TI 2006-015/2
Tinbergen Institute Discussion Paper

Competition and Entry in Banking: Implications for Stability and Capital Regulation

Arnoud W.A. Boot[1,2]
Matej Marinc[1,3]

[1] Amsterdam Center for Law and Economics (ACLE), University of Amsterdam;
[2] Tinbergen Institute, and CEPR;
[3] University of Ljubljana.

Tinbergen Institute
The Tinbergen Institute is the institute for economic research of the Erasmus Universiteit Rotterdam, Universiteit van Amsterdam, and Vrije Universiteit Amsterdam.

Tinbergen Institute Amsterdam
Roetersstraat 31
1018 WB Amsterdam
The Netherlands
Tel.: +31(0)20 551 3500
Fax: +31(0)20 551 3555

Tinbergen Institute Rotterdam
Burg. Oudlaan 50
3062 PA Rotterdam
The Netherlands
Tel.: +31(0)10 408 8900
Fax: +31(0)10 408 9031

Competition and Entry in Banking: Implications for Stability and Capital Regulation *

Arnoud W. A. Boot[†] and Matej Marinč[‡]

January 22, 2006

Abstract

We assess the influence of competition and capital regulation on the stability of the banking system. We particularly ask two questions: *i*) how does capital regulation affect (endogenous) entry; and *ii*) how do (exogenous) changes in the competitive environment affect bank monitoring choices and the effectiveness of capital regulation? Our approach deviates from the extant literature in that it recognizes the fixed costs associated with banks' monitoring technologies. These costs make market share and scale important for the banks' cost structures. Our most striking result is that increasing (costly) capital requirements can lead to *more* entry into banking, essentially by reducing the competitive strength of lower quality banks. We also show that competition improves the monitoring incentives of better quality banks and deteriorates the incentives of lower quality banks; and that precisely for those lower quality banks competition typically compromises the effectiveness of capital requirements. We generalize the analysis along a few dimensions, including an analysis of the effects of asymmetric competition, e.g. one country that opens up its banking system for competitors but not vice versa.

*The authors would like to thank Gabriella Chiesa, Manju Puri, Anjan Thakor, Elu von Thadden and seminar participants at the University of Mannheim for insightful discussions and comments.

†Amsterdam Center for Law & Economics (ACLE), University of Amsterdam, and CEPR, Roetersstraat 11, 1018WB Amsterdam, The Netherlands, *email*: a.w.a.boot@uva.nl.

‡University of Ljubljana, Kardeljeva ploščad 17, 1000 Ljubljana, Slovenia, *email*: matej.marinc@ef.uni-lj.si, and Amsterdam Center for Law & Economics (ACLE), University of Amsterdam, Roetersstraat 11, 1018WB Amsterdam, The Netherlands, *email*: m.marinc@uva.nl.

1 Introduction

A key public policy issue concerning the banking sector is how competition and regulation affect the functioning of financial institutions, and specifically, what the interaction is between competition and (the effectiveness) of regulation. In this paper, we particularly ask two questions: *i*) how does capital regulation affect endogenous entry; and *ii*) how do changes in the competitive environment affect bank monitoring choices and the effectiveness of capital regulation?

The importance of these issues is unquestionable. The increasingly competitive and dynamic environment of banking puts severe strains on the viability and effectiveness of regulation. Competition also affects the behavior of the players in the industry directly. More competition could induce banks to take more risks, which could undermine the stability of the industry (see Vives (2001) for a review).[1] Simultaneously, there is a concern about the impact of capital regulation on the competitive dynamics, including level playing field issues.

We analyze these issues in an industrial organization framework in which we distinguish multiple banks, and we let banks differ in quality. These quality differences are linked to the banks' abilities in monitoring potential borrowers, and affect the riskiness of banks and the profitability of their lending operations. We let banks compete for borrowers and analyze how their choices of monitoring technology, and hence risk, are affected by capital regulation and the intensity of competition. We show that increasing competition – that is, opening up locally segmented markets for cross-market competition (holding the total number of banks fixed) – improves the monitoring incentives of better quality banks and deteriorates the incentives of lower quality banks, and that precisely for those lower quality banks competition typically also compromises the effectiveness of capital requirements. These results point at the difficulty of introducing more competition in protected markets when the local banking system is of low(er) quality.

