MARKET POWER AND RISK TAKING BEHAVIOR OF BANKS*

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Resumen: Consideramos un modelo de competencia monopolística en un sector bancario para analizar los efectos de la concentración de mercado sobre la toma de riesgo de los bancos. Mostramos que, cuando los depositantes están completamente asegurados, un mayor nivel de competencia induce a los bancos a invertir en activos riesgosos. Cuando la concentración de mercado es alta los bancos tienden a tomar menos riesgo. Mostramos además, que el bienestar social es maximizado, ya sea a través de una entrada libre o de una restricción a la entrada.

Abstract: We consider a monopolistically competitive banking sector in order to analyze the effects of market concentration on the risk-taking behavior of banks. We show that, under full deposit insurance, a higher level of competition induces banks to invest in a risky asset. When the market concentration is high banks tend to take less risk. We also show that maximum social welfare is achieved either through free entry or through entry restriction.

Clasificación JEL: G21, L11, L13

Palabras clave: agentes tomadores de riesgo, concentración de mercado, política óptima de entrada, risk-taking, market concentration, optimal entry policy.

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1. Introduction

In the past decades, the world economy has witnessed several banking crises. Banks' investment in risky assets are often viewed as one of the principal causes of bank failures. Banking crises are important to analyze not just because of the devastation they bring to one particular sector of the economy, but because they typically affect the entire economy.

Banks raise deposits to invest by offering deposit rates. Excessive deposits could induce banks to invest in more risky assets. Most of the central banks, following the recommendations of the BIS (Bank for International Settlements),[1] take various regulatory measures to discourage banks from investing in risky assets. There are some popular measures in practice. First, a minimum capital requirement which obliges the banks to include in their investments a minimum amount of their own capital (often it is a specific percentage of the total deposit invested). Second, a deposit rate ceiling, which imposes a maximum limit to the deposit rates offered by the banks. This is used to combat the negative effects of the financial liberalization (where there is no control on the deposit rates). Financial liberalization increases competition, provoking high deposit rates, and in consequence, lower profits which imply more incentives to gamble. Hellmann, Murdock and Stiglitz (2000) show that a Pareto efficient regulatory policy can only be implemented through a combination of minimum capital requirements and deposit rate ceilings. Furthermore, the central banks provide deposit insurance to protect depositors in the case the bank where they have deposited their capital fails.

The principal objective of this paper is to analyze the influence of market concentration on the banks' risk taking behavior under a regime of deposit insurance. We model a banking sector that consists of a finite number of banks. Banks compete in deposit rates to attract depositors. Banks can invest either in a prudent asset or in a gambling asset. Investment in either asset is subject to a minimum capital requirement. The prudent asset yields a higher expected return compared to the gambling asset, but if the gamble succeeds it pays off a higher private return. There is a continuum of depositors with a unit of monetary fund apiece. These individuals can choose to deposit their money in a bank which pays off a return in the next period. They also incur a per unit transport cost in order to travel to a bank. We assume that depositors are completely insured, i.e., they certainly receive the deposit rates that they were promised.

[1] See Basel Committee on Banking Supervision (2001).

As our objective is to study the effects of market concentration on risk-taking, we use a model of monopolistic competition in the banking sector á la Salop (1979) where the space is a unit circle on which banks and depositors are uniformly distributed. Market power stems from the transport cost. The transport cost should not be interpreted just as the cost or time spent in traveling to a bank. Banks are differentiated because they provide different combinations of services to their customers such as credit facilities, availability in foreign countries, number of ATM's, internet banking, etc.

We look at a symmetric Nash equilibrium. By symmetry we mean an equilibrium where banks offer identical deposit rates. We analyze two types of equilibria. A prudent equilibrium where all banks invest in the prudent asset and a gambling equilibrium, where all banks invest in the gambling asset. Two types of market structures can occur. When the equilibrium deposit rate is high enough to compensate all potential depositors for the transport cost, all of them place their funds, and we say that the market is *covered*. On the other hand, when the rate is not high enough to compensate for such costs, there are individuals who do not deposit their funds, and an *uncovered* market is said to arise. We use the unit transport cost relative to the number of banks as a measure of market concentration.

We show that when concentration is low, banks compete aggressively to obtain a greater market share by offering high deposit rates which results in a covered market where all depositors place their funds. Due to the low profits generated by competition, all banks invest in the gambling asset. Then a Covered Gambling Equilibrium exists. For high levels of concentration, banks never gamble because they want to preserve the high profits derived from greater market power and there exists only a Covered Prudent Equilibrium. For even higher levels of market concentration, an uncovered market arises, where the deposit rates are so low that they do not compensate for the cost of traveling to a bank and some depositors decide to stay out of the market. Dam and Sánchez (2004) and Repullo (2004) use models á la Salop(1979), and show that high competition makes to banks invest in the gambling asset. Keeley (1990) uses an empirical model to show that banks tend to invest more in prudent assets as they gain market power.

Banks invest in the gambling asset because, due to limited liability, if they fail, they are not obliged to pay back their depositors. This generates a moral hazard at the bank level. In a model without deposit insurance, the depositors' decision is influenced by the banks portfolio choice. In the current model, we assume that depositors are completely insured. This assumption make depositors indifferent, worsening the moral hazard problem. Demirgüç-Kunt and Detragiache (1998) find empirical evidence that deposit insurance system has provoked banking crises in several countries.

Next, we analyze a welfare maximization problem. Depending on the parameter values, maximum welfare can be achieved either through free entry or through an entry restriction. In the free entry case, the economy is stuck in a gambling equilibrium. The expected social loss from speculation is compensated by a higher deposit rate offered by the banks, thereby increasing consumers' surplus. In the entry restriction case, welfare is maximized for the level of market concentration where gambling is completely eliminated at equilibrium. This is consistent with the "last bank standing effect" observed by Perotti and Suárez (2002) who show that, in the presence of this effect (surviving banks may profit, at least temporarily, from their competitors' failure), the existence of mergers and regulatory policies could lead to greater efficiency because they create certain market power that gives incentives to the solvent banks to invest in prudent assets. In our model, we use regulations on entry (a fixed entry/permanence quota) as a mechanism to create market power.

The organization of the paper is as follows. In section 2, we describe the basic model. We analyze prudent and gambling equilibria and characterize the equilibrium in section 3. In the following section, we analyze the problem of welfare maximization. We conclude in section 5. All proofs are relegated to the Appendix.

2. The Model

Consider a banking sector with n risk neutral banks who are uniformly distributed on a unit circle. Banks compete in deposit rates in order to attract depositors. Let $\mathbf{r} = (r_1, ..., r_i, ..., r_n)$ be the deposit rates offered by the banks. We denote the demand for deposits of bank i as $D(r_i, r_{-i})$, where r_{-i} is the vector of rates offered by all other banks.

