCDUC}. See comparisons in Table II.

（3）When deposits are no protected and depositors are risk averse（λ < 0）

There exist two factors determining the equilibrium risk: one is moral hazard problem in loan market between *depositors* and *entrepreneurs* and another one is depositor's

risk averse preference. Under this situation, risk averse depositors will weight more on marginal costs of taking risk than marginal benefit of taking risk. If absolute value of λ is larger, we expect lower project return and risk. The first-order condition is:

$$[p'(y)y + p(y)] = -[p(y) + \frac{\lambda}{(1-\lambda)}]R_D'(y) \qquad (20)$$

With $\lambda < 0$, deposit will weight deposit market more than loan market. The optimal project return is y^{CLCDRA}. Note that $[p(y) + \frac{\lambda}{(1-\lambda)}] < p(y)$ for $\lambda < 0$, the equilibrium risk could be less than y^{CLCDUC}($y^{CLCDRA} < y^{CLCDUC}$), which shows when risk averse depositors weigh more on marginal costs of taking risk, the equilibrium risk could be restrained more.

In Table II, comparing the case in Part C with $\lambda < 0$ with corresponding case in Part D, we know $R_D'(y)$ in (20) is same as $R_L'(y)$ in (14) and from part C, $R_L'(y) > R_D'(y)$. Based on above inference, we conclude that y^{CLCDRA} is less than y^{MLCDRA}. Because of competitiveness in deposits and risk averse preference, risk conservative investors will let risk even lower that in Part C. See Table II and Figure 4. for details.

When both loan and deposit markets are competitive, depositors and firms share project return together. From (16), firm will choose higher project return if depositors ask for higher deposit rate.[16] *This is moral hazard problem between entrepreneurs and depositors in loan market.* Both of them have to consider the perils come with higher deposit rate.

Deposit insurance is another important factor. With fully coverage deposit insurance, it could easily shift such risk to insurance agent and ask for deposit rate as high as possible. The moral hazard problems will interacts each other in covered deposit insurance. This is result happened in (1). Without deposit insurance, depositors will balance risk and benefit of higher deposit rate in equally weighs. Therefore moral hazard problem in deposit market is wiped out. The equilibrium deposit rate and project return will be mild rather than excessive high. This is result happened in （2） and (3). In (3), risk averse depositors will weigh more heavily on the cost of taking risk and cause lower project return and deposit rates. With lower risk taking, we also find firm's project share will be higher with decreasing in λ.[17] Therefore, in competitive deposit market, depositors' share will shrink

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[16] From firm perspective could help us to understand the situation.We rearrange（16）into $p(y) = -p'(y)(y - R_D)$. On the left hand side is firm's marginal benefit of increase return and risk and on the right hand side is firm's marginal cost of increase return and risk. When depositors ask for higher deposit rate, it also decreases firm's marginal costs in taking high risk and firms will take higher risk.

[17] We could prove it by taking derivative $y - R_D(= -\frac{p(y)}{p'(y)})$ with respect to y. It shows there exist

with lower coverage of deposit insurance.

3.3 Summary of these four parts

By varying different market competition in loan and deposit markets, we explore the joint effects of competition and deposit insurance on risk taking. For simplicity, the market structure is taken as exogenous factor in our model. The loan rate and deposit rate determined in the model are closely related to the risk instead of the amount of loan and deposit. With this modeling, we are able to observe how firms, banks and depositors respond to interest rate pricing and the risk accompanying with it. The relationships between risk taking in banking and competition we get are mixed. *Competition* has different effects on moral hazard problems in different markets. In deposit market, more competition will induce higher risk taking incentives, especially when deposit insurance is full covered. In contrast, competition for loan will reduce risk firms are willing to take. With different market structure combinations with loan and deposit, we find moral hazard problem works differently along with competitiveness of different markets, loan and deposit.

Our main findings could be summarized as following[18]:

（1） Unless deposit market is competitive and deposit insurance is full coverage, competition for loan will produce lower risk in non-collusive game between firms and banks. Competition in loan *only* will reduce firm's incentive to take risk. This is because firms will hold large residual income from their investment project and they will not jeopardize their investment interest in taking risk behavior.

