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Fixed Rate Loan Contracts, Maturity Transformation and Competition in the Deposit Market

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Abstract

This paper suggests that the optimal contract in lending under asymmetric information is a fixed rate loan contract. It is shown that deposit banks have an advantage to provide maturity transformation with fixed rate contracts. This is because the spatial nature of deposit market competition makes the oligopolistic cooperation likely. Cooperation, on the other hand, provides banks more stable funding when depositors derive utility from both monetary compensation (interest) and the proximity of banks services. It is also shown that by committing in loan markets to fixed rate returns banks can reduce their incentives to compete over deposits.

Tiivistelmä

Tutkimuksessa osoitetaan, että pankkien talletusvarainhankinta on epätäydellisen kilpailun vallitessa muuta varainhankintaa vakaampaa. Tästä johtuen pankeilla on suoraan rahoitusmarkkinoilta varoja kerääviin instituutioihin verrattuna paremmat edellytykset tarjota kiinteäkorkoisia luottoja, joiden maturiteetti on varainhankinnan maturiteettia pidempi. Lisäksi tutkimuksessa osoitetaan, että sitoutumalla kiinteäkorkoisiin luottoihin pankki voi rajoittaa halukkuuttaan voimakkaaseen talletuskorkokilpailuun ja siten edesauttaa kartellin pysyvyyttä talletusmarkkinoilla.

Contents

1 Introduction

The argument for fixed rate loans is motivated by the ability of this type of contract to stabilize the income of the risk-averse party. For example Koskela (1976) and Fried & Howitt (1980) have argued for fixed rate loan contracts on these grounds. In this paper a complementary explanation for their use is developed: non-contractible actions and asymmetric information can also produce fixed rate loan contracts.

It is then shown that deposit taking institutions have an advantage to provide maturity transformation with fixed rate loan contracts. By building branches and a payment system they can, in an oligopolistic equilibrium, reduce the variability of their funding costs. This reduces the consistency problem otherwise present in maturity transformation: the possibility of a costly run and an early liquidation of assets.[1]

Oligopolistic equilibrium, on the other hand, turns out to be a credible outcome of competition for deposits. This is because branch banking involves large initial sunk costs that restrict entry, and, it is suggested, because depositors vary by geographical location (or by taste) so that only few banks (usually only one bank) can be "closest" to any consumer. Note that otherwise banks would not be able to recover their initial investments under price competition.

It is further suggested that the choice of loan contract affects the degree of competition in deposit markets. With fixed rate loan contracts the oligopolistic cooperation in deposit markets becomes more likely.

This paper, which examines optimal loan contract, deposit market competition and the concistency problem in maturity transformation was motivated by the fact that loans to consumers and small firms have historically been provided by mainly deposit institutions, and these loans have carried fixed rates. (Sometimes variable rate loans were prohibited – e.g. in Finland until 1986). In Finland the introduction of variable rate loans and the resent increase in deposit rate variability (due largely, however, to changes in regulation) have gone hand in hand with the present financial distress.

To develop the arguments of this paper two very different approaches are employed. First, the optimal choice of loan contract is analyzed in a principal agent framework. This is a very general framework and its results do not depend on e.g. the degree of competition in the markets. Taking the results of the first section as given, section three then analyzes deposit market competition with the tools familiar from Industrial Organization Theory. The second part discusses the consistency problem in maturity transformation.

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[1] Baltensperger and Dermine (1987) suggest that this fixed rate loan argument is weakened by the existance of financial futures markets and modern hedging techniques which make possible the provision of long-term fixed-rate assets financed by floating rate deposits. At least in Finland, however, these futures markets serve mainly to redistribut banks' risk. Depositor participation is truly limited. These markets have not been able to remove maturity risk from the entire banking system.

2 Optimality of Fixed Rate Loans

Proposition 1: *If the expected credit losses from customers increase at an increasing rate as a function of the loan interest rate [due to reduced effort or moral hazard in the selection of the continuously chosen investments (e.g. advertisement)], then the optimal contract in lending is a fixed rate contract.*

Assume that it takes long time to create value. More exactly, assume that the realisation of returns from the firm's projects takes two periods and if liquidated early, the projects yield nothing. Let the second period market interest rate be a random variable r_m that can have values between $r_{m1} < ... r_{mi} < ... < r_{mn}$, with probabilities, $p_1, ... p_i, ... p_n$. ($p_i > 0 \ \forall i$, and $\Sigma p_i = 1$). Let R be the gross compensation from a loan of size unity, and I the firm's revenues from an investment that is undertaken if a loan contract is drawn.

