FUNDACION BBV

DOCUMENTA

# Competition for deposits, risk of failure, and regulation in Banking

C. Matutes and X. Vives

*Junio 1992*

INVESTIGACION

# *Competition for deposits, risk of failure, and regulation in Banking*

C. Matutes and X. Vives *Junio 1992*

Centro de Estudios Bancarios de la Fundación BBV.

Director del Centro: D. Luis Angel Lerena Guinea, catedrático de Economía Internacional de la Universidad Complutense de Madrid.

Director de Programas de Investigación: D. Xavier Vives

Seminario de Investigación número 5

# COMPETITION FOR DEPOSITS, RISK OF FAILURE, AND REGULATION IN BANKING

*Carmen Matutes and Xavier Vives**
*Universitat Autònoma de Barcelona*

**Abstract**

We develop a model of banking competition for deposits based on modern financial intermediation theory and industrial organization analysis. The standard demand deposit contract makes banks vulnerable to failure and introduces (endogenous) expectations based vertical differentiation. A multiplicy problem and introduce the possibility of confidence crises. It is found that "excessive" competition is not responsible for the fragility of unregulated banking (the multiplicity problem) but nevertheless competition is socially excessive at benchmark market equilibria. Our frmanework allows us to disentangle the effects of failure perceptions on rivalry. We find that a safer bank will command a higher margin and market share, and that in a symmetric equilibrium the possibility of failure softens competition. Further, fair and risk-based deposit insurance, even in the absence of moral hazard problems, induces competition above uninsured market levels introducing a rationale for deposit rate regulation. Our analysis provides a framework to assess the welfare trade-offs associated with deposit insurance, uncovering positive effects, like extending the market an minimizing frictions, beyond well-known stabilizing consequences.

Keywords: Banking competition, risk of failure, network externalities, vertical differentiation, financial intermediation, deposit insurance, rate regulation.

## 1. Introduction

The purpose of this paper is to analyze some relevant issues in banking competition, including the implications of the possibility of bankruptcy in rivalry, the impact on competition of depositors' expectations, the connections between the potential fragility of unregulated banking and "excessive" competition, and the role of deposit insurance and rate regulation. In the process we also make a methodological contribution to the modeling of banking competition, particularly on the deposit side, by bringing together various strands of the literature, namely modern financial intermediation theories and industrial organization analysis.

Episodes of widespread failures and runs are recurrent in the history of banking, having influenced heavily successive regulation. In this respect, competition for depositors has traditionally been considered a source of instability problems, runs, and excessive risk taking well

* We are grateful to Patrick Bolton, Ramón Caminal, Pierre-André Chiappori, Jean Dermine, Mathias Dewatripont, Kai-Uwe Kühn, Paul Klemperer, Jorge Padilla, Jean Charles Rochet, and Josef Sakovics for helpful comments. The research reported in this paper has been supported by the Fundación Banco Bilbao Vizcaya. Further partial support has been provided by the Spanish Ministry of Education through CICYT grants PB 87-0340 and PB 89-0074.

before deposit insurance was established (1). The solution to these problems has been one of the main objectives of regulation. Regulatory measures like rate regulation, the lender of last resort and deposit insurance have been widely implemented. Deposit rate regulation was stablished in the US during the 1930's and in Europe at different times. In fact, rates have remained regulated in most countries until recently. Sometimes govenments (specially in Europe) have encouraged collusive agreements among banks in the belief that this would promote stability (2). In the US, the creation of a lender of last resort, via the introduction of the Federal Reserve System (1914) and ultimately the establishment of deposit insurance (1934) have provided stability to the system. Indeed, regulation (which also included direct restrictions on banks' operations) (3) succeeded in preventing bank runs, and limiting the number of failures between 1940 and 1980. In this period, from about a total of 13,500, only 299 insured commercial banks failed, and mostly as a result a fraud, as opposed to 9,106 between 1930 and 1933, when the number of banks was less than 24,500 in 1930 (Jaffee (1989)).

Deregulation in banking was fostered by the entry in the 1970's of money market mutual funds offering high yields to investors (combined with the disintermediation process).

Banks and thrifts were increasingly allowed to compete in deposit rates (by the end of 1983, all depository institutions could freely set the rates paid on all deposits) and other restrictions were relaxed. The 1980's have witnessed a substantial increase in bank failures, including the thrifs debacle, straining the safety net and triggering a debate over banking regulation (4). Existing proposals of reform apart from improved accounting and supervision, include "narrow bank" proposals (100% reserve requirement in the extreme) and changing the deposit insurance system towards risk based premiums and limiting its coverage (5). Rate regulation has been set aside as a regulatory tool, the emphasis being replaced by the forcus on establishing limits to deposit insurance, which is now seen by some practiciones as the main cause of excessive rate rivalry. (6)

Regulatory reforms (and proposals for reform) follow one another and yet the mechanism by which "excessive" competition for depositors exist or may be destabilizing is far from clear. It is therefore important to understand the links between competiton and the potential fragility or instability of the banking sector. It is essential to analyze the impact of the possibility of failure of a bank on the behavior of depositors in a context where they receive competing rate offers. Only then the implications of deposit insurance on competition can be understood and the potential need of rate regulation assessed.

In this paper we take as a starting point the elements of the intermediation theories advan-

---

1 See Sprague (1910) and Friedman and Schwartz (1965).

2 See Baltensperger and Dermine (1987) and Vives (1991).

3 Basic regulation is contained in the Pepper-McFadden Act (1927) and in the Banking Act (1933) (Glass-Steagall), the latter separating commercial from investment banking.

4 The mounting losses accumulated in the S&L crisis provide a good example. The Federal Savings and Loans Insurance Corporation (FSLIC) created in 1934 became insolvent. Furthermore, the crisis affects commercial banks as well: between 1985 and 1988 almost twice as many banks (698) as S&L (357) closed because of financial difficulties (Jaffee(1989)). _ 5. See for example, Boot and Greenbaum (1991) for a summary of existent proposals of reforms and new proposals.

6 Deposit insurance "subsidises uneconomical banking practices and destroys the market's ability properly to price deposit and loan rates" and encourages "deposit rates that are too high and lending rates that are too low-given the level of risk- just to win business" (Euromoney (p.33, US Banking, February, 1991)).

ced by Diamond (1984) and Diamond and Dybvig (1983) and buld a competiton model of banking inspired in moder industrial organization analysis (product differentiation and network externalities in particular). We consider that financial intermediaries emerge as a response to the imperfections and incompleteness of financial markets arising mainly from asymmetric information problems. Banks serve many functions, among them facilitating transactions and portfolio management, but it is their special role as intermediaries between lenders and borrowers under asymmetric information which leaves them vulnerable to confidence crises. (7) Indeed, banks take advantage of their superiority in minimizing incentive trasaction costs in monitoring loans but have to offer a standard demand deposit contract to lenders, not contingent on the realized portfolio of the bank, since depositors can not monitor the returns of the bank. Confidence crises are not unique to banking but it is in this sector when they are more prominent and where they might cause larger negative externalities.

We do not pretend to build a comprehensive model of banking competition. Some important aspects, such as competition on the asset side and the moral hazard problem associated with taking too much risk in certain limited liability contexts, are not addressed (8). For the most part, banks in our paper bear the full cost of bankruptcy, abstracting thus from limited liability issues. This way we simplify the analysis and isolate the interaction of competition for deposits and failure risk.

The ingredients of our model include differentiation, asymmetric information, economies of scale and rational depositors. First, product differentiation is pervasive in retail banking as competition on the number and location of branches and ATM networks shows. Furthermore, parametrized product differentiation allows comparative statics exercises with respect to the degree of market power and enriches considerably the welfare and public policy analysis. Next, any banking model should incorporate the fact the investors do not observe the returns obtained by borrowers. As a result, a standard debt contract, with nonpecuniary penalties a la Diamond (1984) or monitoring à la Gale-Hellwig (1985) is required for incentive purposes. Economies of scale are at the core of banks activity as intermediaries. Banks invest in risky projects which require the funds of many depositors (minimum size); there may also exist benefits to diversification (though empirical evidence suggest that they are exhausted at relatively small sizes). Finally, depositors are assumed to be rational and have homogeneous beliefs.

Our research program starts by looking at free banking competition in a contest where banks can fail and then examine the implications of deposit insurance and rate regulation. Our analysis uncovers that the quality of a bank (its probability of success) is endogenously determined by depositors' expectations which create a vertically differentiated structure (9) and which may result in a multiplicity of equilibria (including corner or "naturla monopoly" equilibria where one bank is out of the market) or even no banking ("systemic confidence crisis"). Quality is endogenous, yet it is fragile because of the self-fulfilling character of expectations. The efeect of the margin of the bank on its failure probability is the first mechanism through which different possible depositors' expectations become self-fulfilling: a bank which is perceived safer will command a higher margin, which in turn will make the bank actually safer. Economies of scale (minimum size

7 Apart from the leading contributions of Diamond and Dybvig (1983) and Bryant (1980) to the bank run/confidence crisis literature see also Postlewaite and Vives (1987), Jacklin and Bhattacharya (1988) and Aghion, Boltion and Dewatripont (1988).

8 For an analysis of theses issues see Genotte and Pyle (1990) and Genotte (1990).

inverstments and diversification economies) reinforce this mechanism and contribute to the multiplicity problem. For example, a bank which is perceived safer commands a higher market share which makes the bank actually safer because of better divesification. In fact, a bank can be understood as a network: a larger bank with more depositors will be letter diversified and will have a lower probability of failure (higher quality). Our model, can be understood also as a generalization of the standard network externalities model to a situation where margins, as well as market share, influence quality (probability of success) (10).

The root of the multiplicity of equilibria lies in the coordination problem which arises from the interplay of the standard deposit contract and the expectations of depositors and not from "excessive" competition. A monopoly bank could suffer from instability. This is in line with the results of Diamond and Dybvig (1983), although in our case instead of runs we have no-banking equilibria. However, we find that when banks are direct competitors, even thoug the possibility of failure softens rivalry, they tend to compete excessively: by lowering rates social welfare could be increased via a reduction of the probability of failure, which is costly given the presence of bankruptcy penalties associated to incentive contracts. Our results are also in line with those of Yanelle (1989, 1991) who studies a model of endogenous financial intermediation with double-sided competition. She finds also multiple equilibria in different extensive form multistage games.