（2） Competition for deposit will induce higher risk, especially when deposit insurance is full covered. Limited liability and full coverage deposit insurance will induce serious moral hazard problem in deposit market and trigger firm moral hazard problem in loan market. In competitive deposit market with deposit insurance, no matter what kind of loan market is, equilibrium risk could be extremely high. It is the interactions between bank moral hazard problem and firm's moral hazard problem in both loan and deposit markets. We get same results as Niinimaki(2004): he find competitive deposit market will result in excessive risk taking for higher bank funding costs.

（3） Generally, deposit market without deposit insurance will induce overall lower risk level. This is because risky deposits could eliminate moral hazard problem in deposit market. Depositors will ask for lower deposit rate or monitor banks closely in order to protect their investment from bank risk-taking behaviors. In this situation,

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negative relationships between y and $-\frac{p(y)}{p'(y)}$. As we already know that higher y will accompany with higher λ, firm's project share will be shrunk.

[18] Please see Appendix I for thorough discussion.

equilibrium risk will be determined solely by loan market. In this situation, monopolistic loan market will result in higher risk because of agency cost in loan market and competitive loan market, as stated in (1), will result in lower equilibrium risk.

（4） Moral hazard problem in deposit market could be more severe than in loan market, when it was triggered by competition and poor designed deposit insurance scheme. This is because of bank's participation constraint, which will push loan rate under higher deposit rate pressure. Therefore moral hazard problem in deposit could induce loan market's moral hazard problem and bank risk-taking. On other hand, firm's moral hazard in loan market only exist in monopolistic loan market and can not induce bank moral hazard in deposit market. However, monopolistic bank is not likely to charge excessive high loan rate, which could reduce his expected profit. See table I. part A.

（5） Risk-averse depositors will choose lower risk level than risk neutral depositors. However, there are complicated situation. Competitiveness in deposit market will induce risk averse depositors take higher risk when investment project return has negative relationship with depositor's utility; otherwise, competitiveness in deposit market will induce risk averse depositors take lower risk.

4. Conclusions

In this paper, we provide more general analytic framework to explore the competition effects on risk in moral hazard context. Moral hazard problems could exist in loan and deposit markets. Most studies related to competition effect on risk taking emphasize on how competition induce moral hazard problem in single market. Boyd and De Nicolo(2005) point out moral hazard could happen in both markets rather than in single one. In order to get more general study on banking competition and risk taking, we need to integrate both loan and deposit markets and distinguish the relationships between moral hazard and competition in different market structures.

In our findings, the effect of competition for deposits will depend on the coverage of deposit insurance, which will magnify risk-taking incentives in deposit market. Under full coverage of deposit insurance, competing for deposits could force banks to offer higher deposit rates for investors and this rises up loan rate at same time because of bank's participation constraint. Through this financial intermediation channel, extreme risk-taking could be happened. With partial or no coverage, deposits are risky as subordinated debts of banks and investors will react with asking for higher required rate for compensating risk bearing.

In contrast, competitive loan market could reduce risk-taking, instead. Firms could benefit from competitive loan market for lower funding costs and will not take risky project or increase variance of project return, which may also jeopardize his own interests.

However, competition loan market is just a sufficient condition for less risky banking. It still depends on competitiveness in deposit market and deposit insurance coverage. That's why we need to integrate both markets in a model and see how different competition definitions interacts each other and how deposit insurance change agent's risk taking incentive. The relationships between market competition and risk taking will depend on where the competition taken place, deposit insurance coverage and investors' reaction on risk bearing.

Because deposit insurance has decisive impacts on risk taking for deposit market, we summarize our results according to the coverage of deposit insurance.

A. When deposit insurance is full coverage

Competing for deposits will induce excessive risk, no matter what kinds loan market structures are. The bank moral hazard problem in deposit market through bank's participation constraint triggers firm's moral hazard problem in loan market because of higher loan rates. We obtain same results as Niinimaki(2004), who claims competition for deposit under fully covered deposit insurance could have extreme risk.

On the other hand, when deposit market is monopolistic, competition for loans will result in lower risk. Our results are different from Niinimaki's in this part: he claims loan market competitiveness is independent of deposit insurance and risk taking. To more specific, competitive loan and monopolistic deposit market could result in lower risk, because no moral hazard happened in loan and deposit market.

Therefore, we expect positive relationship between competition and bank risk-taking, when deposit market is competitive. In contrast, when only loan market is competitive, risk will be lower. There exits negative relationship between competition and risk.