There is a continuum of depositors uniformly distributed on the circle. Each depositor has a unit fund which he can deposit in a bank and earn a deposit rate next period. It is worth noting that if an individual deposits 1 dollar in bank i then he gets back r_i. Hence, we assume that $r_i \geq 1$ which is the interest payment plus his deposit of a dollar. The depositors incur a per unit cost t for traveling to a bank. We use the transport cost relative to the number of banks (t/n) as a measure of market concentration. It is appropriate because if the transport cost relative to the number of banks is very high, given the total number of depositors, each bank can exercise its market power by reducing the deposit rate.

Banks invest their total capital in assets. Banks are subject to a minimum capital requirement of k per cent. A bank can choose to invest in a *prudent* asset or in a *gambling* asset.[2] If a bank decides to invest in the prudent asset, it receives α and if it decides to invest in the gambling asset, it obtains γ with probability $\frac{1}{2}$ and zero with probability $\frac{1}{2}$. We assume that the prudent asset has a higher expected return ($\alpha > \frac{\gamma}{2}$), but if the gamble succeeds it pays a higher return compared to the prudent asset ($\gamma > \alpha$). We also assume that depositors are completely insured. Expected profits when bank i chooses to invest in the prudent and the gambling asset, respectively are:

$$\begin{aligned}\pi_i^P(r_i, r_{-i}) &= (\alpha(1+k) - r_i)D(r_i, r_{-i}),\\ \pi_i^G(r_i, r_{-i}) &= \frac{1}{2}(\gamma(1+k) - r_i)D(r_i, r_{-i}).\end{aligned}$$

From the above profit functions it is clear that each bank is risk neutral. Given that the expected return from the prudent asset is higher than that of the gambling asset, it might seem surprising that some banks might invest in the gambling asset. Here the assumption of $\gamma > \alpha$ plays a crucial role. First thing to note is that if a bank invests in the gambling asset and the gamble fails then, due to limited liability, the bank does not have to pay back its depositors. It is well known that risk neutrality plus limited liability is equivalent to risk loving. By this argument a bank gambles since the return is very high when the gamble pays off. This creates moral hazard at the bank level and sometimes causes the banks to take risks.

3. Market Equilibrium

In this section we analyze the equilibrium when the number of banks in the economy is fixed. We analyze two types of symmetric equilibria: a *prudent* equilibrium where all banks invest in the prudent asset, and a *gambling* equilibrium, where all banks invest in the gambling asset.

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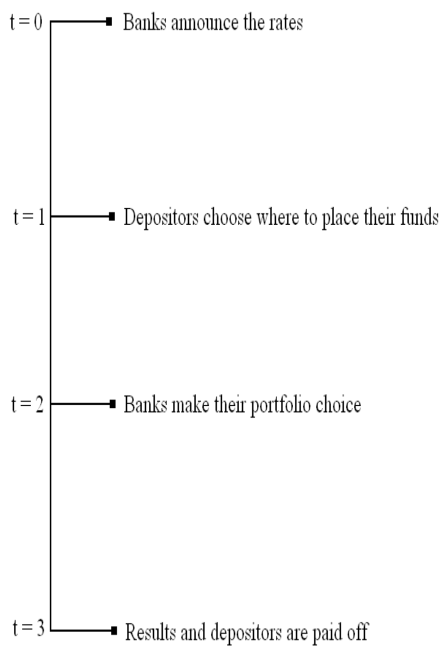
[2] Note that the bank could invest a fraction of its total capital in each asset, but this is not optimal due to risk neutrality.

The timing of events, which is summarized in figure 1, is as follows. First, banks simultaneously offer their deposit rates. Then the depositors choose a bank in which they place their funds. Next, banks make their portfolio choice. Finally, the projects are realized and depositors are paid off. An adequate solution concept for this model is *Subgame Perfect Equilibrium* and we solve the game using backward induction.

Figure 1

Timing of Events



Stage 3: Banks Make Their Portfolio Choice

A bank i invests in the prudent asset if the expected profits of doing so exceed the expected profits from investing in the gambling asset ($\pi_i^P \geq \pi_i^G$), i.e., if the following *No Gambling Condition* (NGC) is satisfied:

$$r_i \leq 2m(1+k) \equiv \bar{r}, \quad \text{where} \quad m \equiv \alpha - \frac{1}{2}\gamma \qquad \text{(NGC)}$$

If we reverse the above inequality, we have the *Gambling Condition* (GC). If (GC) is satisfied, a bank invests in the gambling asset because it turns out to be more profitable to do so.

Stage 2: Depositors Choose Where to Place Their Funds

In order to make his choice, a depositor considers the rates offered by different banks (stage 1 of the game) and the transport cost for traveling to a bank. Consider a bank i. An individual at a distance x deposits his unit fund if $r_i - 1 \geq tx$. Call this restriction the *Participation Condition* (PC). If this condition is satisfied for all x and for all banks, all the individuals in the economy deposit. In this case a *covered market* is said to arise. Now consider any two banks i and $i+1$ (or $i-1$). If there is a depositor at a distance x from i (hence, at a distance $\frac{1}{n} - x$ from $i+1$) such that the above condition is reversed (i.e., a *No Participation Condition* (NPC) holds) with respect to this depositor and both the banks, then this depositor does not place his fund in either of the two banks. So if between two consecutive banks on the circle there is a non empty subset of individuals who do not deposit, then an *uncovered market* is said to arise. The market structure, covered or uncovered, depends on the individuals' decision about placing their funds. Hence, these market structures are endogenous.

If we would have considered a framework without deposit insurance, the banks' portfolio choice in the last stage would affect the depositors' decision, since in case the gamble fails they would have received nothing (i.e., a gambling bank inflicts an expected loss on its depositors). Under such framework the depositors' decision would not only be a function of the deposit rates offered by the banks, but also on the expected volume of deposits with his bank.[3]

Stage 1: Banks Announce the Deposit Rates

In this stage, each bank chooses a deposit rate to maximize its profits. They maximize taking into account two restrictions ((NGC) or (GC)

[3] See Dam and Sánchez-Pagés (2004) for a model without deposit insurance.

from stage 3, (PC) or (NPC) from stage 2). Hence, we have 4 possible symmetric equilibria: a Covered Prudent Equilibrium (CPE), a Covered Gambling Equilibrium (CGE), an Uncovered Prudent Equilibrium (UPE) and an Uncovered Gambling Equilibrium (UGE). The necessary conditions for their existence are examined in the next two subsections.