Assume that there are two periods. In the first period the contract is drawn and the firms make their investment. At the beginning of period 2, the firm's (agents) observe private demand ε, ε being a random variable with bounded support $[\varepsilon_-\varepsilon^-]$, and the second period market interest rate r_{mi} and choose their effort e. ε and e are not observed by the bank. The choice of effort affects the final outcome of investment and is costly to the agent. The firm's initial wealth is zero.

The firm's utility at the end of period 2 is

$$\Pi = \max [\ I(e(R(r_{mi}),\varepsilon),\varepsilon) - R(r_{mi}), 0\ ] - u(e)$$

and that of the bank

$$\Pi_B = \min [\ R(r_{mi}) - r_{mi},\ I(e(R(r_{mi}),\varepsilon),\varepsilon) - r_{mi}\ ]$$

when the state of the world is i.

As we observe, the firm's revenues, I, do not directly depend on r_m. They do, however, depend on R, as this affects the choice of effort. ε and r_m are independent. (This seems like an acceptable approximation since most of the variability of the firm's returns is independent of the market rate of interest).[2]

The bank's expected profits can be written

[2] You may find the assumption that the firm's revenues are uncorrelated with the market interest rate somewhat strong. It they were perfectly correlated, on the other hand, interest rate levels would have no effect on firms' investments. If you are troubled with this, think of a world where market rate changes move the whole distribution of ε by some fraction of market interest change. Optimal contracts would then imply that a small proportion of all clients loans were variable rate. All that follows should then be read with this correction in mind.

$$E\Pi_B = E[R(r_{mi}) - r_{mi} - \psi(R(r_{mi}),\varepsilon)]$$
$$= \int_\varepsilon \Sigma_i p_i [R(r_{mi}) - r_{mi} - \psi(R(r_{mi}),\varepsilon)]\ f(\varepsilon)\ d\varepsilon$$

where ψ will be specified shortly. Similarly firm's expected utility is:

$$E\Pi = \int_\varepsilon \sum_i p_i [(I(e(R(r_{mi}),\varepsilon),\varepsilon) - R(r_{mi}) - u(e)$$
$$+ \psi(R(r_{mi}),\varepsilon)]\ f(\varepsilon)\ d\varepsilon$$

(zero if no loan agreement is made). $\psi((R(r_{mi}), e(R(r_{mi}), \varepsilon), \varepsilon) = \psi(R(r_{mi}), \varepsilon)$ is the value of the limited liability option issued by the bank valued at the end of the second period. This equals credit losses.

The principal's (bank's) problem in period 1 is to choose $R(r_{mi})$ so that Π_B is maximized given the agent's choices of effort and that the agent chooses to participate:

$$\underset{R}{\text{Max}}\ E\ \Pi_B = \int_\varepsilon \sum p_i\ [R(r_{mi}) - r_{mi} - \psi(R(r_{mi}),\varepsilon)]\ f(\varepsilon)\ d\varepsilon$$

over $R(\cdot) \in \mathbf{R}$, the set of possible return functions.

s.t. (i) $E\ \Pi \geq 0$ agent participates.

(ii) $\Pi(e|\varepsilon,R(r_{mi})) \geq \Pi\ (e'|\varepsilon,R(r_{mi}))\ \forall\ e' \in E$ and $e \in E$.

and agent chooses action e given ε and R.

Let Ω be the expected value of credit lossed $\Omega = \int_\varepsilon \sum p_i\ \psi$. The assumed characteristics of the function being maximized (in proposition 1), namely $\Omega' > 0$, $\Omega'' > 0$, guarantee, that a single maximizing R^* exists. (The profit function for the bank is strictly concave in R, when participation constraint (i) and incentive compability condition (ii) are satisfied.)