B. When deposit insurance is uncovered or partial covered

Under uncovered deposit insurance scheme will induce overall lower risk level for any kind of loan and deposit market structure. When loan market is monopolistic, competition for deposits has no effect on risk. Therefore, there is no such relationship between competition and risk taking.

When loan market is competitive, competition for deposit will induce higher risk. The relationship between competition and risk will be positive. We also find lowest risk happened in competitive loan market and monopolistic deposit market. This is because no moral hazard problem happened in both market.

Several policy implications are worth us to note. First, we confirm flat and fully coverage deposit insurance could encourage risk taking in deposit market, especially when banks compete for deposit in a deregulated financial system. In order to restrain such moral hazard problem, it should allow risk-adjust mechanisms such as financial information disclosure to depositors, subordinated bonds, risk-adjust insurance premium, to eliminate or reduce the extent of risk taking. Second, more competition in loan market is not necessary

to increase risk taking. In competitive loan market, because of lower loan rate, firms could have larger share of residual income from investment. There is no moral hazard incentive for firms. Therefore, any competitive policies in restraining competitiveness in loan market could encourage firm's risk taking incentives for agency problem in monopolistic loan market. We have similar viewpoint with Boyd and De Nicolo(2005), who emphasize more concentrated loan market will induce borrower to take higher risk. Based on our model's results, a competitive loan market and monopolistic deposit market produce lower risk in banking. The reason is no moral hazard in loan market and mild moral hazard in monopolistic deposit market for deposit insurance. This may provide a guideline for market architecture is crucial in containing risk.

Our research indicates definitions of competition (where to happen), deposit insurance have substantial effects on bank rate pricing and risk taking. Competition is not necessary incubate moral hazard problem, but depends on where it happen and governmental regulatory measurements. Incorporating these factors in our model, more comprehensive relationships could be derived from our combinatorial analytical structure. From financial system viewpoint, competitive deposit market accompanying full covered deposit insurance justify governmental interventions, such as deposit rate ceiling(Hellman et al.(2000), Repullo(2004)); on the other hand, competitive loan market may be encouraging from the perspectives of social welfare because less extent of moral hazard and lower risk might reach.

Tables:

Table I. Comparison the first-order conditions between monopolistic and competitive loan market, when deposit market is monopolistic.

Market Structure / Coverage or Degree of risk aversion	Part A. Bank has market power in loan market	Equilibrium Risk	Part B. Bank competes for loans	Equilibrium Risk
λ< 0	$p'(y)y + p(y) + p(y)R_L'(y) = \frac{\lambda p'(y)R_D}{(\lambda + (1-\lambda)p(y))}$	y^{MLMDRA}	$p'(y)y + p(y) = \frac{\lambda p'(y)R_D}{(\lambda + (1-\lambda)p(y))}$	y^{CLMDRA}
λ=0	$p'(y)y + p(y) + p(y)R_L'(y) = 0$	y^{MLMDUC}	$p'(y)y + p(y) = 0$	y^{CLMDUC}
λ=1	$p'(y)y + p(y) + p(y)R_L'(y) = p'(y)r_f$	y^{MLMDC}	$p'(y)y + p(y) = p'(y)r_f$	y^{CLMDC}

Note:

1. The ordering of equilibrium risk: $y^{MLMDRA} < y^{MLMDUC} < y^{MLMDC}$ and $y^{CLMDRA} < y^{CLMDUC} < y^{CLMDC}$。
2. In competitive loan market, all equilibrium risk will less than corresponding equilibrium risk in every coverage of deposit insurance: $y^{CLMDRA} < y^{MLMDRA}$, $y^{CLMDUC} < y^{MLMDUC}$ and $y^{CLMDC} < y^{MLMDC}$。

Table II. Comparison the F.O.C. conditions between monopolistic and competitive loan market, when deposit market is competitive.