3.1. *Covered Market*

A covered market arises when all depositors place their funds. We analyze two possible equilibria: a Covered Prudent Equilibrium (CPE) and a Covered Gambling Equilibrium (CGE).

3.1.1. Covered Prudent Equilibrium

In order to compute the demand, we look at the individual who is indifferent between depositing in bank i and in any other bank. When bank i offers r_i and all other banks offer r, a depositor is indifferent if $r_i - tx = r - t\left(\frac{1}{n} - x\right)$. If this indifferent depositor places his fund in bank i, then all other depositors between him and the bank would do the same. Hence, the demand for deposits of bank i is given by:

$$D_i(r_i, r) \equiv 2x(r_i, r) = \frac{r_i - r}{t} + \frac{1}{n}. \tag{1}$$

There are two restrictions that must be taken into account: the *No Gambling Condition* which must be satisfied for all banks to make sure that the equilibrium is indeed prudent and the *Participation Constraint* which guarantees that there is no depositor who has incentives not to place his fund, and that hence the market will be covered. Since we look at symmetric deposit rates at equilibrium, it is sufficient to check the participation constraint for the individual who is at the same distance from two neighboring banks (i.e., at a distance $1/2n$ from each bank). Hence, (PC) for bank i implies the following:

$$r_i \geq 1 + \frac{t}{2n}, \tag{PC}$$

Thus, in this stage bank i solves the following problem:

$$\max_{r_i} \left\{ (\alpha(1+k) - r_i) \left(\frac{r_i - r}{t} + \frac{1}{n} \right) \right\},$$

$$\text{subjet to} \quad \text{(NGC)} \quad \text{and} \quad \text{(PC)}.$$

Denote by r^{CP} the candidate optimum in a symmetric equilibrium. Using the Kuhn-Tucker first order conditions, we obtain the following candidate optima:

$$r^{CP} = \begin{cases} \bar{r}, & \text{if } \ \frac{t}{n} \leq \alpha(1+k) - \bar{r}, \\ \alpha(1+k) - \frac{t}{n}, & \text{if } \ \alpha(1+k) - \bar{r} \leq \frac{t}{n} \leq \frac{2}{3}(\alpha(1+k) - 1), \\ 1 + \frac{t}{2n}, & \text{if } \ \frac{2}{3}(\alpha(1+k) - 1) \leq \frac{t}{n} \leq 2(\bar{r} - 1). \end{cases}$$

In order to make things more interesting we assume that

$$\alpha(1+k) - \bar{r} < \frac{2}{3}(\alpha(1+k) - 1) < 2(\bar{r} - 1).$$

Notice that we have one interior and two corner solutions. First analyze the corner solution $\bar{r}$. This must satisfy (PC), which implies $\frac{t}{n} \leq 2(\bar{r} - 1)$. Since the profit function is strictly concave in r_i, at $\bar{r}$ this function must have a positive slope, which implies

$$\frac{t}{n} \leq \alpha(1+k) - \bar{r}.$$

Hence, these two together imply that $\bar{r}$ is candidate optimum only if

$$\frac{t}{n} \leq \min\{\alpha(1+k) - \bar{r},\, 2(\bar{r} - 1)\} = \alpha(1+k) - \bar{r}.$$

Consider now, the interior solution $\alpha(1+k) - \frac{t}{n}$, which must satisfy both restrictions (NGC) and (PC). This implies

$$\alpha(1+k) - \bar{r} \leq \frac{t}{n} \leq \frac{2}{3}(\alpha(1+k) - 1).$$

Finally, the other corner solution

$$\left(1 + \frac{t}{2n}\right),$$

which must satisfy (NGC) implying that $\frac{t}{n} \leq 2(\bar{r} - 1)$. Also, at this point the profit function must have a negative slope, hence we must have

$$\frac{t}{n} \geq \frac{2}{3}(\alpha(1+k) - 1).$$

These two together imply

$$\frac{2}{3}(\alpha(1+k)-1) \leq \frac{t}{n} \leq 2(\bar{r}-1).$$

3.1.2. *Covered Gambling Equilibrium*

We compute the demand for deposits of bank i when it offers r_i and all other banks offer r. Notice that we assume the depositors are completely insured and hence, they are paid the promised deposit rates no matter what the banks' portfolio choices are. Then, the demand for deposits will be identical to that of a prudent bank. Thus, the demand is given by equation (1).

Here, there are two restrictions that must be taken into account: the *Gambling Condition* which must be satisfied for all banks to ensure that the equilibrium is indeed gambling and, as in the CPE, the *Participation Constraint* which guarantees a covered market. Bank i solves the following maximization problem:

$$\max_{r_i}\left\{\frac{1}{2}(\gamma(1+k)-r_i)\left(\frac{r_i-r}{t}+\frac{1}{n}\right)\right\},$$
$$\text{subjet to (GC) and (PC).}$$

Denote by r^{CG} the candidate optimum in a symmetric equilibrium. Using the Kuhn-Tucker first order conditions, we obtain the following candidate optima:

$$r^{CG}=\begin{cases}\gamma(1+k)-\frac{t}{n}, & \text{if} \quad \frac{t}{n}\leq\gamma(1+k)-\bar{r},\\ \bar{r}, & \text{if} \quad \gamma(1+k)-\bar{r}\leq\frac{t}{n}\leq 2(\bar{r}-1),\\ 1+\frac{t}{2n} & \text{if} \quad \frac{t}{n}\geq 2(\bar{r}-1).\end{cases}$$

Again to make things interesting we assume that

$$\gamma(1+k)-\bar{r}<\frac{2}{3}(\gamma(1+k)-1)<2(\bar{r}-1).$$

Notice that we have one interior and two corner solutions. First consider the interior solution

$$\gamma(1+k)-\frac{t}{n}.$$

This must satisfy both (GC) and (PC). This implies

$$\frac{t}{n} \leq \min\left\{\gamma(1+k) - \bar{r}, \frac{2}{3}(\gamma(1+k) - 1)\right\} = \gamma(1+k) - \bar{r}.$$

Next examine the corner solution $\bar{r}$. This must satisfy the (PC), which implies

$$\frac{t}{n} \leq 2(\bar{r} - 1).$$

Given the concavity of the profit function, at $\bar{r}$, the profit function must have a negative slope, which implies

$$\frac{t}{n} \geq \gamma(1+k) - \bar{r}.$$

Hence, these two together imply that $\bar{r}$ is a candidate optimum only if

$$\gamma(1+k) - \bar{r} \leq \frac{t}{n} \leq 2(\bar{r} - 1).$$

Notice that $\bar{r}$ is the deposit rate that makes a bank indifferent between investing in a gambling and a prudent asset. Finally, the other corner solution

$$\left(1 + \frac{t}{2n}\right)$$

must satisfy the (GC). This implies

$$\frac{t}{n} \geq 2(\bar{r} - 1).$$

Also, at this point the profit function must have a negative slope and hence, one must have

$$\frac{t}{n} \geq \frac{2}{3}(\gamma(1+k) - 1).$$

These two together imply

$$\frac{t}{n} \geq \max\left\{2(\bar{r} - 1), \frac{2}{3}(\gamma(1+k) - 1)\right\} = 2(\bar{r} - 1).$$

Until now, we have described the candidate optima of the bank's maximization problem under a covered market structure when all banks invest either in a prudent asset or in a gambling asset. Now, we analyze the uncovered market. The Nash equilibrium is characterized in section 3.3.