When we permit endogenous entry, and thus allow for an increase in the aggregate number of banks, we get arguably the most striking result of our analysis. We show that existing work has overlooked a key benefit of increasing capital requirements in that it reduces the competitive strength of lower quality banks vis-a-vis high(er) quality banks, and this effect encourages entry. This insight complements observations by practitioners and policymakers who have sometimes argued that the real contribution of the existing Basel I capital requirements is that it has raised capital levels across the industry and, in doing so, has improved the stability of the financial system. We show that discouraging weaker players is an important aspect of the link between capital requirements and the

[1] See Boyd and De Nicolo (2005) and Beck, Demirgüç-Kunt, and Levine (2005) for an important caveat to this: competition and stability *could* go hand in hand.

quality of the industry. This cleansing effect of capital regulation also gives a moment of pause for the ambitions of the new Basel II capital requirements. Trying to differentiate capital requirements between banks and tailor them to the exact risks taken by these institutions might truly be of secondary importance if raising capital requirements across the board has had such favorable effect on the industry.

While increasing capital requirements always has a cleansing effect on the industry by discouraging weaker banks, the net effect on entry could go either way because of the direct costs that (costly) capital requirements impose on the industry. We will establish conditions for which capital requirements encourage entry and vice versa. Roughly speaking, higher capital requirements have a positive effect on entry provided there are sufficiently many (but not too many) lower quality banks in the economy *and* local banking markets are not fully segmented, i.e. interbank competition should be sufficiently high. We show that for such intermediate quality banking systems increasing capital requirements not only reduces the competitive strength of lower quality banks but also encourages entry.

The reason why capital requirements work against the competitive strength of low quality banks deserves some further discussion. In our analysis, this is a consequence of deposit insurance. As long as the deposit insurance premium cannot be made fully type (and/or risk) dependent, deposit insurance effectively subsidizes low quality banks relative to high(er) quality banks. This makes low quality banks more competitive that they would otherwise be, and makes it more difficult for good banks to gain market share at their expense.[2] The consequence of this is that lending rates are pushed down by the over-competitive low quality banks, and this discourages entry. Increasing capital requirements mitigates this by reducing the deposit insurance subsidy for lower quality banks, thereby reducing their competitive strength and encouraging entry.[3]

Our approach deviates from the extant literature in that it recognizes the fixed costs associated with banks' monitoring technologies. These fixed costs give importance to a bank's market share.[4] The fixed costs put low quality banks at a double competitive

[2]While lack of contractability generally makes it infeasible to have deposit insurance premiums fully risk-based (i.e. type and risk dependent) and effectively introduces cross-subsidies, systemic concerns in the banking industry create all kinds of other cross-subsidies and interdependences in the banking industry. For example, many agree that the functioning of the banking sector depends crucially on the confidence that the public has in the financial system at large. Any of such interdependencies – unless fully priced ex ante – would induce competitive distortions as analyzed in this paper.

[3]In our analysis we assume that capital requirements are binding. Some have observed, however, that banks choose levels of capital above the minimum (see Flannery and Rangan (2004)). Note that this is compatible with our results since the positive effects of raising capital requirements are due to low quality banks that seek to maximize the deposit insurance subsidy, and thus have little interest in being well capitalized. In contrast, good banks can be expected to be adequately capitalized, for example to protect their franchise values.

[4]Recent empirical evidence points at scale economies in banking, see for example Focarelli and Panetta

disadvantage: a higher unit cost of monitoring because of their intrinsically less efficient monitoring technology *and* an amplification of this by their smaller scale of operation due to the difficulties low quality banks face in competing for market share with good banks. These effects lead to less monitoring and hence more risk by low quality banks. For good banks, competition allows them to gain market share and this encourages monitoring. These issues turn out to be particularly relevant when countries with different quality banking systems open up their domestic markets to competition. Strong countries gain, but substantial instability could be expected in weaker countries.