Market Structure / Coverage or Degree of risk aversion	Part C Bank has market power in loan market	Equilibrium Risk	Part D. Bank competes for loan.	Equilibrium Risk
λ< 0	$p'(y)y + p(y) + p(y)R_L'(y) = -\frac{\lambda}{1-\lambda}[R_D'(y)]$	y^{MLCDRA}	$[p'(y)y + p(y)] = -[p(y) + \frac{\lambda}{(1-\lambda)}]R_D'(y)$	y^{CLCDRA}
λ=0	$p'(y)y + p(y) + p(y)R_L'(y) = 0$	y^{MLCDUC}	$p'(y)y + p(y) = -p(y)R_D'$	y^{CLCDUC}
λ=1	$R_L'(y) + \frac{cp'(y)}{(p(y))^2} > 0$	y^{MLCDC} (extreme risk)	$R_D'(y) > 0$	y^{CLCDC} (extreme risk)

Note:

1. In Part C, $R_D'(y) = R_L'(y) + \frac{cp'(y)}{(p(y))^2}$, and $R_L'(y) > R_D'(y)$, *for* $p'(y) < 0$; in Part D, $R_D'(y)$ is equal to $R_L'(y)$ in Part C. Therefore, $y^{MLCDUC} = y^{CLCDUC}$. When λ=1, serious moral hazard problems in both loan and deposit markets, $y^{MLCDC} = y^{CLCDC}$.

2. The ordering of equilibrium risk: $y^{MLCDRA} < y^{MLCDUC} < y^{MLCDC}$(extreme risk), $y^{CLCDRA} < y^{CLCDUC} < y^{CLCDC}$(extreme risk)
3. When $\lambda<0$, after comparing F.O.C. in Part C. and Part D., with $R_L'(y) > R_D'(y)$, we could prove $y^{CLCDRA} < y^{MLCDRA}$.