3.2. *Uncovered Market*

An uncovered market emerges when there exist at least two consecutive banks in the circle between which there is a non empty subset of depositors who do not place their funds in either of these banks. We examine two possible equilibria: an Uncovered Prudent Equilibrium (UPE) and an Uncovered Gambling equilibrium (UGE).

3.2.1. Uncovered Prudent Equilibrium

We compute the demand for deposits issued by bank i. When bank i offers r_i, a depositor at distance x will prefer to stay out of the market if $r_i - 1 < tx$ and hence, bank i will have a maximum deposit of $\frac{r_i-1}{t}$ from each side. Thus, it has the following demand for deposits:

$$D(r_i) = \frac{2(r_i - 1)}{t}.$$

In such an equilibrium there are two restrictions that must be taken into account: the *No Gambling Condition* which makes sure that the equilibrium is indeed prudent and the *No Participation Constraint* which guarantees an uncovered market. Since in an equilibrium banks offer identical deposit rates, it is sufficient to show that the depositor at a distance $x = \frac{1}{2n}$ from a bank does not deposit in this bank. Thus, the *No Participation Constraint* reduces to:

$$r_i \leq 1 + \frac{t}{2n} \tag{NPC}$$

Hence in this stage, bank i solves the following maximization problem:

$$\max_{r_i} \left\{ (\alpha(1+k) - r_i) \left(\frac{2(r_i - 1)}{t} \right) \right\},$$
$$\text{subjet to (NGC) and (NPC).}$$

Denote by r^{UP} the candidate optimum in a symmetric equilibrium. Using the Kuhn-Tucker first order conditions, we obtain the following candidate optima:

$$r^{UP} = \begin{cases} \bar{r}, & \text{if} \quad 2(\bar{r}-1) \leq \frac{t}{n} \leq \alpha(1+k)-1, \\ \frac{\alpha(1+k)+1}{2}, & \text{if} \quad \frac{t}{n} \geq \alpha(1+k)-1. \end{cases}$$

To analyze a non-trivial case, we assume that

$$2(\bar{r}-1) < \alpha(1+k)-1.$$

Solving the maximization problem in the case of uncovered market needs a bit more explanation. First notice that, in case of a UPE, the deposit rate of bank i needs to satisfy two constraints. The No Gambling Condition implies

$$r_i \leq \bar{r},$$

and the No Participation condition implies

$$r_i \leq 1 + \frac{t}{2n}.$$

Consider figure 2. The profit function of the bank is strictly concave reaching a maximum at

$$r_i = \frac{\alpha(1+k)+1}{2}.$$

If we have

$$\bar{r} \leq 1 + \frac{t}{2n} \leq \frac{\alpha(1+k)+1}{2}$$

(as depicted in this figure), then $\bar{r}$ is a candidate for the equilibrium. This also implies that is a candidate if

$$2(\bar{r}-1) \leq \frac{t}{n} \leq \alpha(1+k)-1.$$

Now suppose

$$\frac{\alpha(1+k)+1}{2} \leq \min\{\bar{r}, 1 + \frac{t}{2n}\}.$$

Then

$$\frac{\alpha(1+k)+1}{2}$$

is a candidate optimum. Hence, for this we must have

$$\frac{t}{n} \geq \alpha(1+k) - 1.$$

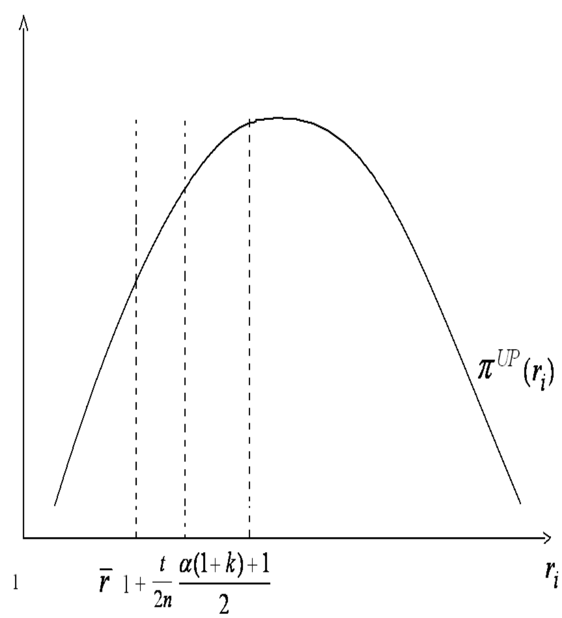
There is also the other corner solution

$$1 + \frac{t}{2n}.$$

If the (NPC) binds, then this is same as a Covered Prudent Equilibrium. Hence, in this case we call the solution r^{UP} as in the CPE and ignore this corner solution. The same is true for a UGE.

Figure 2

A Case of Uncovered Prudent Equilibrium



3.2.2. Uncovered Gambling Equilibrium

Notice that we assume full deposit insurance and hence, the depositors are paid back the promised rate no matter what the banks' portfolio choices are. Hence, the demands for deposit are the same under both gambling and prudent equilibria. Again there are two restrictions that must be taken into account: the *Gambling Condition* which ensures the equilibrium is indeed gambling and the *No Participation Constraint* that guarantees an uncovered market. Thus, bank i solves the following problem:

$$\max_{r_i}\left\{\frac{1}{2}(\gamma(1+k)-r_i)\left(\frac{2(r_i-1)}{t}\right)\right\},$$
$$\text{subjet to}\quad (GC)\quad\text{and}\quad (\text{NPC}).$$

Denote by r^{UG} the candidate optimum in a symmetric equilibrium. Using the Kuhn-Tucker first order conditions, we obtain the following candidate optimum:

$$r^{UG}=\frac{\gamma(1+k)+1}{2}\qquad\text{if}\qquad \frac{t}{n}\geq\gamma(1+k)-1.$$

Observe that we have one interior and one corner solutions. We ignore the corner solution $\bar{r}$ since at this rate, the profits from investing in the prudent asset and the gambling asset are the same. This equilibrium (if it exists) may be refered to as a UPE. Consider the interior solution

$$\frac{\gamma(1+k)+1}{2},\ \text{which must satisfy both (GC) and (NPC).}$$

This implies

$$\frac{t}{n}\geq\gamma(1+k)-1.$$

Until now, we have only described the necessary conditions for the existence of prudent and gambling equilibria under both market structures. In the next subsection, we provide a full characterization of equilibrium.