An optimal R^* schedule must satisfy:

$$\int_\varepsilon \sum p_i\ \Pi_B(e|\varepsilon,R^*)\ f(\varepsilon)\ d\varepsilon \geq \int_\varepsilon \sum p_i\ \Pi_B(e|\varepsilon,R)\ f(\varepsilon)\ d\varepsilon. \qquad \forall\ R$$

Then, that R^* is not made contingent on the realisation of r_m results from the fact that ex ante choice of any mean preserving variation in R^*, following a tie with market rate would result (because of the convexity of Ω) in a lower expected profits for the bank. Therefore, the optimal contract must have R^* that is independent from the state of the world i. The contract is not made contingent on r_i as this provides no information about the choice of effort.

3 The Consistency Problem in Maturity Transformation

These optimality conditions suggest that when loan markets are considered in isolation, the interest rate on a loan should optimally be fixed. The use of fixed rate contracts in lending was not a problem, as banks are assumed to be risk neutral, if the financial intermediary can obtain credit with the same maturity as the loans have. The depositors, however, need insurance for liquidity and thus agree to deposit for short periods of time only. The borrowers, on the other hand, prefer longer term finance, as it is assumed to take a longer time for them to create value. It is therefore optimal that the financial intermediary provide maturity transformation.

With fixed rate loan contracts, a rise in the short term interest rate (deposit rate), however, then yields losses to the bank and vice versa. Since a rise in interest rate is observed by depositors, and since this increases the probability of bank failure, this might induce depositors to withdraw their money as sequential service provides first withdrawers full compensation, whereas the last will be left without any compensation at all. Sequential service, on the other hand, is necessary as the depositors need for capital is privately observed.

Diamond and Dybvig have shown that there exists a deposit run equilibrium – an equilibrium where all depositors panic and try to withdraw their money. A bank run equilibrium (a la' Diamond and Dybvig) is such an equilibrium where all depositors, even those who had planned to deposit for longer periods, withdraw, as they perceive the other similar depositors to withdraw. This possible "panic" equilibrium can lead to premature liquidation of the bank's assets, which is here assumed to be costly to the bank, to the depositors and thus to the society.[3] This possible equilibrium, which leaves everyone worse off, is what is here called the consistency problem in maturity transformation.

In what follows, it will be assumed that depositors update their perceptions of bank failure from their knowledge of market interest rate and bank loan contracts – and given a sufficiently high probability of bank failure all depositors withdraw.[4] The problem of possible runs can make fixed rate contracts non-optimal for the lending institution. Or, at least, it may encourage more frequent use of variable rate loans than would be optimal. The more stable the funding costs, however, the more frequent we should expect the use of fixed rate loan contracts to be.

[3] This setting, of course, is very similar to that of Diamond and Dybvig, where they show that deposit insurance can be optimal. It would indeed be optimal here as well. This can, however, have its own welfare effects, as is nowadays recognized.

[4] Information based runs are analyzed in Jackling and Bhattacharya (1988).

4 The Deposit Market Equilibrium and the Volatility of Deposit Funding

PROPOSITION 2: *If depositors' utility from deposits depends not only on the interest rates on deposits, but also on the proximity of branches and access to the payment mechanism, banks can in a oligopolistic equilibrium reduce the volatility of their funding costs by investing in a payment system and branch network.*

The results that follow depend on very few assumptions that are characteristic of deposit markets. It is necessary that depositors derive utility from at least two aspects of deposits: a) monetary compensation (interest) and b) the convenience and proximity of deposits as compared to alternative investments, including easy access to payment system. It is also necessary that the cross partial derivative of the utility fuction of depositors is positive: $U_{12} > 0$, i.e. for example that a smaller transaction cost (greater proximity) raises the marginal utility of the monetary compensation.

Deposit market competition is analyzed here using a spatial competition model – more exactly the Salops model of circular city – for two reasons: First, it is easy to build a realistic model that meets these requirements with this model. Secondly, it is shown that in this spatial setting the oligopolistic solution is very easy to attain, and is thus a credible outcome.

Consider a circular city (Salop 1979) where there is a unilaterally distributed continuum of depositors each endowed with 1 unit of assets. Depositors have a transaction cost t when moving along the perimeter of the city (size of unity). Assume for simplicity that banks have no access to risky assets other than loans and that loan riskiness is not a choice variable of the bank. (All loan applicants are identical).