Figure 1. Bank is monopolistic in loan and deposit markets

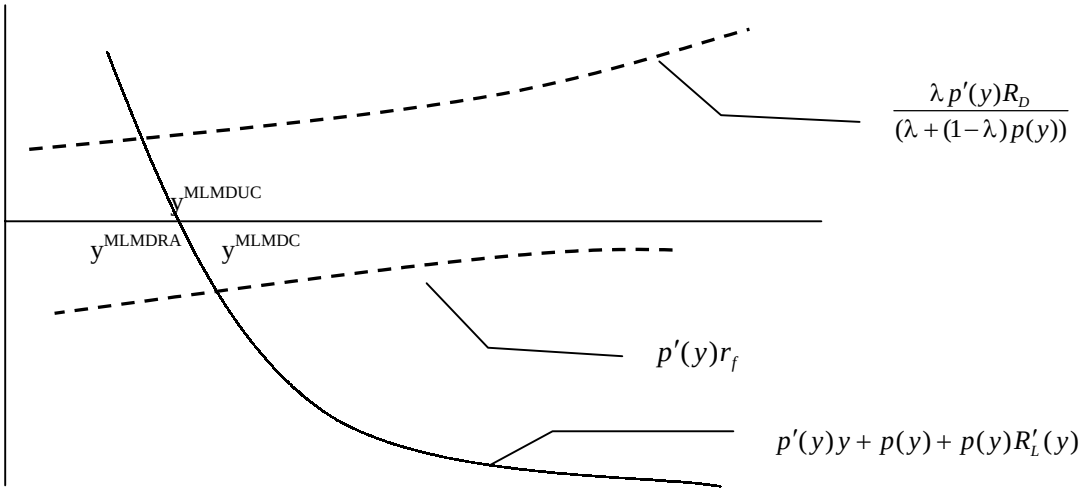


Figure 2. Bank competes for loan and is monopolistic in deposit market

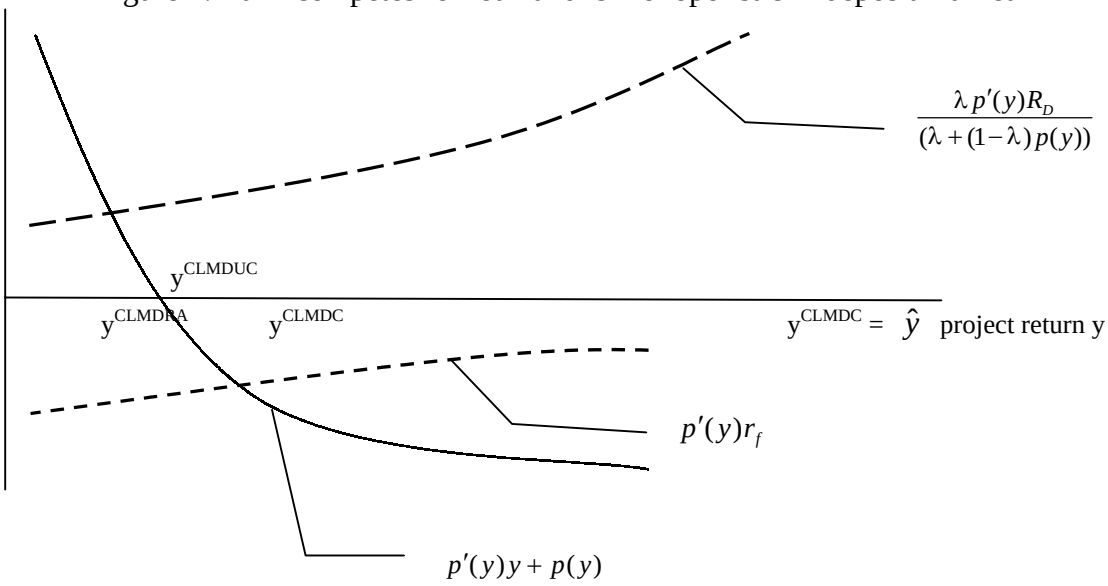


Figure 3. Bank is monopolistic in loan market, but compete for deposit

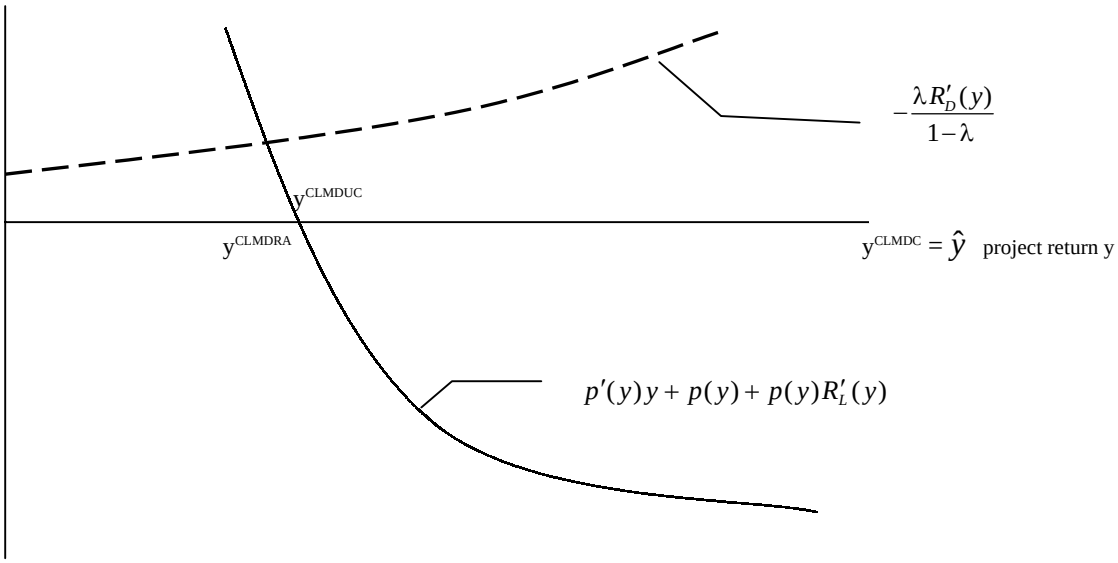
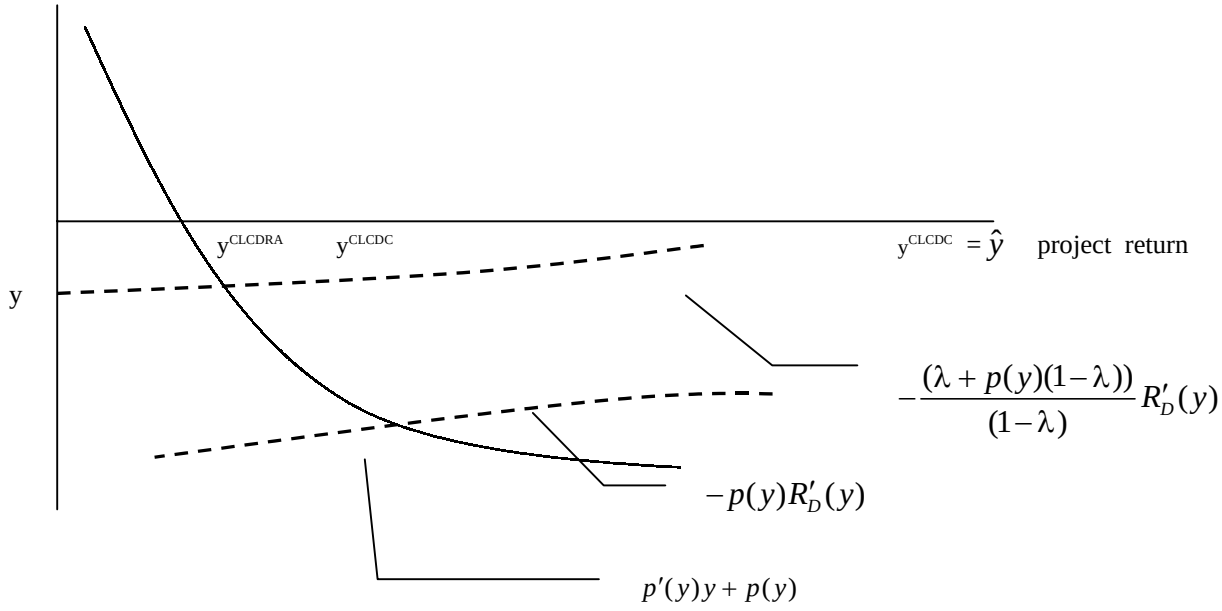