3.3. *Characterization of Equilibrium*

In the following proposition, we characterize the equilibrium. Recall $\frac{t}{n}$ is used as a measure of market concentration.

PROPOSITION 1. *For given levels of k, t and n, there exist values of market concentration λ_G and λ_P such that:*

(a) if $\frac{t}{n} \leq \lambda_G$ (low market concentration), there is only a Covered Gambling Equilibrium with banks offering deposit rate $\gamma(1+k) - \frac{t}{n}$;

(b) if $\frac{t}{n} \in [\lambda_G, \lambda_P]$ (intermediate levels of market concentration), there is only a Covered Prudent Equilibrium with banks offering deposit rates $\alpha(1+k) - \frac{t}{n}$ and $1 + \frac{t}{2n}$;

(c) if $\frac{t}{n} \geq \lambda_P$ (very high concentration), only an Uncovered Prudent Equilibrium exists, with banks offering deposit rate $\frac{\alpha(1+k)+1}{2}$ or $\bar{r}$.

PROOF. See Appendix.

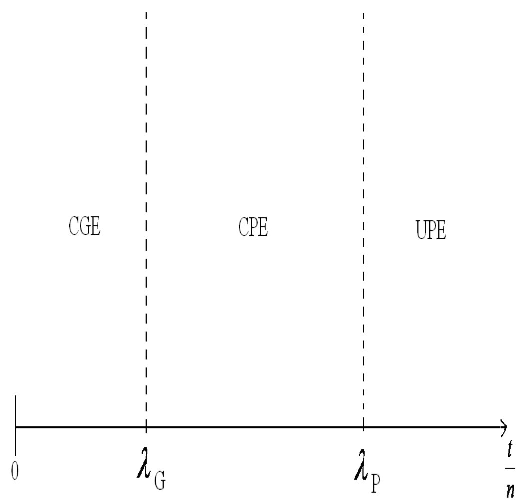
This proposition tells us that when market concentration is low, competition makes the banks' profits so low that banks have incentives to invest in the gambling asset. On the other hand, when concentration is high, banks have high profits. So they have incentives to choose the prudent asset. This proposition is summarized in figure 3.

The logic for the above results is fairly intuitive. High bank competition erodes banks' profit. They compete fiercely by offering high deposit rates. Since banks are able to choose between a gambling asset and a prudent asset, and limited liability makes bank behave like risk-lovers, a very high return (γ) on gambling in case of success leaves little incentive for banks to behave diligently. In a dynamic model this is similar to the famous "charter value effect". Often it is argued that in a highly competitive environment banks take high risk since they have very little to lose ("gambling at resurrection"). On the other hand, with a very high market power banks offer a lower deposit rate with the prospect of earning higher "monopoly rent". Banks thus have incentives to behave prudently to preserve the rent.

4. Entry and Social Optimum

We have established that higher market power for banks leads to less risk taking. What happens to social welfare? In this section we first derive welfare as a function of market concentration, and then analyze possible policy implications that might emerge within this stylized framework. It will be clear immediately that welfare is always lower in the uncovered market. Hence, we concentrate only on the covered market.

Figure 3
Characterization of Equilibrium



First, let us compute the total welfare in case of a CPE. In any equilibrium welfare is the sum of banks' profit and net consumers' surplus minus the total cost of deposit insurance. Consider a bank i. The total measure of depositors going to this bank is $\frac{1}{n}$. Hence, at any equilibrium deposit rate r, the bank's profit is

$$(\alpha(1+k)-r)\frac{1}{n}.$$

The total revenue of these depositors is $\frac{r}{n}$. These depositors also incur a total transport cost of

$$2t\int_0^{1/2n} x dx.$$

Hence, the aggregate net consumers' surplus associated with this bank is

$$\frac{r}{n}-\frac{1}{n}-2t\int_0^{1/2n} x dx.$$

In a prudent equilibrium, there is no cost of deposit insurance. Hence, the total welfare in this case is given by:

$$W^{CP}\left(\frac{t}{n}\right) = n\left[(\alpha(1+k)-r)\frac{1}{n}+\frac{r}{n}-\frac{1}{n}-2t\int_0^{1/2n} xdx\right]$$
$$= \alpha(1+k)-1-\frac{t}{4n}.$$

Notice that in case of a CGE with a rate r, the total expected cost of deposit insurance is $\frac{r}{2}$. Hence, the (expected) welfare is given by:

$$W^{CG}\left(\frac{t}{n}\right) = n\left[\frac{1}{2}(\gamma(1+k)-r)\frac{1}{n}+\frac{r}{n}-\frac{1}{n}-2t\int_0^{1/2n} xdx\right]-\frac{r}{2}$$
$$= \frac{1}{2}\gamma(1+k)-1-\frac{t}{4n}.$$

The welfare function is depicted in figure 4. One can have two situations. If the return on the prudent asset is relatively high, i.e., $11\alpha > 7\gamma$, then

$$W^{CG}(0) < W^{CG}(\lambda_G).$$

In this case, welfare is maximized at

$$\frac{t}{n} = \lambda_G = \frac{3}{2}(\gamma-\alpha)(1+k).$$

On the other hand, if the return on the prudent asset is relatively low, i.e., $11\alpha < 7\gamma$, then

$$W^{CG}(0) > W^{CG}(\lambda_G).$$

Hence, the maximum welfare is reached at $\frac{t}{n}=0$.

Now suppose that the public authority has the objective of maximizing social welfare and that this is achieved through a policy of entry restriction. This mechanism works as follows. If new banks want to enter the market or if the incumbent banks want to stay in the business, they have to pay a fixed entry/permanence fee of amount F.

In light of figure 4a, welfare is maximized at $\frac{t}{n}=0$. Hence, the socially optimal number of banks is $n^* \to \infty$, and the fee charged is $F=0$. In other words, the optimal policy is "no restriction on entry". Notice that at $\frac{t}{n}=0$ each bank earns a profit $\frac{t}{n^{*2}}$. Hence

$n^* \to \infty$ implies a long run equilibrium (characterized by a zero-profit condition). At the maximum social welfare, all banks invest in the gambling asset and the depositors receive a higher deposit rate.