Key to the analysis are the quality differences between banks. These differences create an asymmetric impact of competition on the behavior of banks. Our work contrasts with the extant literature on banking competition that has primarily been analyzed in a symmetric context with equally capable banks (see Repullo (2004), Matutes and Vives (2000) and Boyd and De Nicolo (2005)).[5]

However, quality differences between banking institutions and banking systems are of primary concern to regulators and policy makers. For example, countries with weak banking systems are reluctant to open up their market to competition because this could undermine their banking systems further. Indeed, our analysis confirms that competition has a negative impact on weak banking systems. Possibly even more troublesome, we show that competition makes capital regulation typically less effective precisely in those weak banking systems, while it strengthens the incentive effects of capital regulation in high(er) quality banking systems. Nevertheless, our analysis is rather positive on the role of capital requirements. Capital requirements do mitigate risk-taking incentives, and when we allow for endogenous entry (and no longer hold the aggregate number of banks fixed), they 'cleanse' the banking system by reducing the competitive strength of weak banks, and in doing so could encourage entry.

In an extension, we analyze the effects of asymmetric competition, e.g. one country that opens up its banking system to competition but not vice versa. The key result here is that higher capital requirements *always* encourage entry of existing banks in a previously closed low quality banking market; i.e. make such entry more profitable. We also analyze what effect the threat of entry has on domestic merger incentives. In another extension, we consider late entry by de novo banks without existing (incumbent) borrowers. While

(2003). For the older – more mixed – evidence see the survey paper by Berger, Demsetz, and Strahan (1999).

[5] Allowing for quality differences introduces effects similar to the ones analyzed in the industrial organization literature that focuses on non-price competition through product differentiation (see for example Shaked and Sutton (1982)). See also the recent papers by Freixas, Hurkens, Morrison, and Vulkan (2004) and Kopecky and VanHoose (forthcoming) that also allow for heterogeneity in ability between banks. Neither focuses on the interaction between capital regulation, deposit insurance and competition which is the focus of our analysis.

such late entry is more difficult, we show that higher capital requirements always make such entry more attractive.

The paper is organized as follows. In Section 2 we develop the model, including the specification of the competitive environment. Section 3 presents some basic results. Section 4 analyzes how competition affects the effectiveness of the capital requirements. In Section 5, we endogenize entry, and analyze how entry is affected by changes in capital requirements. Section 6 discusses extensions, and Section 7 contains the empirical predictions. Section 8 concludes.

2 The Model

2.1 Preliminaries

There are four players in the model: borrowers (companies asking for loans), depositors (and providers of capital), commercial banks, and the regulator (who sets the capital requirement and provides deposit insurance).

Banks specialize in lending and fund themselves with deposits and capital. We assume that banks acquire core expertise in monitoring borrowers, and that this expertise is valuable to the companies that they finance. In particular, we have the monitoring technology of a bank affect the success probability of the project that the bank is financing. This captures the role that banks play in relationship banking: banks invest in borrower-specific knowledge and engage in qualitative asset transformation.[6]

The funding of the banks comes from (liquid) deposits and capital. The liquidity of deposits is rooted in deposit insurance that we assume to be present. Deposit insurance is available at a fixed cost. This potentially introduces moral hazard on the part of banks and helps explain the role of capital requirements: capital requirements may contain asset substitution moral hazard. Thus our paper is related to studies of the role of capital in reducing risk-taking, see for example Hellmann, Murdock, and Stiglitz (2000).[7] We assume that bank management is aligned with shareholders.

The regulator sets the capital requirement and provides for deposit insurance.

2.2 Model Details

Preferences and time line: There is universal risk neutrality, with r_f representing the riskless interest factor (one plus the interest rate). We have four dates, $t = 0$, 1, 2 and 3.

[6]See Boot and Thakor (2000), and Ongena and Smith (2000) for a review of relationship banking.