A consequence of our analysis is that higher levels of product differentiation (friction) and hence market power are not necessarily detrimental from a welfare point of view. Indeed, higher margins do tend to decrease failure probabilities and may compensate the increased market friction. The introduction of fair and risk based deposit insurance, even in the absence of moral hazard problems, will induce fiercer competition since depositors will not "discount" the rates offered by banks (anyway they will be paid back). Excessive competition would be aggravated with flat insurance premiums. However, deposit insurance does prevent the occurrence of systemic confidence crisis, minimizes frictions (transport costs), and tends to extend the market by increasing the incentive to deposit (althoug, by insuring that all banks are active, may preclude the realization of desirable diversification economies). Our model thus allows the analysis of the welfare trade-offs involved in deposit insurance and provides a rationale for deposit rate regulation (11).

Section 2 introduces the model. Section 3 examines banking rivalry with given perceptions of depositors. Section 4 characterizes the equilibria of the model. Section 5 studies equilibria with deposit insurance and explores the welfare implications of insurance and rate regulation. Concluding remarks close the paper.

## 2. The model

Risk neutral banks raise money from depositors, offering them a standard demand deposit contract, and invest the proccedings giving loans to firms. Depositors can not invest directly in firms' projects. In this sense we take the need of financial intermediation for granted.

[9] See Gabszewicz and Thisse (1979) and Shaked and Sutton (1983) for an analysis of vertical differentiation. Gehrig (1990) has also studied vertical differentiation aspects of intermediated markets in the presence of search costs of trading partners.

[10] See, for example, Katz and Shapiro (1985) and Farrell and Saloner (1985, 1989) for examples of network externalities models and Dybving and Spatt (1983) for an early adoption externalities model.

[11] Bhattacharya (1982) also provides a rationale for interest rate restrictions.

The features of the model are as follows:

i. Differentiation. This is introduced via a standar Hotelling model. Depositors are uniformly distributed on a unit segment ¿0,1¿. There are two banks: bank a is located at 0 and bank b is located at 1. Depositors are risk neutral, have an inelastic supply of one unit of funds with a reservation value v (the return of a risk free outside opportunity), and face linear transport costs at rate t ($t \geq 0$). They have to decide whether to deposit in a bank or keep their endowment, and in the former case in what bank to deposit.

ii. Incentive contracts and price competition. Depositors do not observe the returns of the bank. Bank i offers a fixed (gross) rate $r_i$ to its customers according to a standard debt contract with nonpecuniary bankruptcy penalties similar as in Diamond (1984). If the bank fails (that is, the revenue obtained by the banks does not cover the face value of debt) it declares bankruptcy. In this case we make the simplifying assumption that depositors do not receive anything and that the funds left are frozen by the govenment (12). The bank suffers an endogenous nonpecuniary penalty which leaves it indifferent with respect to the case which it had to pay the posted rate. If bank i quotes a rate r¿ per depositor and intends to pay z, it suffers a nonpecuniary penalty equal to $\delta(z) = \max(r_i - z, 0)$.

iii. Investment. Bank i can invest the proceeds of its deposits in entrepreneurial projects. Let $n_i$ represent the deposit market share (and the total amount of funds at the disposal) of bank i. Denote by $R_i$ the non-negative (random) return of a unit of funds invested by bank i when the bank invests n¿. It is assumed that $ER_i = R$, where $\bar{R} > v$ is a positive constant (independent of $n_i$). $R_i - R$ is distributed according to a distribution function $F(.; n_i)$ which is of class $C^2$ (on both arguments) with support on $[\theta_1,\theta_2]$, $\theta \geq -R$. The bank can also invest in reserves (with no return). Bank i, investing $n_i$, declares bankruptcy when revenues can not cover payment obligations: $R_i < r_i$.

Assuming the bank invest all its funds, and given the standard debt contract the expected profits of bank i can be written simply as $E\pi_i = (R - r_i)\, n_i$. This is so since expected revenue equals $E\{R_i\, n_i\}$, with $ER_i = R$, and expected deposit costs equal $n_i r_i$, given the bankruptcy penalty à la Diamond. Given our assumptions the bank always invests all deposits in risky loans (and nothing at the risk free rate v).

iv Diversification and size. We say that a bank needs a minimum size to be viable whenever an investment project needs the funds of a (small but positive) proportion of total funds s to be financed. A bank needs then to atract at leat a market share of s. Otherwise the bank can not invest and it is not viable. For convenience and simplicity of exposition we adopt the convention that in the presence of minimum size investments bank i setting rate $r_i \leq R$ fails with probability one only if $n_i = 0$. Given $r_i$ the probability of failure of bank i is given by $F(r_i - R;\, n_i)$ (with $F(r_i - R;\, 0) = 1$ with a minimum size requirement). Notice that the probability of failure is decreasing in the expected net revenue per unit of

12 Alternatively we could suppose that the bank keeps the income it has obtained and suffers a larger endogenous nonpecuniary penalty ($r_i$ per unit deposited whenever the bank fails and 0 otherwise) which leaves it again indifferent with respect to the case where it had to pay the posted rate.

funds $R - r_i$. It is reasonable to suppose that a bank by investing more can diversify anyway some of the risk it faces. We say that diversification economies exist if $F_2$ $F_1$ will denote the partial derivate of F with respect to the it argument) is negative whenever the bank makes non-negative expected net revenue: $R - r_i \geq 0$ In this case the probability of failure is decreasing in the market share of the bank $n_i$.

v The extensive form we consider is as follows (see Figure 1). Depositors are endowed with homogeneous prior beliefs ($^e p_a$, $^e p_b$) about the probabilities of success of banks. Banks, knowing these beliefs. set deposit rates. In turn, depositors, upon observing the rates offered, choose which bank to patronize. Consumers deposit in the bank which offers the higher expected return net of success $p_a$ and $p_b$, the market share of bank i is given by $n_i = 1/2 + (p_i r_i - p_j r_j)/2t$, $j \neq i$ provided $p_i r_i - p_j r_j$ is in the interval $[-t, t]$ and $p_i r_i - t n_i \geq v$, $i = a,b$. If $p_i r_i - p_j r_j$ is in the interval $[-t, t]$ but $p_i r_i - t n_i < v$, then some consumers in the middle of the interval are not served (do not deposit) and banks do not compete directly with one another but have local monopolies. If $p_i r_i - p_j r_j$ is not in the interval $[-t, t]$, then all consumers prefer the bank with higher expected return and the other bank is left out of the market. Banks invest the funds collected, returns are obtained, and, except in case of failure, deposit payments are made. In equilibrium depositors' expectations are fulfulled, that is, $^e p_i = 1 - F(r_i^* - R; n_i^*)$. where $r_i^*$ and $n_i^*$ denote equilibrium magnitudes. The model therefore has a rational expectations flavor.

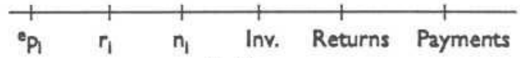

Fig. 1

The equilibria of our model can be understood also as perfect Bayesian equilibria (PBE) of a game with Bayesian depositors having (degenerate) point prior beliefs ($^e p_a$, $^e p_b$) which are constant out of the equilibrium path (and fulfilled in equilibrium, obviously). If depositors expect (equilibrium) rates $r^*$ to obtain and banks set those rates then at a PBE necessarily the point initial expectations are confirmed. Otherwise, if banks set different rates (which is a zero probability event), Bayesian consistency does not impose any restriction on the updating of beliefs. Our model would call then for depositors not to modifiy their initial beliefs (13).

We could term the situation considered parametric perceptions since in this case banks take as given the perceived probabilities of failure of depositors. In Appendix II we consider another extensive form (updating rule) according to which banks can influence the expectations of depositors with their choice of deposit rates. The insights derived from this alternative extensive form are similar to the ones derived from the parametric specification but the model is less tractable (see the discussion in Appendix Ii for a comparison of results between the two approaches).

An example satisfying our assumptions with uniform distributions, and which will be used subsequently, is the following. Given $n_i > 0$, $R_i - R$ is uniformly distributed on $[-\Theta, \Theta]$, where $\Theta = \beta - (\beta - \alpha) n_i$ ., and $R \geq \beta > \alpha > 0$. Note that $R_i$ is symmetrically distributed around its mean R.

[13] Two requirements must be fulfilled at a PBE: (1) beliefs must be consistent, that is ($^e p_a$, $^e p_b$) must equal the true probabilities of success, and (2) banks must maximize expected profits taking into account the updating rule followed by depositors.

The probability of success of a bank with a market share of n which offers a deposit rate r is given then by $p = 1/2 + (R-r)/2(\beta-(\beta-\alpha)n)$. provided $n>0$ (equal to zero if $n = 0$ and projects need a minimum size). Furthermore, these are diversification economies since $F_2$ is negative when $r \leq R$.

In the next section we examine competition among banks for given fixed perceptions. In section 4 we close the model by endogenizing perceptions and consider the equilibria of the game.

## 3 Bank competition with given depositors' perceptions

In this section we consider fixed perceptions $(p_a, p_b)$ of depositors and examine possible outcomes of rate competition among banks. Given a rate $r_b$ such that $p_a R \geq p_b r_b - t$ (which insures that bank a is not out of the market), the optimum response by bank a is very much similar to the typical Hotelling model. The optimum response is easily seen to be $r_a = B_a(r_b) = (p_a R - t + p_b r_b)/(2p_a)$. It can be checked that it never pays for bank a to price out of the market bank b setting a rate $r_a = (p_b r_b + t)/p_a$(14). The higher $p_b$ the larger the deposit rate set by firm a (see Figure 2). This is because the higher $p_b$ the lower becomes a' s market share for a given $r_a$ and hence it is not as costly to attract an additional customer (the increase in $r_a$ must be paid to a smaller consumer base). Instead, an increase in $p_a$ has an ambiguous impact; on one hand, a slight increase in $r_a$ attracts a larger number of new consumers the larger is $p_a$ and thus a higher $p_a$ provides bank a with an incentive to offer a larger deposit rate. On the other hand, a larger $p_a$ means that, for any given $r_a$, bank a enjoys a larger market share and hence increasing $r_a$ becomes mor costly; that is, bank a becomes a fat cat in the terminology of Fudenberg and Tirole (1984) (see Figure 3). If $p_a = p_b = p$, and given a market of fixed size, the market share fat cat effect vanishes, and increasing p makes banks more aggressive.