On the other hand, when the return on the prudent asset is relatively high (figure 4b), the welfare is maximized at $\frac{t}{n} = \lambda_G$. Hence, the socially optimal number of banks in the market is

$$n^* = \frac{t}{\lambda_G} = \frac{2t}{3(\gamma - \alpha)(1+k)}.$$

At this level, all banks invest in the prudent asset and the depositors receive a lower deposit rate $\alpha(1+k) - \lambda_G$. Notice that at this level of market concentration, each bank earn a profit equal to

$$\frac{t}{n^{*2}} = \frac{9((\gamma - \alpha)(1+k))^2}{4t}.$$

Hence, entry can be restricted to n^* by charging a fee such that the profit is zero. Hence, F is given by:

$$F = \frac{9((\gamma - \alpha)(1+k))^2}{4t}.$$

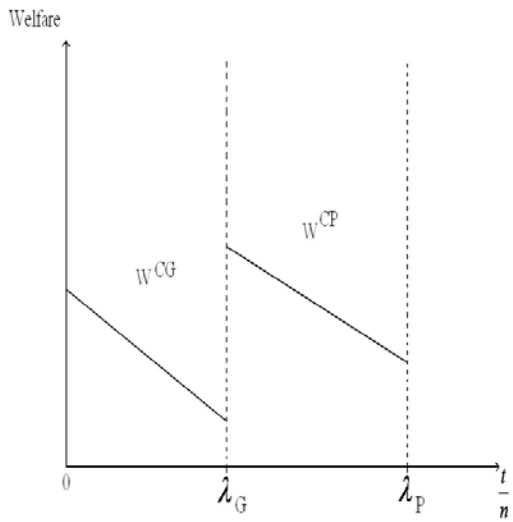
The above discussion is summarized in the following proposition.

PROPOSITION 2. *(i) If the return on the prudent asset is relatively high then no restriction on entry of new banks is the socially optimal policy. (ii) If the return on the prudent asset is relatively low then welfare is maximized with a finite number of banks. The optimal policy is to charge a fixed fee in order to restrict entry to this level.*

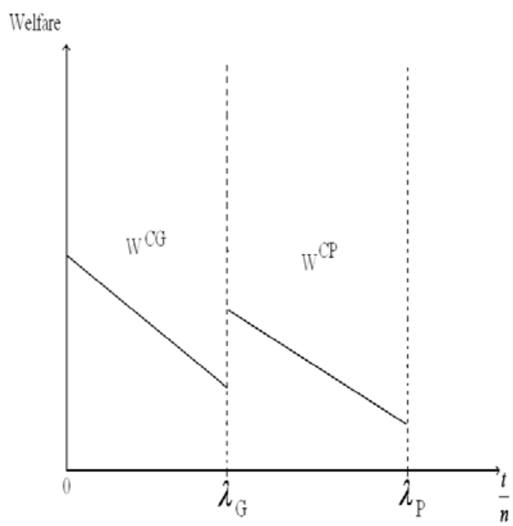
Notice that the only objective of the government is the maximization of social welfare. Depending on the values of the parameters, welfare is maximized at a gambling equilibrium or at a prudent equilibrium. In the later case, it happens that at the welfare maximizing level of market concentration gambling is completely eliminated. These results should be interpreted carefully, and no way should be confused as general conclusions regarding policy implications of models when banks have the opportunity to choose between a safe and a risky asset. Within the current model, part (ii) of the above proposition is true since there is a negative relationship between risk taking and market concentration. Yet, our findings are consistent with the "last bank standing" effect of Perotti and Suárez, they assert:

Figure 4

a) Welfare when 11 $\alpha > 7\gamma$



b) Welfare when 11 $\alpha < 7\gamma$



> ...Promoting the takeover of failed banks by solvent institutions results in greater market concentration and larger rents for the surviving incumbents...Entry policy may subsequently serve to fine-tune the trade-off between competition and stability... (Perotti and Suárez (2002).

The idea is that banks' speculative behavior is often viewed as the result of a trade-off between short term gains from speculation and long term loss of franchise value. Hence, we find it appropriate that in the long run competition, the government (in accordance with the competition authority) may resort to this sort of entry policy to increase market concentration in the short run.

5. Conclusions

In this paper, we use a model of monopolistic competition to study banks that compete in deposit rates. We assume that depositors are fully insured and we analyze the effects of market concentration on the risk-taking behavior of banks. Using a static model, we show that for very low levels of concentration, banks invest only in the gambling asset. We show that when the market concentration is high banks tend to take less risk. We also show that for very high levels of concentration, an uncovered market emerges where the rates are so low, that they do not compensate for the increased transport cost. We also show that social welfare can be maximized with free entry or with a entry restriction imposed by the public authority.

The policy recommendation is much confined to the specifications of this very stylized model, and should no way be confused as being the only policy to make banks behave prudently. Among several others, a risk-based capital requirement is also able to achieve similar policy goals. This method is often used by the Mexican central bank.[4] In this paper optimal entry policy is purely determined by efficiency concerns, and does not incorporate many other aspects of the banking sector. In this regard, we even ignore agents other than banks and depositors. The main crux of our welfare analysis is the discontinuity of the welfare function with respect to market power. There should not be any surprise that welfare decreases with the degree of market concentration. The important point is the existence of multiple equilibria (namely, prudent and gambling), and one

[4] In Mexico, the market risk is calculated by using VAR approach and capital requirement is an increasing function of the amount of risk taken by banks.

Pareto-dominates the other. The issue of entry restriction is a way to create more market power, which can be done in several other ways. One way is to allowing for bank mergers if the efficiency gains are high enough to offset the loss in consumers surplus.[5]

In the current model, a minimum capital requirement fails to fully eliminate gambling. Hence, entry restriction may lead to no gambling which is an optimal policy as well. One limitation of the current model must be highlighted. We concentrate only on the deposit market, and abstract from credit market competition.[6] As shown by Boyd and De Nicolò (2004), in the presence of a credit market, the negative relation between risk taking and market power may be well reversed. In this regard, a similar policy may fail to achieve the desired goal of welfare maximization.

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[5] See Rodríguez (2003) for some evidence of bank mergers in Mexico.

[6] We thanks an anonymous referee for pointing out this aspect.

Appendix

Proof of Proposition 1

First, we show that two candidates, $\bar{r}$ and $1 + \frac{t}{2n}$ do not survive as parts of an UGE.