[7]Allen, Carletti, and Marquez (2005) analyze a related rational for capital. In their analysis institutions choose capital in response to lending market induced market discipline. In Morrison and White (2005) raising capital requirements could be an appropriate response to counter a confidence crises.

At $t = 0$ the regulator sets the capital requirements k, and banks decide whether or not to enter the banking industry. At $t = 1$, each borrower is matched with a bank. Banks then decide on their investments in monitoring technology. We call the initial bank that the borrower is matched with the 'incumbent bank'. This bank makes the borrower an initial offer. At $t = 2$ the borrower might find a second competing bank. If this happens, the initial incumbent bank and competing bank compete as Bertrand competitors. The borrower chooses the best offer. Subsequently, the winning bank collects the necessary capital and deposits, and makes the loan, and the borrower invests. Payoffs are realized at $t = 3$. In Figure 1 we have summarized the sequence of events.

INSERT FIGURE 1

Borrowers: A borrower needs a single-period loan of \$1 to finance a project at $t = 2$, with a payoff at $t = 3$. All borrowers are identical. A borrower's project has a return of either Y or 0 (zero). The probability of success (i.e. the pay-off Y) depends on a bank's investment in monitoring technology ν_j with $j \in \{I, C\}$, where $j = I$ refers to the incumbent bank and $j = C$ is the competing bank. We let the probability of success be equal to the investment ν_j, and hence normalize ν_j to $\nu_j \in [0, 1]$. All other things equal, when a borrower can choose between two competing offers, it will choose the bank with the highest ν_j.[8] The aggregate demand for loans from all borrowers is normalized to 1.

Depositors and providers of capital: With complete deposit insurance, depositors are willing to supply their funds at the risk free interest rate r_f. The deposit insurance premium is fixed, and to simplify matters we assume that this premium is included in the gross costs of deposits. Hence, the cost of deposits is $r_D > r_f$. Banks face a binding capital requirement k. They collect this proportion k of the total funds needed from the providers of bank capital and $[1 - k]$ from depositors.

Capital is costly. We let the cost of capital equal ρ, where $\rho > r_D$.[9]

Commercial banks: Banks choose to enter the banking industry at $t = 0$. All banks are initially (perceived) identical. At $t = 1$, with N banks present, each is matched with $1/N$ of the borrowers.[10] Banks then learn whether their type τ is good (G) or bad (B), thus $\tau \in \{B, G\}$, and following this they choose their investments in monitoring technology.

[8] Actually, we will assume (see later) that a borrower can only switch at a cost. Consequently, the incumbent bank has an incumbency advantage, and the competing (second bank) needs to overcome this when making its offer.

[9] See Holmstrom and Tirole (1997) and Diamond and Rajan (2000) for explicit models of why the cost of capital might be higher than the return that depositors demand. Note that this assumption bypasses the question *how* capital is raised, including potential adverse selection problems.

[10] Since all banks are perceived identical at that moment, this even distribution of borrowers over all banks is quite natural.

Banks have an intrinsic monitoring ability $\underline{\nu}_\tau$, with $0 < \underline{\nu}_B < \underline{\nu}_G$. A bank can increase its monitoring ability to a higher level ν at a cost $\frac{c}{2}[\nu - \underline{\nu}_\tau]^2$.[11]

Competitive environment: Competition between banks occurs in two phases. In the first phase (at $t = 1$), all N banks get allocated $1/N$ of the total borrowers. Each bank specifies an interest rate offer R for its allocated borrowers. At $t = 2$, borrowers succeed in locating a competing offer with probability q. With probability $[1 - q]$, they do not find a competing offer. When the latter happens, borrowers have no choice but to accept the initial offer, provided this gives them a non-negative expected return on the project. When a second bank is found, both the initial (incumbent) and the second bank compete as Bertrand competitors. We assume that at this stage the borrowers and the competing banks can observe the monitoring technology adopted by each bank and their types. Each borrower then chooses for the bank that gives him the highest expected return on his project net of funding costs.