[14] The discontinuous Hotelling best response function, when one firm captures the hinterland of the other firm, does not arise here since banks are located at the extremes of the segment.

The following proposition and associated Table I give the equilibria of our modified (because of failure probabilities) Hotelling game according to different regions of parameters (see Appendix I for a complete statement and proof of Proposition I).

Proposition I. Given $p_a = p_b = 0$:

I. When $p_iR < v$, $i = a,b$, there is no active banking.

II. When $p_bR < v$ and $p_aR > v$, bank a is a natural monopoly (with blockaded entry).

III. When $p_iR \geq v$ $i = a,b$:

(i) If $(p_b+p_b)R>(2v+3t)$., banks compete. If the difference in perceptions of success of banks is small relative to the transport cost $(3t>R(p_b-p_b))$ then there is a unique interior equilibrium, in which the safer bank (a) enjoys a higher margin and market share. Otherwise $(3t\leq R(p_a-p_b))$, bank a enjoys a natural monopoly (with impeded entry).

(ii) If $2(t+v)>(p_a+p_b)R$. banks have local monopolies.

(iii) Otherwise, there are multiple "touching markets" equilibria, with all the market being served.

Let us focus first in the symmetric case, $p_a=p_b=p$, to understand the parameter regions inducing different equilibria (see Figure 4). Suppose that the parameters R and t are such that with p = 1 the equilibruium is of the competitive type. Then when p is very low both banks are out of the market since they can not offer an expected return larger than the reservation value v. For larger p's banks enjoy local monopolies (LM) since their potential market areas do not overlap. Further increases in p make the market areas of the rivals just "touch" (TM) as in Salop's kinked equilibrium (Salop (1979) and Economides (1984)). For still larger p's banks compete directly (DC). It is interesting to notice that the margin $x = R-r$. is not monotone in p: the possibility of failure has an ambiguous impact on margins depending on the type of equilibrium. The margin increases over the regions of LM $(x = (R/2)-v/2p)$ -and also TM $(x = R-(v+t/2)/p)$- and decreases in the region of DC $(x = t/p)$. A monopoly bank which is considered safer can offer lower rates. A bank facing competition (of equal perceived soundedness) will become more aggressive, as we have argued, when the perception of success increases simultaneously for both institutions. Nevertheless the margin with DC is always larger than the margin with LM whenever probabilities of success are larger than 1/2 (this must be the case with symmetric distributions).

Proposition I highlights the importance of the perceptions of depositors in banking competition. Identify now the "reputation" or "quality" of a bank with its perceived probability of success. This introduces vertical differentiation in banking competition: if all banks were to offer the same rates, and there were no other differentation elements, depositors would prefer the safer ones. A natural monopoly structure (a natural oligopoly in a market with m banks) may thus emerge. This is a situation where only a few firms can survive in the market despite the fact that fixed costs may be low and entry free. Essentially, strong price competition among high quality firms may leave no room for lower quality products.

In our duopoly model, two types of natural monopoly situations may emerge. In the first, one bank, say b, is perceived as of sufficiently low quality that it cannot attract depositors, independently of the behavior of bank a (case II, natural monoply with blockaded entry , NM (BE) region in Figure 4). The second situation is

one where bank b could earn positive profits as a monopolist, but the high quality bank drives it out of the market (case III (i), natural monopoly with impeded entry, NM (IE) region in Figure 4).

Since our model incorporates horizontal differentiation as well, the possibility of one bank driving its rival out in equilibrium depends on the magnitude of the transportation cost. Only when the transportation cost is low relative to the difference in the quality of banks, may such an equilibrium arise. Indeed, when $3t/R > p_a - p_b$., both firms share the market and directly compete with one another (case III (i) interior equilibrium; region DC in Figure 4).

When banks are direct competitors the safer bank (a, when $p_a > p_b$) enjoys a higher margin and market share [15]. The safer bank setting a lower deposit rate can attract a larger market share (the fat cat effect we have referred to before). Interpreting the fixed perceptions of depositors as corresponding to a case where banks a and b are entering a new market which is small compared to the set of markets already served (and therefore the business in this new market does not affect the overall failure probability of the institutions), a larger bank (which is more diversified and therefore safer) captures a larger fraction of the new market while offering a lower deposit rate than a smaller rival [16].

[15] This need not be the case in the touching markets case III (ii).

[16] Further, in this interpretation, the condition stated in the vertical differentiation literature (eg. Shaked and Sutton (1983)) for the emergence of a natural oligopoly seems to be satisfied: the burden of the increase in quality (increase in the customer base to profit from diversification economies) falls basically on fixed costs (investment in the branch network, ATM systems and promotion).

An initial advantage may therefore snowball showing the banking market a tendency towards concentration.

## 4. Equilibrium characterization

Given perceptions $p_i$, $i$ = a,b Proposition 1 characterizes possible equilibria in deposit rates. An equilibrium of the game requires depositors perceptions to be self-fulfilling: the probabilities of success must satisfy $p_i = 1 - F(r_i - R; n_i)$, $i$ = a,b, where $n_i$ is the outcome of price competition among banks taking parametrically the probabilities of success $p_i$ as in Proposition 1. Several types of equilibria may arise.

Proposition 2. Apart from equilibria of the local monopoly or touching markets type, possible equilibria are as follows:

(i) Interior symmetric equilibruium. When it exists it is unique and is characterized by $x^*=R-r^*=t/p^*$ (with $2p^*R > 3t + 2v$). The success probability $p^*$ and the equilibrium margin $x^*$ are independent of R. Provided $p^*<1$, $p^*$ and $x^*$ increase with t.

(ii) Interior asymmetric equilibria (where the safer bank has a higher margin and market share).

(iii) Corner asymmetric equilibria: $ni > 0$, $n_j=0$, $i \neq j$. These are always possible when there is minimum size investment provided the monopoly (rational expectations) equilibrium exists (it involves necessarily $pi>0$, $p_j=0$, $i \neq j$.

(iv) No banking equilibruium: $n_i=0$ (and $p_i=0$), $i$ = a,b. It is always an equilibrium with minimum size investments.

**Proof:**

(i) From Proposition !, we know that if there is a symmetric equilibrium then $R-r^*=t/p^*$. Furthermore, $p^*$ must be the true probability of success. Therefore, $p^*= 1-F(r^* - R; 1/2)$. Let us now define x as R-r. It is clear then that an equilibrium exists and it is unique if the system of equations:

(1) $p= 1- F(-x; 1/2)$.

(2) $x= t/p$

has a unique solution, $x^*$, $p^*$. Notice that, since the probability of failure decreases with the margin, (1) defines p as an increasing function of x. On the other hand, from (2) x is a decreasing function of p; furthermore, from (2), when $p = 0$, x is infinity. Hence, (1) and (2) intersect only once. Hence the equilibrium exists and it is unique provided that consumers derive non-negative surplus; from Proposition 1, we know that this requires $2p^*R>3t + 2v$. Furthermore, notice that (2) implies that $x = t$ if $p = 1$. Therefore, in equilibrium $p^*<1$ if $1- F(-t; 1/2) < 1$.

The comparative statics properties of this equilibrium are easily derived. Totally differentiating (1) and (2) we obtain:

$dp^*/dR= dx^*/dR=0$, thus $dr^*/dR=1$,

$dp^*/dt=(pF_1)/(p^2 + F_1 t)> 0$, and
$dx^*/dt=p/(p^2+F_1t)>0$, thus $dr^*/dt<0$,

(ii) See the example at the end of the proof. Furthermore, asymmetric interior equilibria have to satisfy Proposition 1 (i) and therefore the safer bank has a higher margin and market share.

(iii) If the monopoly (rational expectations) equilibrium exists then ${}^ep_a=0$ is self-fulfilling and there is a positive $p_b$ which is also self-fulfilling. Indeed, if ${}^ep_a=0$, then bank a is indifferent about the rate to set and $n_a=0$. It follows that $p_a=0$ since the bank needs a positive market share to invest.

(iv) Let ${}^e p_i=0$, $i = a,b$. Then banks have no customers for any interest rates offered. In consequence, $n_i=0$, $i = a,b$, and the probability of failure of any bank is one provided a minimum investment is needed.

In the uniform example equilibria of the type (i), (ii), (iii) and (iv) obtain simultaneously (with (iii) and (iv) obtaining provided a minimum bank size is needed). Symmetric local monopoly (and hence, the natural monopoly equilibrium) and "touching markets" equilibria may also arise. Figure 5 shows the region of existence in (R,t) space for all these equilibria when $\beta=4$, $\alpha=2$, and $v=1$.

Remark: At the benchmark symmetric interior equilibrium (i) when R increases the margin stays constant and depositors appropriate the increased expected returns. Further, an increased friction in the market (increased t) raises margins and probabilities of success. Enhanced market power makes failure less likely.

An striking fact is that, in contrast with the typical Hotelling competition case (even modified as in Proposition 1 with some fixed probabilities of failure) where equilibria are unique- except possibly in the touching markets region-, there is in general a multiplicity of equlibria. The main root of the multiplicity is the self-fulfilling character of expectations of depositors in the presence of the standard deposit contract. A bank with high perceived quality (probability of success) sets a lower rate and commands a larger market share which may sustain and make self-fulfilling the initial belief. This may happen even in the absence of diversification economies and minimum size projects as the following example shows.