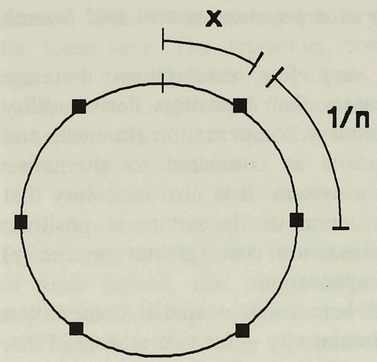
Each period depositors face payments to randomly selected counterparts, that if left unpaid yield them great disutility (e.g. in the form of angry debtors at their door). These payments occur randomly during the period and are symmetric, i.e. all consumers who pay receive an equal amount immediately after their own payment. Assume also that every potential depositor has an alternative to this. She can invest in a stock exchange, where short-term (government and/or bank) debt instruments are sold. The customers who choose not to deposit, can make payment transactions by selling their assets in the stock exchange and delivering the money in person to the counterparty with an expected transaction cost of t_1.[5] It is also assumed that in every period there is some ex ante unknown privately observed fraction of depositors who derive utility from next period consumption only, and will thus not redeposit. These depositors will be replaced by other similar ones in the following period.

Banks decide on the deposit rates each period after they observe the market rate for that period. It is assumed that during normal times banks do not run

[5] Selling market instruments can be done by phone, and the money is sent to the home. This is true also for bank withdrawals and payments (one can e.g. picture the employer paying each period with a check). Hence, there is no costly moving along the perimeter of the city at these stages of the game. Note also that the payment clearing is centralized and provided by the public authority in this economy.

into financial crises as all consumers, who receive payments, instantly redeposit their money. Thus the setting of the game remains the same from period to period. Given all this, the desicion problem of the depositors is to allocate their money each period between (a) a market instrument for one period and (b) a deposit with access to the payment mechanism, which is nearby.

Figure 1.



- Transport cost = t
- Length of the city = 1
- Depositors, each with 1 unit of assets are distributed unilaterally along the perimeter of the city
- Reservation value = $U(r_m,t_1)$

4.1 The Competitive Solution

Assume that there are only two periods, that the short term interest rate is a random variable $r_m = \tilde{r}_m$ that has expected value $E(r_m) = \bar{r}_m$. Entry is possible only in period 1. Assume further, that banks must pay a fixed cost f, when setting up a payment system of a branch. Running the payment system, i.e. servicing the depositor, costs c.

In period 1 banks must decide, whether to set up branches and sell deposits and access to the payment system, or to sell their securities at the stock exchange only. If deposit institutions decide to enter, they are in the first period distributed unilaterally around the city so that their expected per period profits (given that they maximise their profits) are no greater than $\bar{r}_m f$ (a branch can be sold after the second period for f). Assume that in the first period n banks enter with $\Pi^e(\tilde{r}_m, r_d, f) \leq 0$, i.e., the expected profits, if they can invest only in market securities, must be non-positive. Assuming that this holds with equality and that deposit rates vary symmetrically in relation to market interest, the expected cost of capital does not depend on the form of capital.

In period 2 banks that have entered decide on r_d. We shall assume first that the banks' asset values are (or equity capital is) sufficient, and that the utility for the marginal consumer x from easy access to the payment mechanism is great enough so that she will participate (deposit) in each case analyzed. Given n banks and the structure of the game, there is always a consumer x who is indifferent between depositing to a bank i or its closest neighbour. $x \in [0,1/n]$ and x is indifferent between bank i and its neighbouring bank (no subscript) if

$$r_{di} - tx = r_d - t(1/n - x).$$

Demand for deposits is thus

$$D_i(r_{di}, r_d) = 2x = [r_{di} - r_d + t/n]/t,$$

given that

$$U_x(r_d, t_x) \geq u_x(r_m, t_1).^{6}$$

Given the demand, banks maximize profits by setting the deposit rate:

$$\max_{r_{di}} \Pi_B = [R(r_m,D_i) - r_{di} - c]D_i.$$

$R(r_m, D_i)$ is the maximal average return for the funds D_i. Plugging in the formula for demand, remembering that in a Nash equilibrium $r_{di} = r_d$ for identical banks, and differentiating with respect to the deposit rate, r_{di}, gives the first order condition:

$$r_{di} = r(r_m,D_i) - c - t/n. \qquad (4.1)$$

r is the return that can be attained for additional funds.[7]

In the optimum, the deposit rate depends only on the marginal return at D_i, $r(r_m,D_i)$, the marginal costs of production for deposit services, c, the transaction costs for moving, t, and the number of competitors, n. If the maximal return for additional money, r, varies with r_m with a derivative r' then so does the optimal

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[6] The perceived derivative of demand is

$$\frac{\partial D_i}{\partial r_{di}} = \frac{1}{t}.$$

It is assumed that the amount of deposits in the economy does not increase with the interest rate and that the asset return function is continuous and differentiable around 2x.