One important additional consideration is that if a borrower switches to a competing bank, he incurs a fixed switching cost S. This allows the incumbent bank to earn rents even if the competing bank is equally capable. In other words, the incumbent bank effectively has an 'incumbency advantage' vis-a-vis the competing banks.

3 Initial Analysis: Some Basic Results

We solve the model using backward induction. We first analyze the optimal interest rate offers that banks grant their borrowers. Subsequently, we compute the optimal investments in monitoring technology ν_j at $t = 1$, anticipating the events at $t = 2$.

3.1 Optimal Bank Interest Rate Offers

At $t = 1$ each borrower is matched with a bank, i.e. the incumbent bank. The initial offer that this bank makes is a monopolistic offer. To see this note that the bank can always improve on this offer when its borrower succeeds in obtaining a competing offer. Hence, setting a monopolistic interest rate is optimal. The incumbent bank sets the interest rate equal to the maximum payoff of the borrower in order to obtain all surplus; thus $R^{\max}(\nu_I|\text{no competition}) = Y$.

At $t = 2$, the borrower finds with probability q a competing bank; with probability $[1-q]$ the borrower only has access to the offer of the incumbent bank. When the borrower has no access to a competing offer, he accepts the monopolistic offer and loses all rents. When the borrower has a competing offer, both banks compete for the borrower as Bertrand

[11] Using a generalized cost function satisfying the Inada conditions produces similar results but at a cost of substantial complexity (details available on request).

competitors.

A bank maximizes its market value of equity, i.e. its expected profits net of costs of debt, discounted by the cost of capital. The lowest interest rate $R^{\min}(\nu)$ that a bank with investment in monitoring technology ν is (just) willing to offer follows from its zero NPV condition[12]

$$-k+\frac{\nu}{\rho}\{R^{\min}(\nu)-[1-k]r_D\}=0.$$

Hence,

$$R^{\min}(\nu)=[1-k]r_D+\frac{k\rho}{\nu}. \tag{1}$$

The incumbent bank is able to outbid the competing bank if it can make an offer such that the borrower obtains a surplus at least equal to what he could obtain with the best competing bank's offer $R^{\min}(\nu_C)$. The incumbent bank is willing to do so, only when this offer exceeds its break-even rate $R^{\min}(\nu_I)$. We proceed as follows. The maximum interest rate that the incumbent can charge the borrower without losing the borrower to a competitor with $\nu=\nu_C$ is $R^{\max}(\nu_I|\nu_C)$. Observe that $R^{\max}(\nu_I|\nu_C)$ is such that the borrower is indifferent between this offer and the best offer of the competing bank. That is,

$$\nu_I[Y-R^{\max}(\nu_I|\nu_C)]=\nu_C[Y-R^{\min}(\nu_C)]-S,$$

where we have taken into account that the borrower incurs a switching cost S when he switches to the competing bank. Inserting expression (1) for $R^{\min}(\nu_C)$, we get

$$R^{\max}(\nu_I|\nu_C)=Y[1-\frac{\nu_C}{\nu_I}]+\frac{\nu_C}{\nu_I}[1-k]r_D+\frac{\rho k+S}{\nu_I}. \tag{2}$$

The incumbent bank is willing to lend at this interest rate if $R^{\max}(\nu_I|\nu_C)\geq R^{\min}(\nu_I)$. This holds (use (2) and (1)) if,

$$S+[\nu_I-\nu_C]X\geq 0,$$

where $X\equiv Y-[1-k]r_D$.

If $S+[\nu_I-\nu_C]X<0$, the incumbent bank cannot outbid the competing bank. In that case, the competing bank will prevail. The best the incumbent bank can then do is to offer its break-even rate $R^{\min}(\nu_I)$, and the competing bank can now ask a maximum interest rate $R^{\max}(\nu_C|\nu_I)$ equal to

$$\nu_C[Y-R^{\max}(\nu_C|\nu_I)]-S=\nu_I[Y-R^{\min}(\nu_I)].$$

Substituting from (1), this gives,

$$R^{\max}(\nu_C|\nu_I)=Y[1-\frac{\nu_I}{\nu_C}]+\frac{\nu_I}{\nu_C}[1-k]r_D+\frac{\rho k-S}{\nu_C}. \tag{3}$$

[12]Note that the cost of investing in monitoring technology incurred at $t=1$ is sunk once the competition phase is reached at $t=2$, and thus is not considered when the bank sets the interest rate.