Example. Assume that there are no diversification economies or minimum size projects and that R takes the values, $R_1$, $R_2$ and $R_3$ with probabilities $\alpha_1$, $\alpha_2$ and $\alpha_3$ respectively, and has expected value $R > R_2$. There are parameter constellations for which a symmetric interior equilibrium with $p_1 = \alpha_3$ coexists with a symmetric interior equlibria of the type $p_a = \alpha_2 + \alpha_3$. and $p_b = \alpha_3$(17).

Economies of scale are additional driving forces behind the multiplicity of equilibria. In the presence of diversification economies an initial advantage in depositors' perception ca be made self-fulfilling because the effect of the increased margin and market share commanded are rein-

[17] For example, both equilibria coexist when $R_3=2R_2=4R_1$, $\alpha_3=1/4$ and $\alpha_2=1/2$, $1.12R_1 < 3t < 1.31R_1$ and $9R_1 > 4v + 2t$. However, we have checked that this can not be the case with returns following uniform distributions.

forced by the reduced failured probability associated to a larger institution. This effect may induce induce corner equilibria driving a bank out of the market. Further, if a minimum market share is needed to invest the non-banking equilibrium and corner equlibria (the latter under regularity conditions) always exist. The consequence is that typically equilibria of the type (i), (ii), (iii) and (iv) in Proposition 2 obtain simultaneously as we have seen with the uniform example.

The coordination problem and the multiplicity of equilibria are akin to situations encountered in the network externalities literature where the self-fulfilling character of expectations induces the possibility of multiple equilibria (see, for example, Katz and Shapiro (1985), Farell and Saloner (1985, 1989)). A bank can be understood as a network in which when more consumers join everyone benefits and where the network needs a minimum size to be viable. Indeed, in the presence of diversification economies a larger bank has, ceteris paribus, a lower probability of failure (18). Our model involves a generalization of the usual network externalities situation to a case where the quality of the product of a firm (19).

Expectation-driven equilibria are not uncommon in the banking literature. The non-banking equilibrium in our model is reminiscent of the "bad" equilibrium, our confidence crisis, in the bank runs literature (Diamond and Dybvig (1983)). These authors show that the optimum deposit contract between the banks and risk averse depositors, who face private liquidity risk, involves a fixed payment to early withdrawals. This deposit contract has a good equilibrium which realizes optimum risk sharing, but also has a bad equilibrium in which all depositors panic, withdraw their funds and the bank collapses. This may happen to an otherwise sound bank. In the bad equilibrium (0,0) of our model depositors anticipate that banks are not viable and do not deposit in either bank. Banking may not get started even when it is the only way of linking lenders and borrowers. Rather than a "run" what the coordination problem implies is the potential nonviability of banks. Further, in our setting we also obtain the possibility of an "instituion confidence crisis", that is the situation where depositors mistrut one of the banks making it not viable. With minimum size projects this tituation arises because of depositors mistrust and not because of actions of the rival bank. Equilibria can not be of the natural monopoly with impeded entry type (with one bank out of the market because of competition from the rival bank). Equilibria can not be of the natural monopoly with impeded entry type (with one bank out of the market bacause of competition from the rival bank). Indeed, when $n_i=0$, the $p_i=0$ and the expected return that bank i can promise depositors is zero and therefore the bank is left out of the market (as in II(i) in Proposition 1: natural monopoly with blockaded entry).

In summary, equilibria may be multiple due to a coordination problem among depositors which makes different levels of confidence possible in equilibrium (self-fulfilling). A basic mechanism is through the margin: a bnak which is perceived unsafe must offer higher rates than the safer bank and this in turn (via a margin reduction) makes the first bank actually unsafe. This basic mechanism is reinforced in the presence of network effects (diversification economies and/or minimum size projects). The outco-

18 Furthermore, the branch and ATM systems also involve a network externality with which we do not deal in this paper.

19 It can be easily seen that in our generalized framework incentives to become compatible may differ from the standard network externalities model. For example, asymmetric compatible equilibria may exist without the need to invoque a converter (as in Farell and Saloner (1989)).

me is a multiplicity of euqilibria in which banks have different levels of quality. Nevertheless, quality, endogenously determined in the market, may be fragile since it is based on the expectations of depositors. It is worth remarking that behind the multiplicity issue there is not "excessive competition" since the described mechanisms are at work with a single bank facing no competition.

## 5. Regulation. Deposit Insurance and Welfare

Up to now we have considered a free banking context with no regulation. We deal in this section with two common types of public intervention in banking markets, deposit insurance and rate regulation, and assess their welfare impact in the context of our model. We stydy first the best case for deposit insurance, with fair and risk based pricing, and evaluate the welfare trade-offs which involves. We then briefly examine the effects of flat pricing of insurance, and consider at the end of the section rate regulation.

### Fair and risk-based deposit insurance

Suppose that there is a deposit insurance fund (DIF) run by the governmente which fully insures deposits, at a fair price, and that can monitor the solvency of the bank at a cost K. The DIF guarantees that the banks' posted rates will be honoured (provided they are less than R). The DIF finances the deposit insurance with a bank specific tax on net revenue or financial margin (with a linear rate which is contingent on the quoted rates and market shares), and throug auditing and monitoring, enforces the paymet of residual funds in a state of bakruptcy and of posted rates otherwise. The DIF covers the difference with posted rates in case of bankruptcy. The optimum incentive contract (to minimize the expected cost of monitoring given a certain expected return for depositors) is a standard deb contract a la Gale-Hellwig (1985) with the difference that here the DIF instead of depositors, who do not have monitoring capabilities, monitor the bank (20). Notice that now incentives are provided to the banks with monitoring instead of nonpecuniary penalties.

The sequence of events is as follows. Bank i quotes rate $r_i$, obtains a market share ¿¿ and makes its investments. Returns from investments are obtained. If the bank declares bankruptcy then the DIF monitors the returns at a cost K and pays $(r_i-R_i)$ per unit of funds deposited while the bank pays $R_i$. Otherwise the bank pays the posted rate to depositors and a linear tax on the realized financial margin. The tax is contingent on $r_i$ and $n_i$, and the expected cost of monitoring bank i is then $(1-p_i)K$. (See Figure 6).

FIGURA 6

We focus on a case where the insurance premium is anticipated by the banks when setting interest rates (21). That is, a bank knows

[20] If a minimum size investment is needed and for given deposit rates a bank does not obtain the minimum market share to operate the DIF has the power to uniformly tax the agents in the economy in order to obtain funds to inject the minimum capital required by the bank to invest and operate. This can be interpreted as a lender of last resort facility of the DIF.

[21] Chan, Greenbaum and Thakor (1991) show that in the presence of private information and moral hazard, perfect competition and fair deposit insurance may be incompatible with one another. The reason is than riskier banks do not have incentives to reveal that they are high risk so as to pay a lower premium and earn positive (rather than zero) expected profits. It is worth emphasizing that in our model fair insurance is possible; the main reason is that a riskier bank cannot hide its type since the rate that it sets is observable. (Otherwise,

that if it takes a more risky poition it has to pay for it, i.e., banks take into account the riskiness of their positions since a higher probability of failure translates into higher taxes. In this way both with and without deposit insurance banks maximize expected returns with full consideration of the costs of bankruptcy. In consequence, insurance does not introduce limited liability in the model and we can isolate the impact of insurance on competition for deposits. We then consider briefly the possibility of flat insurance premia, and hence allow the insurance system to introduce limited liability. Contrasting the impact of insurance under these two alternative assumptions allows us to disentangle the variour ways in which insurance operates.

Given how we have modelled the DIF, expected profits to the bank are:

$$((1 - \tau_i) E \{R_i - r_i \mid r_i < R_i\}) n_i$$

If bank i fails the DIF has to pay $r_i - R_i$ per unit of funds deposited. If the DIFS sets a tax rate which corresponds to a fair insurance premium:

$$\tau_i E \{R_i - r_i \mid r_i < R_i\} n_i = E \{r_i - R_i \mid r_i > R_i\} n_i$$

Thus, when the insurance premium is anticipated, expected profits to the bank are $E\pi_i = (R - r_i) n_i$. Notice that a bank never has incentives to set a rate larger than R and that for rates $r_i$ less than R expected profits are always positive.

In case of failure the bank pays $R_i$ and the DIF $r_i - R_i$. Nevertheless, banks have to be provided incentives to pay the posted deposit rate whenever they can and whatever funds they have otherwise. The tax on profits does not accomplish this since it implies a levy only when profits are positive. Incentives to the bank are provided via monitoring at the cost K. The total expected incentive (monitoring) cost is $((1-p_a)+(1-p_b))K$.

Depositors now will be paid back for sure and, from their point of view, ${}^e p_i = 1$, i=a,b. This means that the equilibrium is like in the classical Hotelling model, with firms maximizing $E\pi_i = (R - r_i) n_i$, and the multiplicity of equilibria is eliminated. Hence:

**Proposition 3. With fairly priced deposit insurance, equilibria are as follows:**

(i) If $R > v + 3t/2$ then there is a unique symmetric equilibrium $R - r^{DI} = t$.

(ii) If $R < t + v$ then there is a symmetric local monopoly equilibrium with $r^{DI} = (R+v)/2$ and $n_i = (R-v)/2t$.

(iii) If $v + t < R < v + 3t/2$ then there is a symmetric touching markets equilibrium with $r^{DI} = v + t/2$. Asymmetric TM equilibria also exist.

Deposit insurance rules out the possibility of vertical differentitation across banks. That is, depositors perceive the quality of both banks to the same (${}^e p = 1$) because the DIF guarantees that posted rates will be honoured. As a result, insurance eliminates the multiplicity of equilibria associated to the market solution cutting through the multiple self-fulfilling expectations, but does it increase welfare?

First, it is clear that DI improves upon the situations where the market fails and both banks are not viable in the presence of minimum size investments (stabilization effect). This is reminiscent of Diamont and Dybvig

---

since we do not assume a perfectly competitive structure it is unclear whether there would be a schedule such that it was both incentive compatible and fairly priced).