[7] 4.1 can be written

$$\frac{\partial \Pi_B}{\partial r_{di}} = -D_i + [R(r_m,D_i) - r_{di} - c]\frac{\partial D_i}{\partial r_{di}} + \frac{\partial R(r_m,D_i)}{\partial D_i}\frac{\partial D_i}{\partial r_{di}}D_i = 0$$

To see that this is equivalent to 4.1 one must remember the formulas for the demand and its derivative, and note that $\partial R(r_m,D_i)/\partial D_i = [r(r_m,D_i) - R(r_m,D_i)]/D$. This follows from the fact that average returns are total return ($\mathbb{R}$) divided by deposits D. Differentiating $\mathbb{R}/D$ with respect to D gives $(rD - \mathbb{R})/D^2$. Dividing everything by D gives the result.

deposit rate. Banks can not restrain themselves from competition no matter what prior commitments they have.

If banks can freely enter and exit the money markets and/or lending is a competitive business, so that E(R) varies one-to-one with r_m (the cost of a possible substitute from the firm's point of view), then r' will be positive and equal to one. This could be the case, for example, for the mortgage bond investments of S&L's.

In the type of a world that was considered in part 1, r' is, however, equal to zero if all lending is to firms and banks are not allowed to invest in the money markets. This suggests that there may be reasons to control banks access to money markets. With limited access to money markets, r' can be less than one. This alone would make deposit funding more stable than market funding.[8]

4.2 The Cooperative Solution

Assume now that there are an infinite number of periods and that the short term interest rate is a still a random variable $r_m = \tilde{r_m}$ that has expected value $E(r_m) = \bar{r_m}$ in each period. If building branches takes one period this assumption guarantees that no new entry after initial entry is profitable.

As is obvious from Figure 1, spatial deposit market competition after initial entry is competition with few competitors, i.e. oligopolistic competition. Therefore, it is natural to analyze the deposit market equilibrium using the instruments familiar from the analysis of oligopolistic competition.[9] In this circular city setting any single bank actually prices its deposits taking into account only the prices of its two closest neighbours.

The competitive solution attained earlier is also a solution for this infinitely repeated game, but, as is well known, there exists another one.[10] Consider the following set of strategies. Bank i will set the best oligopoly deposit rate r_M (monopoly price for deposits), if bank j and k (neighbouring banks) set this same rate, but if j or k even once plays differently, i will play r_C infinitely. Banks j and k have similar strategies. This is a typical supergame setting and we know that bank i will have no incentive to compete for deposits in a state of the world r_m if:

[8] Two earlier papers attempting to explain the sluggisness of deposit rates are, according to Santomero (1980), Goldfeld and Jaffee (1970) and Stigum (1976). Both of these papers analyze deposit rate setting in a world, where the amount of deposits in the economy is an increasing function of the interest rate. The role of imperfect competition is not analyzed.

[9] In equilibrium, if entry is not restricted, these firms must however be making zero profits. This implies that banks, realizing a positive probability of after entry imperfect competition, will enter even though with non-cooperative strategies this would mean losses. There will thus be more entry.