Figure 4. Bank is competitive in loan and deposit market



Appendix I

A. Without deposit insurance ($\lambda = 0$)

Without deposit insurance coverage, depositors will take possible loss in case of project failure and no risk shifting will occur. Therefore, there is no moral hazard problem happened in deposit market. The only risk, existing in loan market, depends on the competitiveness of loan market. Generally, equilibrium risk could be mild rather than extreme high. From these first order conditions, in competitive loan and deposit market situation, we already prove part D's R_D' is equivalent to part C's R_L', which indicates $y^{MLCDUC} = y^{CLCDUC}$.

Comparing these project return (and risk) according to those derived first order conditions, we find the ordering: $y^{CLMDUC} < y^{MLMDUC} = y^{MLCDUC} = y^{CLCDUC}$. From the ordering, there are several results could be concluded.

(1) Under no deposit insurance situation, project risk could be contained because of no risk shifting happened. Depositors will not ask for extreme high required return, even in competitive deposit market.

(2) When deposit market is monopolistic and loan market is competitive, project risk is lower than other three situations. This is because of no moral hazard problem happened.

(3) Except for the case of competitive loan market and monopolistic deposit market, the others market combinations all have same equilibrium. Without deposit insurance, there is no moral hazard problem in deposit market even competition exists. Monopolistic loan market, on the other hand, could induce agency costs between firms and banks and result in higher risk. In competitive loan and deposit market, because of direct interest conflict between depositors and firm, it has similar situation as monopolistic loan market. Hence, it has same equilibrium risk.

B. With full covered deposit insurance ($\lambda = 1$)

With full covered deposit insurance, it will provide mechanism incentives for banks to shift risk to governmental regulator. With competition in deposit market, deposit insurance could exacerbate moral hazard problem by asking for extremely high deposit, which could also result in high project return and risk. This is what we find from competitive deposit market alone with loan market structures, y^{MLCDC} and y^{CLCDC}. On the other hand, in monopolistic deposit market, banks could lower deposit rate with market power and equilibrium risk could be contained. In loan market, competitive loan will lower risk for firm's self interest sake and hence, we find $y^{CLMDC} < y^{MLMDC}$.

In sum, we rank these project return as $y^{CLMDC} < y^{MLMDC} < y^{MLCDC} = y^{CLCDC}$, where y^{MLCDC}, y^{CLCDC} are extreme high.

From the ordering, there several conclusions could be made.

（1） In competitive loan market and monopolistic deposit market, the risk, y^{CLMDC}, will be lower because of no moral hazard in loan market and deposit market even under full covered deposit insurance.