Consider $r^{CG} = \bar{r}$. This is a candidate when

$$\gamma(1+k) - \bar{r} \leq \frac{t}{n} \leq 2(\bar{r} - 1).$$

Now, if bank i deviates with rate r^* and chooses to invest in the prudent asset, its profit is given by:

$$\pi_i^{G \to P}(r^*, \bar{r}) = (\alpha(1+k) - r^*) \left(\frac{r^* - \bar{r}}{t} + \frac{1}{n} \right).$$

This bank chooses r^* to maximize $\pi_i^{G \to P}(r^*, \bar{r})$. Hence, r^* and the profits with $(r^*, \bar{r})$ are given respectively by:

$$r^* = \frac{\alpha(1+k) + \bar{r}}{2} - \frac{t}{2n}$$

$$\pi_i^{G \to P}(r^*, \bar{r}) = \frac{1}{4t} \left(\alpha(1+k) - \bar{r} + \frac{t}{n} \right)^2.$$

This deviation is profitable if:

$$\pi_i^{G \to P}(r^*, \bar{r}) > \pi^G(\bar{r}, \bar{r}),$$

$$\Longrightarrow \frac{1}{4t} \left(\alpha(1+k) - \bar{r} + \frac{t}{n} \right)^2 > \alpha k + (\alpha(1+k) - \bar{r}) \frac{1}{n},$$

$$\Longrightarrow \left(\alpha(1+k) - \bar{r} - \frac{t}{n} \right)^2 > 0.$$

The above always holds. For the deviation to be credible r^* must satisfy the (NGC):

$$r^* \leq \bar{r} \Longleftrightarrow \frac{t}{n} \geq \alpha(1+k) - \bar{r},$$

This holds for the interval we are analyzing. Hence, we say that for the values of $\frac{t}{n}$ in the interval

$$[\gamma(1+k)-\bar{r},\, 2(\bar{r}-1)]$$

all banks choosing a gambling asset with rate $\bar{r}$ can not be an equilibrium (CGE).

Next, consider $r^{CG} = 1 + \frac{t}{2n}$. This is a candidate when $\frac{t}{n} \geq 2(\bar{r}-1)$. Note that:

$$\pi^{CG}\left(1+\frac{t}{2n}, 1+\frac{t}{2n}\right) = \pi^{UG}\left(1+\frac{t}{2n}, 1+\frac{t}{2n}\right)$$
$$= \frac{1}{2}\left(\gamma(1+k)-1-\frac{t}{2n}\right)\frac{1}{n}.$$

Thus, we can establish:

$$\pi^{G}\left(\frac{\gamma(1+k)+1}{2}\right) > \pi^{UG}\left(1+\frac{t}{2n}, 1+\frac{t}{2n}\right),$$
$$\Longrightarrow \frac{1}{4t}(\gamma(1+k)-1)^2 > \frac{1}{2}\left(\gamma(1+k)-1-\frac{t}{2n}\right)\frac{1}{n},$$
$$\Longrightarrow \left(\gamma(1+k)-1-\frac{t}{n}\right)^2 > 0.$$

The above always holds. Also,

$$\frac{\gamma(1+k)+1}{2}$$

must satisfy the (GC)

$$\frac{\gamma(1+k)+1}{2} \geq \bar{r}.$$

This is satisfied for the interval we are analyzing. Thus, a bank deviates with rate

$$\frac{\gamma(1+k)+1}{2}$$

by choosing a gambling asset. Then, we say that for

$$\frac{t}{n} \geq 2(\bar{r}-1),$$

all banks choosing a gambling asset with rate $1+\frac{t}{2n}$ can not be an equilibrium (CGE and UGE).

Next, consider

$$r^{CG} = \gamma(1+k) - \frac{t}{n}.$$

This is a candidate when

$$\frac{t}{n} \leq \gamma(1+k) - \bar{r}.$$

Now, if bank i deviates with rate r^* and chooses to invest in the prudent asset, its profits are given by:

$$\pi_i^{G\to P}\left(r^*, \gamma(1+k) - \frac{t}{n}\right)$$
$$= (\alpha(1+k) - r^*)\left(\frac{r^* - \gamma(1+k) + \frac{t}{n}}{t} + \frac{1}{n}\right).$$

This bank chooses r^* to maximize

$$\pi_i^{G\to P}\left(r^*, \gamma(1+k) - \frac{t}{n}\right).$$

Hence, r^* and the profits from deviation are given respectively by:

$$r^* = \frac{(\alpha+\gamma)(1+k)}{2} - \frac{t}{n},$$

$$\pi_i^{G\to P}\left(r^*, \gamma(1+k) - \frac{t}{n}\right) = \frac{1}{t}\left(\frac{(\alpha-\gamma)(1+k)}{2} + \frac{t}{n}\right)^2.$$

The above deviation is profitable if:

$$\pi_i^{G\to P}\left(r^*, \gamma(1+k) - \frac{t}{n}\right) > \pi^G\left(\gamma(1+k) - \frac{t}{n}, \gamma(1+k) - \frac{t}{n}\right),$$

$$\implies \frac{1}{t}\left(\frac{(\alpha-\gamma)(1+k)}{2} + \frac{t}{n}\right)^2 > \frac{t}{2n^2},$$

$$\implies \left(\frac{t}{n} - c_1\right)\left(\frac{t}{n} - c_2\right) > 0,$$

where,

$$c_1 \equiv \frac{(\gamma-\alpha)(1+k)}{2\left(1-\sqrt{\frac{1}{2}}\right)} \quad \text{and} \quad c_2 \equiv \frac{(\gamma-\alpha)(1+k)}{2\left(1+\sqrt{\frac{1}{2}}\right)}.$$

Notice that $c_1 > c_2$. Hence, the deviation is profitable if either $\frac{t}{n} > c_1$ or $\frac{t}{n} < c_2$. Also, r^* must satisfy the (NGC), i.e., $r^* \leq \bar{r}$. This is given by:

$$\frac{t}{n} \geq \frac{(\alpha+\gamma)(1+k)}{2} - \bar{r} = \frac{3}{2}(\gamma-\alpha)(1+k).$$

It is easy to show that

$$c_2 < \frac{(\alpha+\gamma)(1+k)}{2} - \bar{r} < c_1.$$

Thus $\gamma(1+k) - \frac{t}{n}$ survives as a candidate if

$$\frac{t}{n} \leq \frac{3}{2}(\gamma-\alpha)(1+k) \equiv \lambda_G.$$

Hence, λ_G is an upper bound of the Covered Gambling Equilibrium (CGE).