(1983) where deposit insurance (backed by government) is an institution which prevents the bad equilibrium from obtaining. Second, (except in the TM region) the DIF implies that a symmetric equilibrium prevails and hence, given the number of consumers who deposit, total transportation cost is minimized (uniformization effect). However, there may be costs associated to the uniformization effect in terms of lost diversification economies. Indeed, welfare may decrease when DI is imposed if the market outcome was a corner equilibrium; this case may arise when diversification economies are so important in reducing bankruptcy costs and relative to the unit transportation cost, that concentration of depositors in a single bank may outweigh the benefits of reduced total transportation costs implied by DI. Next, insurance has a market extension effect: the certainty of being paid back incentives consumers to deposit, given posted rates. Finally, there is the issue of how deposit insurance (DI) changes the equilibrium rates (competition effect) and thus the residual probability of failure, and whether this may cancel out the market expansion effect. Results are as follows. When the market outcome is one of local monopolies, introducing DI necessarily involves both an increase in the margin and in the number of consumers served (22), decreasing the probabilities of failure, and improving welfare. If, on the other hand, without insurance the market outcome involves direct competition and the equilibrium is symmetric, DI enhaces competition, i.e., rates are higher, and this causes an increase in the residual probability of failure (23). It is worth to remark that such an increase of competition occurs in the absence of moral hazard and limited liability.

In summary, deposit insurance involves several trade-offs in welfare terms. On the positive side it avoids systemic confidence crises and minimizes frictions (transport costs), and may extend the market. (Notice however that if deposit insurance is limited and partial, as argued in recent proposals of reform in the US, the expectations game among depositors, main source of the potential instability of the system, is reinstated). On the negative side, it may avoid desirable concentration of deposits in one bank (preventing the full realization of diversification economies) and may make banks more aggressive (increasing failure probabilities). The following proposition makes clear that the market extension and the minimization of transport costs effects of deposit insurance improve always expected gross surplus EGS (gross of bankruptcy costs). The probabilities of failure will decrease in a local monopolies regime but increase with direct competition. the outcome is thus ambiguous (and in the context of our modelling will depend on the relative deadweight losses -DWL- with and without deposit insurance: monitoring cost versus nonpecuniary penalties).

Table II gives the welfare magnitudes both with and without a deposit insurance fund (DIF). ERG stands for expected revenue of government. Without DIF the ERG consists of the residual funds that failed banks have (and which are assumed not to be payed out to depositors) and the DWL are the nonpecuniary penalties associated to failure. With DIF both magnitudes are equal to the expected costs of monitoring. Notice that in both cases banks bear the full cost of failure, that is, limited liability is obviated

[22] Recall that if with DI equilibrium is moved from the local monopolies region to direct competition the margin increases according to the comment following Proposition 1.

[23] When without DI there is an asymmetric interior equilibrium, the bank which is at a disadvantage in this case may set a lower deposit rate when DI is introduced. This happens since the vertical differentiation generated by the expectations of depositors in the uninsured instance may force the lower quality bank to compete more aggressively.

### TABLE II: Welfare

$ETS = EGS - DWL = ECS + ERG + E\pi - DWL$
$EGS = (n_a+n_b)(R-v) - (n_a^2+n_b^2)t/2$
$E\pi = (R-r_a)n_a + (R-r_b)n_b$

*Without DIF*

ECS: $n_a(p_a r_a - v) + n_b(p_b r_b - v) - t(n_a 2 + n_b 2)/2$

ERG: $n_a E\{R_a | r_a > R_a\} + n_b E\{R_b | r_b > R_b\}$

DWL: $n_a(1-p_a)r_a + n_b(1-p_b)r_b - (n_a E\{R_a | r_a > R_a\} + n_b E\{R_b | r_b > R_b\})$

*With DIF*

$n_a(r_a - v) + n_b(r_b - v) - t(n_a^2+n_b^2)/2$

$-((1-p_a)+(1-p_b))K$

$-((1-p_a)+(1-p_b))K$

**Proposition 4.** If we focus on symmetric equilibria in the TM region, deposit insurance commands a higher level of gross expected surplus EGS (gross of bankruptcy costs) than any market equilibrium.

Proof: Recall that $EGS=(n_a+n_b)(R-v)$-DWL-$(n_a^2+n_b^2)t/2$. In a symmetric situation this equals $2n(R-v)-tn^2$, which is increasing in n for $R-v>nt$. If the DI equilibrium involves $n_a=n_b=1/2$ then it attains the maximum EGS possible for a given DWL since transport cost is minimized and (from Proposition 3) $R \geq v+t$ and it is optimum to serve the whole market. If $2n^{DI}<1$ at the DI equilibrium in the local monopoly region (with $n^{DI}=(R-v)/2t$) then necessarily $(p^*a+p^*b)/2<R<v+t$ and therefore any market equilibrium involves (see Proposition IIII(ii)) local monopolies with $n_i^*=(p_i R-v)/2t$. It follows that $n_i^* < n^{DI}$, i=a,b. Therefore $(n_a+n_b)^{Di}$ is larger and this is always better since again $2n(R-v)-tn^2$ is increasing in n for $R-v > nt$ and $n^{DI}=(R-v)/2t$.

Q.E.D.

#### Flat insurance pricing

In practice insurance premiums are not risk-based but flat. We can analyze flat premiums assuming that banks take parametrically the tax rate and than in equilibrium this tax rate is set so as to maintain budget balance of the DIF. In this case, because banks do not anticipate that setting a higher rate involves a higher insurance premium, insurance convexifies the profit function of banks dues to the limited liability effect. Consider the case with no diversification economies. With a parametric tax rate ? the expected profits of bank i are given by:

$$((1-\tau)E(R-r_i \mid r_i < R))n_i$$

The first order condition for profit maximization is easily seen to be:

$$((1-\tau)E(R-r_i \mid r_i < R))/2t - (1-\tau)\, p_i\, n_i = 0$$

Denote symmetric interior equilibrium rates by $r_i=r^{FDI}$. We have that $(1-\tau)E(R-r^{FDI} \mid r^{FDI}<R) = R-r^{FDI}$ since the tax rate is such that the premium is fair. Therefore, the FOC can be rewritten:$R-r^{FDI} = (1-\tau)p^{FDI}t$. The equilibrium margin is then less than t, which is the equilibrium margin with anticipated risk-based deposit insurance at the symmetric interior equilibrium. When banks do not anticipate the cost of setting higher rates, deposit insurance induces firms to take larger amount of risk by setting higher rates.

Diversification economies enhance rivalry provided that unit expected returns are increasing in. This is the case in the uniform example we have been considering. The intuition is that with diversification economies, an increase in posted rates generates a larger increase in revenue in case of success.

In summary, whenever symmetric interior equilibria coexist for the cases of a free market, risk based deposit insurance, and flat deposit insurance (and there are no diversification economies) we have: $r^{FDI} > r^{FDI} > r^*$ and correspondingly $1-p^{FDI} > 1-p^{DI} > 1-p^*$. That is, flat deposit insurance induces more aggressive behavior and higher failure probability than risk-based deposit insurance, which in turn is at a higher level than uninsured competition.

The welfare implications are immediate. Flat deposit insurance is dominated by risk-based deposit insurance since it saves on monitoring costs by inducing more prudent behavior on banks (recall that the monitoring costs equal $2(1-p)K$.

## Excessive competition and rate regulation

We have argued before (section 4) that "excessive" competition could not be blamed for the fragility of banking (multiplicity problem) in an unregulated context. However, when banks compete directly (benchmark interior symmetric equilibrium) there is "excesive" competition in the sense that lower rates would improve social welfare. A first indication that market competition may be excessive is that, contrary to the case where the probability of failure is zero, an increase in the friction in the market (as represented by t) can be beneficial for social welfare. In the classical Hotelling model and increase in the transport cost rate t always decreases total surplus since it increases total transportation cost. However, when failure is a possibility, an increase in t will increase the margin and reduce the probability of failure. In the uniform example it is easily seen that the decrease in the probability of failure more than compensates the increase in transport costs in terms of total welfare if t is small (24).

The preceding analysis of deposit insurance makes clear that -quite independently of the moral hazard problem posed by the nonobservability of investment of banks in a context of limited liability, which we have assumed away- deposit insurance may accentuate excessive competition, inducing higher failure rates than benchmark market equilibria. Our model suggests thus a rationale for setting ceilings on deposit rates both in a free banking context and in the presence of deposit insurance.

**Proposition 5.** Suppose that banks compete directly (symmetric interior equilibria obtain), then:

(i) Deposit insurance makes banks more aggressive and induces higher failure rates than unregulated competition.

(ii) Without deposit insurance, social welfare is increased by setting the smallest deposit rate ceiling such that the expected return to depositors induces everyone to deposit (that is, equal $v+t/2$).

(iii) With deposit insurance, social welfare is increased setting a deposit rate ceiling equal to the rate which induces everyone to deposit ($v+t/2$).

Proof: (i) As argued in Proposition 3(i).

(ii) Unconstrained banks set a deposit rate $r^*$ higher than $v+t/2$. By constraining them to giving the minimal expected return $v+t/2$ such

[24] Indeed, in the case we consider (see Table II)
$ETS = R - v - t/4 - DWL$, and $DWL = (1-p)r - E\{R_{1/2} \mid r > R_{1/2}\}$
Further, in the uniform example when $t=0$, $p^*=1/2$, $dp^*/dt = 2/(\beta+\alpha)$ and $dDWL/dt = -(1+R/(\beta+\alpha)) < 0$.

that the whole market is still served bankruptcy costs $DWL(r)=(1-p)r-E\{R_{1/2} \mid r>R_{1/2}\}$ are lower sinde DWL is increasing in r ($DWL'=1-p > 0$).

(iii) Unconstrained banks would set a deposit rate equal to $R-t > v+t/2$. By constraining them to $v+t/2$ the whole market is still served and the monitoring costs (DWL) $2(1-p)K = 2K F(r-R;1/2)$ are lower.

Q.E.D.