[10] If there is any finite number of periods the paradoxal result remains the same. Banks will start competing in the last period, and therefore in the period one before that and so on.

$$\sum_{n=0}^{\infty} E\delta^n \Pi^i_M(R(r_m),r_m) \geq \Pi^i_{max}|r_M(R(r_m),r_m) + \sum_{n=1}^{\infty} E\delta^n \Pi^i_c(R(r_m),r_m) \qquad (4.2)$$

4.2 formalizes the intuitive notion that when there is more to gain from playing cooperative strategies than from deviation, firms will cooperate.[11] Π^i_M is the oligopoly profit for bank i from setting cooperative deposit rate (playing the cooperative oligopoly strategy. At best this profit is one n'th of the monopoly profit). Π^i_C is the profit under competition (also a sustainable equilibrium) and δ^n is the discount factor for period n. $\Pi^i_{max}|r_M$ is the maximal one period profit of cheating when others play the cooperative strategy. All these are functions of the market interest rate.[12]

This condition for oligopolistic cooperation is similar for all the banks in the city and has to hold for all realisations of r_m if the oligopoly solution is to be sustained. It is easy to see that, since $\Pi_M > \Pi_C$, if the periods are small enough – δ is close enough to one – this will generally hold. The folk-theorem, however, tells us that there are an infinite number of equilibria in a game such as the one above. It seems natural to restrict out attention to the best attainable equilibrium from the bank's point of view. (This is the common line of reasoning). This best oligopoly contract minimizes the cost of finance for 1/n:[13]

$$\min_{r_{di}} [D_i\,[r_{di} + c] + [1/n - D_i]r_m] \qquad (4.3)$$

s.t.: $1/n - D_i \geq 0$

From the nature of this spatial setting and the assumption that there is a continuum of depositors along the perimeter of the city, it follows that in all solutions to this problem there must exist some x~ who is indifferent between deposits and the alternative technology. That is, $\exists\, x \sim \in D_i$, s.th:

$$U_{x\sim}(R_d, t_{x\sim}) = U_{x\sim}(r_m, t_1) \qquad (4.4)$$

[11] You may consider the proveability of this equation if there is renegotiation. For what follows, however, all that is necessary is a single period of non-cooperation, assuming that expected losses from this (as compared with oligopoly solution) are great enough to support oligopoly equilibrium with some r_m. You may alter the equilibrium conditions to take this into account and go through the analysis with this specification in mind.

[12] Note that in a spatial competition model such as that above, there is a natural clientele for all banks. Deviating from cooperation is less profitable in this setting than in the traditional analysis where an ε higher price attracts all the demand. Here increasingly higher deposit rates are needed to attract new depositors from the bank's two competitors. As price discrimination is assumed impossible, this means, however, less profits from the old customers at the same time.

[13] Since all n banks are identical, it is reasonable to analyze the game when each bank invests/issus loans worth 1/n. The amount of loans is not crucial, however.

x~ can be the same as the x in the two period analysis above (it is if the constraint in 4.3 is binding), but it need not be. All depositors closer to the bank than x~ strickly prefer deposits. All depositors farther away prefer the alternative technology.

To see that such a depositor x~ must exist, assume the contrary. Assume that with the cost minimizing deposit rate r_{di}^{*} there is no x~, whose participation is binding, i.e. all depositors strictly prefer deposits to the alternative technology. Then the bank could, however, lower its deposit rate by an ε amount, where ε is close to zero, without loosing any demand. But, then the costs of finance would be lower and r_{di}^{*} could not have been the cost minimizing deposit rate. ■

Imperfect competition can then dampen the interest rate volatility of deposit funding if, in any period, the depositor x~, whose participation contract was binding in the former period, accepts a contract ξ from the bank i, where the interest rate of this contract can be expressed: $r_{d-1} + k\Delta r_m$, where k is less than one, Δr_m is the change in the interest rate and r_{d-1} is the previous deposit rate.

ξ is accepted if:

$$U_{x\sim}(r_{d-1} + k\Delta r_m, t_{x\sim}) \geq U_{x\sim}(r_m, t_1), \tag{4.5}$$

for some $k \in (0,1)$. $t_{x\sim}$ is x~'s cost of transport given that he chooses to deposit.

4.5 will hold if $U_{12} > 0$. That is, if a smaller transaction cost (greater proximity) raises the marginal utility of the monetary compensation. This condition is very intuitive, and it is easy to belive that it will generally hold. This contract ξ, which services x~, need not be an optimal one as banks may want to reoptimize. It is however a possible contract, and this is all that is needed for the result.

In an oligopoly supergame equilibrium banks can thus, with very plausible assumptions, dampen the volatility of their funding as compared with market funding.

4.3 The Role of Fixed Rate Contracts in the Incentives to Compete

If banks profits ($R-r_d$) would not affect depositor behaviour the choice of loan contract, fixed rate or not, would have no effect on deposit market behaviour. (Deposit rate setting would then be independent from loan stock, and the choice of loan contract would have an equal effect on the both sides of the equilibrium condition for oligopoly pricing (4.2)).