Now we analyze the candidate deposit rates for a CPE. First consider

$$r^{CP} = \alpha(1+k) - \frac{t}{n}.$$

This is a candidate if

$$\alpha(1+k) - \bar{r} \leq \frac{t}{n} \leq \frac{2}{3}(\alpha(1+k)-1).$$

Now, if bank i deviates with rate r^* and chooses to invest in the gambling asset, its profits are given by:

$$\pi_i^{P\to G}\left(r^*, \alpha(1+k) - \frac{t}{n}\right)$$

$$= \frac{1}{2}(\gamma(1+k) - r^*)\left(\frac{r^* - \alpha(1+k) + \frac{t}{n}}{t} + \frac{1}{n}\right).$$

This bank chooses r^* to maximize

$$\pi_i^{P\to G}\left(r^*, \alpha(1+k) - \frac{t}{n}\right).$$

Hence, r^* and the profits from deviation are given by:

$$r^* = \frac{(\alpha+\gamma)(1+k)}{2} - \frac{t}{n},$$

$$\pi_i^{P\to G}\left(r^*, \alpha(1+k) - \frac{t}{n}\right) = \frac{1}{2t}\left(\frac{(\gamma-\alpha)(1+k)}{2} + \frac{t}{n}\right)^2.$$

Now, the deviation is profitable if:

$$\pi_i^{P\to G}\left(r^*, \alpha - \frac{t}{n}\right) > \pi^P\left(\alpha(1+k) - \frac{t}{n}, \alpha(1+k) - \frac{t}{n}\right),$$

$$\Longrightarrow \frac{1}{2}\left(\frac{(\gamma-\alpha)(1+k)}{2} + \frac{t}{n}\right)^2 > \left(\frac{t}{n}\right)^2,$$

$$\Longrightarrow \left(\frac{t}{n} - c_1'\right)\left(\frac{t}{n} - c_2'\right) < 0,$$

where

$$c_1' \equiv \frac{1}{2}(1+\sqrt{2})(\gamma-\alpha)(1+k) \quad \text{and} \quad c_2' \equiv \frac{1}{2}(1-\sqrt{2})(\gamma-\alpha)(1+k).$$

Notice that $c_1' > c_2'$. For the deviation is to be profitable we also need $r^* \geq \bar{r}$. This implies

$$\frac{t}{n} \leq \frac{3}{2}(\gamma-\alpha)(1+k).$$

It is easy to show that

$$c_1' \leq \frac{3}{2}(\gamma-\alpha)(1+k).$$

Hence, $r^{CP} = \alpha(1+k) - \frac{t}{n}$ survives as an equilibrium rate for

$$\frac{t}{n} \geq \frac{3}{2}(\gamma - \alpha)(1+k) = \lambda_G.$$

Thus, λ_G is a lower bound on the CPE.

Now consider $r^{CP} = \bar{r}$. This is a candidate when

$$\frac{t}{n} \leq \alpha(1+k) - \bar{r}.$$

Now, if bank i deviates with a rate r^* and chooses to invest in the gambling asset, its profits are given by:

$$\pi_i^{P \to G}(r^*, \bar{r}) \equiv \frac{1}{2}(\gamma(1+k) - r^*)\left(\frac{r^* - \bar{r}}{t} + \frac{1}{n}\right).$$

This bank chooses r^* to maximize $\pi_i^{P \to G}(r^*, \bar{r})$. Hence, r^* and the profits from this deviation are respectively given by:

$$r^* = \frac{\gamma(1+k) + \bar{r}}{2} - \frac{t}{2n},$$

$$\pi_i^{P \to G}(r^*, \bar{r}) = \frac{1}{2t}\left(\frac{\gamma(1+k) - \bar{r}}{2} + \frac{t}{2n}\right)^2.$$

The deviation is profitable if:

$$\pi_i^{P \to G}(r^*, \bar{r}) > \pi^P(\bar{r}, \bar{r})$$

$$\Longrightarrow \frac{1}{2t}\left(\frac{\gamma(1+k) - \bar{r}}{2} + \frac{t}{2n}\right)^2 > \frac{1}{2n}(\gamma(1+k) - \bar{r}),$$

$$\Longrightarrow \left(\frac{\gamma(1+k) - \bar{r}}{2} - \frac{t}{2n}\right)^2 > 0.$$

The above always holds. Also, r^* must satisfy the (GC) $r^* \geq \bar{r}$ which implies

$$\frac{t}{n} \leq \gamma(1+k) - \bar{r}.$$

Hence, the deviation is credible, and $\bar{r}$ does not survive as a candidate rate at a CPE.

Next, consider

$$r^{CP} = 1 + \frac{t}{2n}.$$

This is a candidate for

$$\frac{2}{3}(\alpha(1+k)-1) \leq \frac{t}{n} \leq 2(\bar{r}-1).$$

Note that for this interval, we have discarded the candidate for CGE with a rate $\bar{r}$ which is optimal for this interval. Another possibility is a rate in a UGE, but for this interval there is no optimal rate. Thus, deviating to another rate yields a lower profit. Hence, we can say that for the values of $\frac{t}{n}$ in the interval

$$\left[\frac{2}{3}(\alpha(1+k)-1), 2(\bar{r}-1)\right]$$

all banks choosing the prudent asset with a rate $1+\frac{t}{2n}$ is an equilibrium (CPE). Notice that $1+\frac{t}{2n}$ is the marginal deposit rate between covered and uncovered markets. Hence, $2(\bar{r}-1) \equiv \lambda_P$ is an upper bound on CPE.

Finally we analyze the candidate deposit rates in an uncovered market. First we show that the candidate for a UGE,

$$\frac{\gamma(1+k)-1}{2}$$

does not survive as an equilibrium candidate. This solution is optimum only if

$$\frac{t}{n} \geq \gamma(1+k)-1.$$

The profit with this deposit rate is given by:

$$\pi^{UG}\left(\frac{\gamma(1+k)-1}{2}\right) = \frac{1}{4t}(\gamma(1+k)-1)^2.$$

Notice that there does not exist any gambling deposit rate with which a bank can deviate since the candidate deposit rate along with investment in the gambling asset is a dominant strategy. Another possible deviation is offering another deposit rate r^* and choosing the prudent asset. We can show that a bank can profitably deviate with

$$r^* = \frac{\alpha(1+k)}{2} - \frac{1}{2}\sqrt{(1-\alpha)^2 + \frac{1}{2}\left(\frac{t}{n}\right)^2},$$

and by choosing the prudent asset. The profit generated here is $\frac{t}{4n^2}$ which is higher than

$$\frac{1}{4t}(\gamma(1+k)-1)^2 \quad \text{for} \quad \frac{t}{n} \geq \gamma(1+k)-1.$$

Also, for this deviation to be credible we must have $r^* \leq \bar{r}$. Since,

$$\frac{\alpha(1+k)-1}{2} \leq \bar{r},$$

(because this is optimum in a UPE) for these values of $\frac{t}{n}$, we have $r^* \leq \bar{r}$.

It is easy to show that there cannot be any deviation against the other two candidates of r^{UP}, namely,

$$\frac{\alpha(1+k)-1}{2}$$

and $\bar{r}$ since they constitute part of the dominant strategies for the banks. ∎