（2） When deposit market is competitive, no matter what kind of loan market structure is, because bank's participation constrain which drives up loan rate and causes firms take extreme high risk. (y^{MLCDC}= y^{CLCDC} = extreme risk)。

C. <u>When deposit insurance is uncovered and depositors are risk averse($\lambda < 0$)</u>

In this situation, there several complicated situations we need to consider. We have to rank right hand side from first order conditions, $\frac{\lambda p'(y)R_D}{(\lambda+(1-\lambda)p(y))}$, $-\frac{\lambda}{1-\lambda}R_D'(y)$ and $-\frac{\lambda}{(1-\lambda)}R_L'(y)$.

From the discussion in Part D, we already know that $R_L' > R_D'$. Therefore, $-\frac{\lambda}{(1-\lambda)}R_L'(y)$ > $-\frac{\lambda}{1-\lambda}R_D'(y)$. Taking difference between $\frac{\lambda p'(y)R_D}{(\lambda+(1-\lambda)p(y))}$ and $-\frac{\lambda}{1-\lambda}R_D'(y)$, we get

$$\frac{\lambda p'(y)R_D}{(\lambda+(1-\lambda)p(y))}+\frac{\lambda}{1-\lambda}R_D'(y)$$

$$=\frac{\lambda}{(1-\lambda)(\lambda+(1-\lambda)p(y))}[(1-\lambda)\frac{\partial p(y)R_D}{\partial y}+\lambda R_D'(y)], \text{ where}$$

$$=\frac{\lambda}{(1-\lambda)(\lambda+(1-\lambda)p(y))}\frac{\partial U^D}{\partial y}$$

$$\frac{\partial U^D}{\partial y}=[(1-\lambda)\frac{\partial p(y)R_D}{\partial y}+\lambda R_D']$$

The sign will depend on $\frac{\partial U^D}{\partial y}$ and λ:

(a) When $\frac{\lambda p'(y)R_D}{(\lambda+(1-\lambda)p(y))} > -\frac{\lambda}{1-\lambda}R_D'(y)$ and project return could be summarized as $y^{CLMDRA} < y^{MLMDRA} < y^{MLCDRA}$ and $y^{CLCDRA} < y^{MLCDRA}$. It implies competitive deposit market will induce risk averse depositors to choose a little bit higher equilibrium risk than under monopolistic deposit market. Given risk-averse characteristic, competitiveness of deposit gives depositors sufficient encouragement to take more risk, even the risk level is lower than when $0 \le \lambda \le 1$.

(b) When $\frac{\lambda p'(y)R_D}{(\lambda+(1-\lambda)p(y))} < -\frac{\lambda}{1-\lambda}R_D'(y)$ and project return could be summarized as $y^{CLCDRA} < y^{MLCDRA} < y^{MLMDRA}$ and $y^{CLMDRA} < y^{MLMDRA}$. It implies that competitive deposit market will induce risk averse depositors to choose lower equilibrium risk rather than higher risk, when increasing y will increase depositor's expected utility.

However, for risk averse depositors, without deposit insurance, will generally choose lower risk level under any kind of loan and deposit market structures.

Appendix II

Proposition: The risk level under unlimited liability contract is lower than that under limited liability.

Proof: If borrowing contract is *unlimited liability*, the firm's objective function is:

$$\max_{\{y\}} \pi_f = p(y)y - R_L, \qquad \text{(A1)}$$

F.O.C. $p'(y)y + p(y) = 0$ (A2)

The optimal y is y^{UL}.

From second order condition (S.O.C.), we know F.O.C. is decreasing in y.

S.O.C. $p''(y)y + 2p'(y) < 0$

If the borrowing contract is limited liability, the firm's objective function is:

$$\max_{\{y\}} \pi_f = p(y)(y - R_L) \qquad \text{(A3)}$$

F.O.C. $p'(y)(y - R_L) + p(y) = 0$ (A4)

The optimal y is y^{LL}.

From negative S.O.C., F.O.C. is decreasing in y, too.

S.O.C. $p''(y)(y - R_L) + 2p'(y) < 0$

Comparing *limited liability* and *unlimited liability* situation's F.O.C., because of $p'(y) < 0$, the optimal y under limited liability (y^{LL}) is greater than the optimal y under unlimited liability(y^{UL}). We prove under limited liability debt contract, entrepreneur will tend to take higher risk than in unlimited liability debt contract. Under limited liability contract, borrowers will repay debt only when investment project succeeds. Therefore, debt with limited liability contract type will induce debtors to have moral hazard incentive and take more risk in order to maximize his expected profit.

Q.E.D.

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