But the possibility of deposit runs suggests quite the reverse. As we assumed in the first part of this paper, banks' assets are such that if liquidated early they yield less return. This brought a consistency problem that, if high realisations of the market interest rate brought losses to the bank, this might trigger a panic where all depositors withdraw their money. This would cause

early liquidation of assets and would be costly to the bank and to the whole economy.[14]

This is the main difference between choosing to issue fixed rate or variable rate loans. With fixed rate contracts banks increase the probability of deposit runs (early liquidation of assets) if deposit market competition is to break out. The probability of deposit runs is highest when competition is intense and loans are fixed rate. Deposit runs occur when banks make sufficiently large losses, i.e. $R-r_d$ is sufficiently low in one period, or low in many periods at any given time. Note that

a) Profits are higher in imperfect competition in all states of the world. Therefore competition increases the probability of early liquidation.

b) r' is close to one in competition (with access to money markets) and R' is always less than unity. Losses and runs thus occur with high realisations of r_m.

c) R' is close to one with variable rate loans and zero with fixed rate of return. The losses are then (at times of high r_m) greater and the probability of runs higher with fixed rate loans.

Little more formally this can be seen writing 4.2 as:

$$\sum_{n=1}^{\infty} [E\delta^n \Pi_M^i(R(r_m), r_m) - \delta^n \Pi_C^i(R(r_m), r_m)] \geq \Pi_{max}^i | r_M(R(r_m), r_m) - \Pi_M^i(R(r_m), r_m) \tag{4.6}$$

In 4.6 the choice of contract affects left hand side of the equation but not the right hand side (as deposit rates and marginal return for assets on the right hand side are independent of the old loan stock). Choosing fixed rate contracts will increase the difference between the discounted expected value of profits from oligopolistic and competitive outcomes.

To conclude, the possibility of costly early liquidation will decrease mainly the right hand side of the imperfect competition equilibrium condition (4.2) and will do so more in the case of fixed rate loan contracts. Banks can, therefore, by choosing fixed rate loan contracts, reduce their incentives to cheat and trigger a deposit market competition. This further increases banks willingness to choose fixed rate contracts to begin with.

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[14] In this spatial setting we must be a bit careful here. Note first that if deposits have priority over other bank notes, a bank under stress cannot issue any market instruments. If then the consumer x (most far away) withdraws, a small portion of assets must be liquidated. This brings down the average return. This new average return might then induce the next depositor to react and the chain may go all the way, depending on relative sizes of the cost to liquividation, R^0 (earlier it was assumed at -R), and transport cost, t. Thus perceiving all other depositors to react it may well be rational for all depositors, even those closest to the bank, to react and run (if $-R^0 > t$).

5 Discussion

In this paper it has been suggested that the optimal contract in financial intermediation is a fixed rate loan contract. Deposit banks have an advantage in providing maturity transformation with fixed rate contracts since the spatial nature of deposit competition allows the use of monopoly power, which results in more stable funding. It was also shown that by committing to fixed rate returns in loan markets banks can reduce their incentives to compete for deposits.

So far the most convincing argument for the marked advantage of deposit institutions in loan markets is in Fama (1985). He has suggested that this competitive edge of banks in lending is due to the informational advantage that banks acquire from operating in deposit markets. This argument was formalized by Vale (1990). In this paper I have presented an alternative explanation for deposit institutions advantage in issuing credit. Based on the optimality of fixed rate contracts, it was shown that deposit institutions have an advantage in providing maturity transformation in loan markets.

In recent years the cost of banks deposit funding has however increased and the costs of this funding has become more volatile. It is interesting to note, that this model produces some explanations to these phenomenons. They rest on the fact that the alternative technology for payment transmission has been revolutionized in the last decade (e.g. credit cards). If the transport cost of the alternative technology, t_1 in the participation constraint is interpreted as the cost of the alternative technology, then as t_1 goes down the deposit rates go up. Also as t_1 approaches t_x this will make the deposit funding less stable (as $U_{12} > 0$). It is also suggested that the mere change to variable rate loan contracts could have affected the variability of deposit funding.

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