The conclusion that rate ceilings weakly increase welfare is dependent upon the fact that consumer surplus, government net revenues and banks' profits have the same weight in the social welfare function. Indeed, in our model the rates paid to depositors are just a transfer from the welfare point of view given that the supply of funds is inelastic. There is no aggregate loss to reduce the payment to depositors. If bank's profits are given a weight $\delta < 1$ in the welfare function, (which would then be $W=ECS+ERG+\delta E\pi$) for $\delta$ small rate floors may improve welfare. The intuition is clear: $\delta < 1$ introduces a trade-off between the costs of failure (increased by high deposit rates) and consumer surplus. Indeed, when there is no insurance and $\delta = 0$ the deadweight loss induced by nonpecuniary penalties disappears from the welfare function and only consumer surplus matters. Optimal rates would then be high (subject perhaps to a zero profit constraint for banks). The case $\delta = 1$ has been dealt with in Proposition 5 and tilts the trade-off in favor of limited rates since higher rates are only a transfer from banks to depositors and increase failure probabilities.

With no insurance, and in a symmetric equilibrium, the proposed welfare function achieves a maximum when the deposit rate is such that the associated probability of success is exactly $\delta$(25). Since at the market equilibrium $r^* = R-t/p$, it is clear that when $r^* < R-t/\delta$, the equilibrium rate is lower than the one which maximizes welfare and that optimal regulation calls for a rate floor r' (such that $p(r'-R;1/2)=\delta$) (less than R so that banks make nonnegative profits). On the other hand, if the equilibrium rate exceeds $R-t/\delta$ a rate ceiling, r'', such that $p(r''-R;1/2)=\delta$ if $r'' > v+t/2$ or $r''= v+t/2$ otherwise improves welfare. A similar argument applies when there is insurance (26).

## 6. Concluding Remarks

The theory of competition among financial intermediaries seems to be at an unsatisfactory stage. The standard approach to banking competition, the Klein-Monti model, reduces to standard Cournot (or Bertrand) competition in a context where the opportunity cost of funds is given by a competitive interbank or bond market. Financial intermediation is exogenously given and asymmetric information problems which are at the origin of banking assumed away. In this context runs or stability problems do not arise (27). The traditional industrial organization approach to banking, the Structure-Conduct-Performance paradigm, suffers from similar problems mising important specificities of the banking sector (28).

Recently there have been important contributions to the theory of financial intermediation

---

25 At a symmetric equilibrium we have $ECS=pr - v - t/4$, $EGS= E\{R_i \mid R_i < r\}$ and $E\pi = R-r$. It is easily seen that $W' = p-\delta$ and $W'' <0$

26 In this case, $ECS=r - v - t/4$, $EGS= -2(1-p) K$ and $E\pi = R-r$. We have then $W' = 1-2K f(r-R;1/2)-\delta$ and $W'' < 0$ provided $f>0$. The equilibrium deposit rate is t, while (when $W''<0$) the rate which maximizes the social welfare function is such that $f(r-R;1/2) = (1 - \delta)/ (2K)$.

27 See Baltensperger (1980) and Santomero (1984) for a survey of theories of the banking firm. Dermine (1986) introduces the possibility of failure in the Klein-Monti model without introducing depositors expectations.

28 See, for example, Hahnan (1991) for a summary of the approach in modern terms.

by Diamond (1984), Bryant (1980), and Diamond and Dybvig (1983), which build on asymmetric information problems, but do not model explicitly competition among financial intermediaries. When this is done (a la Bertrand) some problems arise: financial intermediation may not increase social welfare and the banking industry may be characterized by a zero-rent monopoly structure (Yanelle (1991), or equilibrium may fail to exist (Smith (1984)) (29).

We have developed in the present paper a framework that brings together different strands of the literature to study competition in the banking sector. Building on modern theories of financial intermediation we have established a bridge with industrial organization analysis providing a foundation for the understanding of banking competition. From a methodological point of view we have incorporated incentive problems in the modelling of competition among financial intermediaries yielding connections with industrial organization concepts such as network externalities and vertical differentiation. In other words, we have explored the links between incentive and competition theories in the context of financial intermediation. Further, we have assumed the bank offer (horizontally) differentiated products, or that there is friction in the market. Location, service variables and customer specific relations are pervasive in retail banking. Competition à la Bertrand with identical products tends to yield in general, and in particular in banking, counterintuitive results.

We have found that the possibility of failure, with the standard deposit contract at its root, (endogenously) introduces vertical differentiation and that this is an important determinant of competition. As it is well known, vertical differentiation may entail natural monopoly or oligopoly structures. A bank resembles a network and many different outcomes of the competitive process are possible depending on the expectations of depositors, which become key to the explanation of the fragility of banking.

Deposit insurance turns out to be a mixed blessing. It avoids systemic confidence crisis but even if it is fair and risk based and in the absence of moral hazard problems it may increase failure probabilities by inducing excessive competition. On the other hand it will minimize frictions and may enlarge the market. Further, a deposit rate ceiling would increase social welfare whenever banks compete directly.

In consequence, with respect to the current policy debate on reforming deposit insurance in the US our model would caution against its limitation, in order to preserve its stability role, and would point out that even in the best of the worlds (with fair and risk based premiums) deposit insurance may induce excessive competition (above an uninsured context). Rate regulation may be a necessary complement to deposit insurance. This is not to say that we advocate the reinstatement of rate regulation. As it is well known, rate regulation has other costs not contemplated in the present paper, among them, the tendency to overinvest in services and the possibility of regulatory capture (Vives (1991)). These costs should certainly be considered in the present policy debate. Our analysis suggest however that if deposit insurance is deemed necessary, rate regulation does have some benefits.

[29] See also Broecker (1990) for an interesting model of the effects of credit-worthiness tests on interbank competition.

## References


Aghion, P., P. Bolton and M. Dewatripont (1988), "Interbank Lending, Bank Runs and Competiton", mimeo.

Baltensperger, E. (1980), "Alternative Approaches to the Theory of the Banking Firm", Journal of Monetary Economics, 6, 1-37.

Baltensperger, E. and J. Dermine (1987), "Banking Deregulation", Economic Policy, April, 63-109.

Battacharyra, S. (1982), "Aspects of Monetary and Banking Theory and Moral Hazard", The Journal of Finance, 37, 371-384.

Boot, A.W.A. and S.I. Greenbaum (1991), "Deposit Insurance Reform", Banking Research Center, Working Paper n° 176.

Broecker, T. (1990), "Credit worthiness tests and interbank competition", Económetrica, vol. 58, N.2, 429-452.

Bryant, J. (1980), "A model of Reserves, Bank runs, and Deposit Insurance", Journal of Banking and Finance, 43, 749-761.

Chan, Y., S.I. Greenbaum and A.V. Thakor (1991), "Is fairly priced deposit insurance possible?", Banking Research Center, Working Paper n° 152.

Dermine, J. (1986), "Deposit Rate, Credit Rate and Bank Capital: the Klein-Monti Model Revisited", Journal of Banking and Finance.

Diamond, D. (1984), "Financial intermediation and delegated monitoring", Review of Economic Studies, July, 91, 401-419.

Diamond, D. and P. Dybving (1983), "Bank Runs, Deposit Insurance, and Liquidity", Journal of Political Economy, 91, 401-419.

Economides, N. (1984), "The Principle of Minimum Differentiation Revisited", European Economic Review, 24, 345-368.

Dybvig, P.H. and S. Spatt (1983), "Adoption of Externalities as Public goods", Journal of Public Economics, 20, 231-247.

Farrell, J. and G. Saloner (1985), "Standardization, Compatibility, and Innovation", Rand Journal, vol. 16, n.1, 70-83.

Farrell, J. and G. Saloner (1989), "Converters, Compatibility, and the Control of Interfaces", Working paper n. 89-130, U.C. Berkeley.

Fudenberg, D. and J. Tirole (1984), "The Fat cat Effect, the Puppy Dog Ploy and the Lean and Hungry Look", American economic review, P&P, 74, 361-368.

Friedman, M. and A. Schwarts (1965), A Monetary History of the United States, 1867-1960, Princeton University Press, Princeton, NJ.

Gabszewicz, J. and J.F. Thisse (1979), "Price Competition, Quality, and Income Disparities", Journal of Economic Theory, 20, 340-359.

Gale, D. and M. Hellwig (1985), "Incentive-Compatible debt Contracts: The one-period Problem", Review of Economic Studies, October, 647-664.

Gehrig, T. (1990), "Natural Oligopoly in Intermediated markets", mimeo.

Gennotte, G. (1990), "Deposit Insurance and Bank Competition", Working Paper.

Gennotte, G. and D. Pyle (1990), "Capital Controls and Bank Risk", IBER, Finance Working Paper n° 197.

Hahnan, T.H. (1991), "Foundations of the Structure-Conduct-Performance Paradigm in Banking", Journal of Money Credit and Banking, vol. 23, n. 1, 67-84.

Jacklin, C.J. and S. Bhattacharya (1988), "Distinguishing Panics and Information-Based Bank Runs: Welfare and Policy Implications", Journal of Political Economy, 96, no. 3.

Jaffee, D. (1989), "Simposium on Federal Deposit Insurance for S&L Institutions", Journal of Economic Perspectives, vol. 3, n° 4, pp. 3-9.

Katz, M. and C. Shapiro (1985), "Network Externalities, Competition, and Compatibility", American Economic Review, 75, pp. 424-40.

Klein, M.A. (1971), "A Theory of the Banking Firm", Journal of Money, Credit and Banking.

Monti, M. (1972): "Deposit, Credit and Interest Rate Determination under Alternative Bank Objective Functions", in K. Shell and G. Szego (ed.), Mathematical Methods in Investment and Financ, North-Holland.

Postlewaite, A. and X. Vives (1987), "Bank Runs as an Equilibrium Phenomenon", Journal of Political Economy, 95, 485-491.

Salop, S. (1979), "Monopolistic competition with outside goods", Bell Journal of Economics, 10, n° 1, 141-156.

Santomero, A. (1984), "Modelling the Banking Firm", Journal of Money, Credit and Banking, 16, No. 4, 577-602.

Shaked, A. and J. Sutton (1983), "Natural Oligopolies", Económétrica, 51, 1469-1484.

Smith, B. (1984), "Private information, deposit interest rates, and the 'stability' of the Banking System", Journal of Monetary Economics, 14, 293-317.

Sprague, O.M.W. (1910), "History of crises under the National Banking System", Government Printing Office, Washington, D.C.

Vives, X. (1991), "Banking competition and European integration", in A. Giovannini and C. Mayer (ed.), European Financial Integration, Cambridge University Press, 9-31.

Yanelle, M.O. (1989), "The Strategic Analysis of Intemediation", European Economic Review, 33, 294-304.

Yanelle, M.O. (1991), "On Endogenous Intermediation", mimeo.

## APPENDIX I

**Proposition 1**. Given $p_a \geq p_b \geq 0$;

i. When $p_bR<v$, i=a,b, then both banks are out of the market.

II. When $p_bR<v$ and $p_aR<v$ then bank b is out of the market and bank a has a positive market share. If $p_aR \leq 2t + v$ then bank a sets $r_a=(p_aR+v)/2p_a$ and $n_a=(p_aR-v)/2t$. Otherwise, $r_a=(v+t)/p_a$ and $n_a=1$.

III. When $p_iR \geq v$, i=a,b:

(i) If $(p_a+p_b)R>(2v+3t)$ then banks compete. If $3t>R(p_a-p_b)$ there is a unique interior equilibrium: $R-r_i=t/p_i+R(p_i-p_j)/3p_i$, and both banks have a positive market share $n_i=1/2+(p_i-p_j)R/6t$, $n_a \geq n_b > 0$, i=a,b. Otherwise $(3t\leq R(p_a-p_b))$, $n_a=1$ and $n_b=0$, with $r_a=(p_bR+t)/p_a$.

(ii) If $2(t+v)>(p_a+p_b)R$ banks have local monopolies and $r_i=(R/2)+(v/2p_i)$, $n_i=(p_iR-v)/2t$.

(iii) If $2(t+v) \leq (p_a+p_b)R\leq(2v+3t)$ then there are multiple "**touching markets**" equilibria, all with $n_a+n_b=1$, of the form $p_ar_a= \gamma(v+t/2)$ and $p_br_b=2v+t-\gamma(2v+t)/2$, where $\gamma$ is in the interval $[(3v+2t-p_bR)/(2v+t), (v+p_aR)/(2v+t)]$ when pa $\leq((5v+6t)/3R)-2p_b/3$ and in the interval $[2(2v+p_aR)/((2v+t)3), 2(3t+4v-p_bR)/((2v+t)3)]$ otherwise.

Proof:

I- If $p_i < v/R$, firm i cannot atract depositors and earn positive expected profits. Thus, when $p_i < v/R$, bank i is out of the market.

II- The expected profits of firm i are $E\pi_i=n_i(R-p_i)$, where:

$$n_i = (p_ir_i-v)/t, \text{ if } (p_ir_i-v)/t < (v-p_jr_j\pm t)/t, \quad (1)$$
$$(p_ir_i-p_jr_j+t)/2t, \text{ otherwise.} \quad (2)$$

From (1) and (2) it is clear that when $p_b< v/R$, then $n_a$ is defined as in (1), since by setting $r_a= (v+t)/p_a$ firm a can attract all depositors. Maximizing a's profits when $n_a$ is given by (1) we obtain:

$$r^*_a = (p_aR+v)/2p_a \text{ and } n_a^*= ((p_a R-v)/2t, \text{ when } p_aR < 2t+v$$
$$r^*_a = (t+v)/p_a \text{ and } n_a^*= 1, \text{ otherwise}$$

III- Next, let both $p_a$ and $p_b$ exceed v/R. If both firms maximize the profit function and market shares are defined by (1), they set rates equal to:

$$r^*_a = (p_aR+v)/2p_a$$

$$r^*_b = (p_bR+v)/2p_b$$

As a result, $n_i^*= (p_iR-v)/2t$.

Notice than $n_a+n_b<1$ when $(p_a+p_b)R< 2(t+v)$.

Hence, when $(p_a+p_b) < 2(t+v)/R$, the equilibrium rates and market shares are as in (iii).

If both firms maximize profits when market shares are defined by (2), from the first order conditions the unique solutis is:

$R-r_i= t/p_i\pm R (p_i-p_j)/3p_i$, which implies $n_i=1/2 +(p_i-p_j)R/6t$, i=a,b.

It can be easily checked that these rates are global best responses. Thus they define an equilibrium when:

a) $0<ni<1$ and $n_a+n_b=1$,

b) the marginal consumer derives a non-negative surplus.

It can be easily checked that a) holds when $p_a-p_b<3t/R$, and b) when $(3t+2v)/R<(p_a+p_b)$.

Thus, when both conditions hold, firms are direct competitors and the equilibrium is uniquely defined.

If, on the other hand, $3t/R<p_a-p_b$, the firm a can attract all depositors. Since firm b has zero fixed cost it will increase the rate it offers up to R. If we maximize a's profits as in (2) given that firm b sets a rate R, we obtain that a's best response is $((p_a+p_b)R-t)/2p_a$. However, at this rate $n_a$ exceeds 1; thus, a's best response is $(p_bR+t)/p_a$. This completes the proof of case (i).

We next consider case (iii) where, $2(t+v)/R <p_a+p_b<(2v+3t)/R$ and $v/R<p_b$.

Firms cannot be direct competitors since the marginal consumer would derive a negative surplus at the candidate equilibrium rates. On the other hand, if they both maximize the profit function defined as if they had a local monopoly, the sum of the market shares which obtains exceeds 1. Thus, at least one of the firms maximizes its profits at the kink of the supply curve for deposits it faces. We next prove that the rates in (ii) define an equilibrium and that no other rates do.

First we consider the case where $(5v+6t-2Rp_b)/3<Rp_a$. Let $p_ar_a=\gamma(v+t/2)$. Then, firm b has three options:

i) setting the rate that corresponds to the kink of the supply of deposits to firm b, given the rate set by its rival, i.e. the equilibrium candidate, $r^b{}_c$,

ii) maximizing its profit function as in (1), $r_b{}^1 = (p_b R+v)/2p_b$,

iii) maximizing its profit function as in (2), $r_b{}^2= (p_b R-t)/2 +(2v+t)\gamma/4$.

It can be easily checked that $r_b{}^c<r_b{}^1$. Thus, $r_b{}^1$ is not feasible. Likewise, it can be shown that $r_b{}^c$ exceeds $r_b{}^2$ whenever $\gamma < (4v+3t - Rp_b{}^e)2/3(2v+t)=\gamma_{max}$. Thus, we have shown that $r_b{}^c$ is the best reply to the candidate rate set by firm a.

Given that firm b sets $r_b{}^c$ firm a) has three options as well:

i) setting the rate which corresponds to the kind of the supply of deposits to firm a, given the rate set by its rival, i.e. the candidate to equilibrium, $r_a{}^c$,

ii) maximizing its profit function as in (1), $r_a{}^1=(p_aR+v)/2p_a$,

iii) maximizing its profit function as in (2), $r_a{}^2=(p_aR-t)/2+(2v+t)(2-\gamma)/4$.

As before, one can check that when $\gamma < \gamma_{max}$ and $(5v+6t-2Rp_b{}^e)/3 < Rp_a{}^e$, $r_a{}^1$ exceeds $r_a{}^c$. The latter in turn exceeds $r_a{}^2$ when $p_a{}^eR+v2)/(2v+t)= \gamma_{min} < \gamma$. Thus, the rates defined in the proposition are equilibrium rates. That other equilibria are not possible follows from noticing that if $\gamma$ exceeds $\gamma_{max}$, then $r_b{}^2$ and $r_a{}^1$ are feasible, and if $\gamma$ is less than $\gamma_{min}$,

then $r_a^2$ is feasible. Furthermore, we have already shown that both firms cannot set rates so as to satisfy the first order conditions.

Let us now consider the case where $Rp_a^e<(5v+6t-2Rp_b^e)/3$. Once again, it can be easily shown that $r_b^l$ exceeds $r_b^c$ when $(p_a+p_b)R$ is larger than 3v+2t. Likewise, if $\gamma$ is less than $\gamma^*_{max}= (v+Rp_a^e)/(2v+t)$ and $Rp_a^e<(5v+6t-2Rp_a^e))/3$, then $r_b^2<r_b^c$. In addition, when firm b sets the candidate rate, $r_a^c<r_a^l$, provided $\gamma$ is less than $\gamma^*_{max}$. Similarly, $r_a^2<r_a^c$, provided $\gamma$ exceeds the minimum value stated in the proposition, and $Rp_a^e<(5v+6t-2Rp_b^e)/3$. Inexistence of other equilibria is proven as in the previous case.

Q.E.D.

## APPENDIX II

We explore market equilibria and the implications of deposit insurance when banks can influence depositors perceptions. Bank set rates; depositors, having observed the rates offered, form rational perceptions about the probability of failure, or the market share of each bank, and choose whether to deposit and in which bank. That is, given $(r_a,r_b)$, depositors expect $p_i = 1-F(R-r_i;n_i)$, where $n_i$ is the outcome of the expectations game induced on depositors. Once deposits are made, banks make their investments. Returns are realized and interest is paid if the bank does not fail. We term this game variable perceptions, as opposed to the parametric perceptions case considered in the text.

This expectations game may have multiple equilibria. In particular, notice that if a positive probability of success requires a minimum size, then no banking or one of the banks left with no clients are always possible: if a depositor believes that nobody will deposit in one bank, the best she can do is not to deposit in this bank either. If she were the only one to deposit, the expected return would be zero. Proposition 6 characterizes the set of *depositor's equilibria* given $(r_a,r_b)$.

**Proposition 6**

Given $R>r_a\geq r_b>0$, an expectations subgame with multiple equilibria is induced on depositors:

(i) With minimum size investments (0,0) is always an equilibrium.

(ii) With minimum size investments (1,0) is an equilibrium if $p_a(r_a-R;1)r_a-t\geq v$. Similarly for (0,1).

(iii) When interior equilibria $(n_a,1-n_a)$ exist, they are characterized by $\phi(n_a) = p_b(r_b-R;1-n_a)r_b-p_a(r_a-R;n_a)r_a+t\ (2n_a-1) = 0$, and $p_ar_a-tn_a=p_br_b-t(1-n_a)\geq v$. (A sufficient condition for existence is that both (1,0) and (0,1) are equilibria and that the marginal consumer be willing to deposit).

(iv) There may be equilibria where not all the market is served. $(n_a,0)$ with $n_a<1$ defines an equilibrium if $p_a(r_a-R;\ n_a)r_a-t\ n_a = v$. Similarly for $(0,n_b)$. $(n_a,n_b)$ with $n_a+n_b<1$ is an equilibrium if both $(n_a,0)$ and $(0,n_b)$ are equilibria.

Proof:

(i) Suppose that all consumers but one believe that neither bank is able to attract depositors; this consumer does not deposit either, because she would obtain a negative expected surplus since the bank will fail for sure, (a positive probability of success can only obtain with a positive mass of consumers).

(ii) (1,0) is an equilibrium if and only if $p_a(r_a-R;\ 1)r_a \geq v+t$; if all depositors are with bank a, then a single customer never deposits in bank b; all depositors are willing to deposit in bank a if they obtain a positive expected surplus: $p_a(r_a-R;\ 1)r_a \geq v+t$.

(iii) If interior equilibria exist, market shares are determined by the modified Hotelling supplies (that is, $\phi(n_a) = 0$) and the marginal depositor has to obtain an expected return larger than v. If both (1,0) and (0,1) are equilibria then $\phi(0) \geq v$ and $\phi(1) \leq -v$. Interior equilibria exist provided that the individual rationality condition of the marginal consumer is satisfied.

(iv) It should be clear.

Q.E.D.

The fact that a no banking equilibrium is always possible induces a *very large multiplicity of equilibria*: any rates which give banks non-negative profits can be supported as a subgame-perfect equilibrium with the depositors threat of reversion to the nonbanking (depositors) equilibrium. Obviously, it may be argued that the complete set of subgame-perfect equilibria is rather unreasonable because not all equilibria are renegotiation-proof. Indeed, one might expect that when posted rates diverge from expected rates (i.e. the candidate equilibrium rates), depositors may try to coordinate at equilibria better than the no-banking equilibrium. In other words, we should focus on renegotiation-proof equilibria (30). The depositors equilibria can not in general be Pareto ranked (31) due to the transport cost of depositors, nevertheless they can be surplus ranked. Consumers may thus coordinate on the surplus maximal equilibria provided side payments are feasible.

Proposition 7 characterizes (i) the set of subgame-perfect equilibria, and (ii) the interior symmetric equilibrium under regular deposit selection (we say that the selection is regular at $(r_a,r_b)$ if market shares depend smoothly on the rates, that is, if $n_i(r_a,r_b)$ is differentiable at this point). The latter can be also be understood as the surplus maximal equilibrium when t is important enough and diversification economies are not very large so that for given (not very different) rates depositors tend to patronize the two banks with similar market shares.

Proposition 7

(i) Any pair of deposit rates $(r_a,r_b)$ such that $R \geq r_i$, i=a,b, can be sustained as a subgame-perfect equilibrium.

(ii) If there is a symmetric equilibrium (involving a regular depositor selection), it is characterized by: $R-r^e= (r^e\ (\partial p_i^e/\partial n_i)-t)/(f^e r^e - p^e)$, where $f^e$ is the density of $R_i-R$ evaluated at $r^e-R$, and n=1/2.

Proof:

(i) Any pair of deposit rates $(r_a^*,r_b^*)$ associated to nonnegative expected profits can be sustained with the depositors threat of reversion to the $(n_a,n_b) = (0,0)$ equilibrium in case $(r_a,r_b)$ do not equal $(r_a^*,r_b^*)$.

(ii) Suppose that an interior symmetric equilibrium exists such $n_a$ that is differentiable with $(n_a,\ 1-n_a)$ satisfying $(2n_a-1)t - p_a(r_a-R;\ n_a)r_a + p_b(r_b-R;\ 1-n_a)r_b = 0$. Expected profit maximization of bank a yields a FOC:

---

30 Yanelle (1991) considers a similar but enlarged extensive form finds a multiplicity of equilibria, and explores several selection criteria including payoff-dominant and risk-dominant equilibria.

31 Obviously, sometimes equilibria can be ranked. For example, if $p_a(r_a-R;1)r_a-t \geq p_b(r_b-R;1)r_b \geq v$, then (1,0) dominates (0,1).

$$\partial E\pi_a/\partial r_a = (R-r_a)\,\partial n_a/\partial r_a - n_a = 0$$

In equilibrium we neccesarily have

$$\partial n_a/\partial r_a = -\frac{f(r_a-R;\, n_a)\, r_a - p_a}{2t - \dfrac{\partial p_a}{\partial n_a} r_a \quad - \quad \dfrac{\partial p_b}{\partial n_b} r_b} > 0$$

An interior symmetric equilibrium is characterized then by:

$$R-r = \frac{\dfrac{r}{2}\left[\dfrac{\partial p_a}{\partial n_a}(r-R;\, 1/2) \; + \; \dfrac{\partial p_b}{\partial n_b}(r-R;\, 1/2)\right] - t}{f(r-R;\, 1/2)\, r - p(r-R;\, 1/2)}$$

Q.E.D.

If we take as a benchmark the interior symmetric equilibrium (under regularity conditions) with depositors coordinating at surplus maximal equilibria (in the depositors game for given rates offered by banks) we find that $R-r^e = (\partial p_i^e/\partial n_i))/(p^e - f^e r^e)$, where $f^e$ is the density of $R_i-R$ evaluated at $r^e-R$, and $n=1/2$. In equilibrium, with not too large diversification economies, necessarily $p^e-f^e r^e>0$.(32)

The equilibrium margin can be rewritten as

$$R-r = \frac{r(f\,t - p(\partial p_i/\partial n_i))}{p\,(p-fr)}; + \frac{t}{p}$$

a form appropiate to compare with the "parametric" margin $R-r^* = t/p^*$.

The *comparisons of margins* between parametric and variable depositors' perceptions is in general ambiguous. When expectations are parametric, an increase in the deposit rate of a bank increases its market share leaving the failure perceptions constant. When banks can influence expectations, an increase in the deposit rate of a bank, in addition, tends to increase its own perception (probability) of failure for a given market share and, in the presence of diversification economies, the failure perception (probability) of the rival firm via the decrease in the rivals' market share. The first effect makes banks more cautious and the second more aggressive. In the absence of diversification economies therefore the variable perceptions equilibrium margin is higher than the parametric perceptions margin (just note that $\partial p_i/\partial n_i=0$ and $p-fr>0$ in the expression above). In general, with variable perceptions equilibrium stronger diversification economies push margins down via the second effect described. In fact, in the uniform example, it is possible to show that if diversification economies are large ($\alpha$ smaller than $\beta/3$), the margin is lower with variable perceptions than with parametric perceptions, and if they are small ($\alpha$ larger than $\beta/3$), the opposite result obtains.

Finally, with variable perceptions, in the absence of scale economies the depositors expectations game is degenerate in the sense that for given rates there is a unique depositors' equilibrium (given by the modified Hotelling demads). This turns out to imply that (interior) asymmetric equilibria (of the whole game) can not exist. The reason is that at an asymmetric equilibrium either firm could mimic its rival and obtain a market share of 1/2; thus, either one firm or the other would increase profits by setting the same deposit rate as its rival (33).

---

32 This means that a bank by increasing its deposit rate increases the expected return to depositors.

33 With thanks to Paul Klemperer for this observation and the proof. The argument is as follows: an interior equilibrium requires that $n_a x_a \geq x_b/2$; otherwise a will ofer $x_b$ and will get a market share of 1/2. Similarly, $n_b x_b \geq x_a/2$ This implies that $n_b \geq 1/4n_a$. We have then that $1=n_a+n_b \geq n_a+1/4n_a \geq 1$ From which it follows that $n_a=1/2$ since $n_a+1/4n_a$ is minimized at $n_a=1/2$.

Thus, relative to parametric perceptions, variable perceptions enhance the multiplicity of equilibria, have an ambigous impact on competition depending on the extent of diversification economies, and economies of scale become the unique source of multiple equilibria.

Deposit insurance yields the same trade-offs in terms of welfare as with parametric perceptions. The only difference with respect to the case where banks cannot influence depositors' perceptions is in the market expansion and competition effects. When banks deposits is ambigous: through the threat of reversion to the (0,0) equilibrium consumers can enforce an interior symmetric equilibrium, while DI may yield local monopolies and thus lower equilibrium rates. Further, when depositors coordinate at surplus maximal equilibria and a symmetric interior equilibrium obtains then if diversification economies are not very important the margin tends to be larger than in the parametric case and therefore DI would decrease margins and increase the probability of failure. The following remak summarizes the impact of DI on competition with variable perceptions.

*Remark:* Whenever with and without deposit insurance banks compete directly, deposit insurance makes banks more aggressive and induces higher failures rates than unregulated competition if diversification economies are large. The result follows inmediately from the comparison of margin in the different cases given the inverse relationship of margin and probability of failure for a given market share (equal to 1/2 here). Under the assumptions of the proposition the "variable" margin is no smaller than the "parametric" margin, which in turn is larger than the "deposit insurance" margin.

# FUNDACION BBV

*SEDE Y CENTROS OPERATIVOS DE LA FUNDACION*


Alcalá, 16 - planta quinta
28014 Madrid
Teléfs. (91): 374 89 39
374 89 59
374 89 38
Fax (91): 374 89 30

*SEDE*
**Plaza de San Nicolás, 4**
**48005 Bilbao**

Gran Vía, 12 - planta segunda
48001 Bilbao
Teléfs. (94): 487 52 52
487 44 79
487 44 73
Fax (94): 423 44 18