We can now derive the following proposition.

Proposition 1 *Conditional on the monitoring technologies ν_I and ν_C in place, the interest rate offers available to a borrower equal:*

1. *If the incumbent bank does not face a competitor (this happens with probability $[1-q]$), the borrower is offered,*

$$R^{\max}(\nu_I|\textit{no competition}) = Y. \tag{4}$$

2. *If the incumbent bank faces competition (this happens with probability q), it competes as a Bertrand competitor (recall $X \equiv Y - [1-k]r_D$):*

   (a) for $S + [\nu_I - \nu_C]X \geq 0$, the incumbent bank prevails and the borrower is offered $R^{\max}(\nu_I|\nu_C)$, where $R^{\max}(\nu_I|\nu_C)$ is given in (2).

   (b) for $S + [\nu_I - \nu_C]X < 0$, the competing bank prevails and the borrower is offered $R^{\max}(\nu_C|\nu_I)$, where $R^{\max}(\nu_C|\nu_I)$ is given in (3).

Proposition 1 summarizes the interest rate offers available to the borrower at $t = 2$, conditional on the monitoring technologies ν_I and ν_C. We establish next the optimal investments in monitoring technology at $t = 1$, anticipating the events at $t = 2$.

3.2 The Choice of Monitoring Technology

The investment that a bank is prepared to make in its monitoring technology depends crucially on the profitability of the lending operation, and hence the competition it anticipates. Recall that each of the N banks gets allocated $1/N$ borrower. For this initial allocation, a bank has a role as incumbent bank. Competition implies that it may lose this borrower (and/or be forced to lower its lending rate), but the bank could also gain new borrowers by challenging other (incumbent) banks. We first derive some preliminaries.

3.2.1 Preliminaries

The maximum value that an incumbent bank derives from its $1/N$ initial borrower, conditional on having no competing offer, equals

$$V(\nu_I|\text{no competition}) = \frac{1}{N}\{-k + \nu_I \frac{R^{\max}(\nu_I|\text{no competition}) - [1-k]r_D}{\rho}\}.$$

The bank then obtains all surplus. Inserting (4), we can write

$$V(\nu_I|\text{no competition}) = \frac{1}{N}[-k + \frac{\nu_I X}{\rho}]. \tag{5}$$

Conditional on a competing bank being present with monitoring technology ν_C, the value that the incumbent bank derives from its initial borrower equals zero if $S + [\nu_I - \nu_C]X < 0$; in that case it loses the borrower to the competing bank. If $S + [\nu_I - \nu_C]X \geq 0$, the incumbent bank outbids the competing bank and sets its interest rate equal to $R^{\max}(\nu_I|\nu_C)$ as given in (2). The value that it derives from its initial borrower is now,

$$V(\nu_I|\text{competition}, S + [\nu_I - \nu_C]X \geq 0) = \frac{1}{N}\left\{-k + S + \nu_I \frac{R^{\max}(\nu_I|\nu_C) - [1-k]r_D}{\rho}\right\}.$$

Substituting (2), this gives

$$V(\nu_I|\text{competition}, S + [\nu_I - \nu_C]X \geq 0) = \frac{S + [\nu_I - \nu_C]X}{\rho N}.$$

Hence, summarizing we have,

$$V(\nu_I|\text{competition}) = \max(0, \frac{S + [\nu_I - \nu_C]X}{\rho N}). \tag{6}$$

The incumbent bank can also compete for the borrowers of other banks. Strictly speaking, these other banks are the incumbent banks for those borrowers. To prevent confusion, we will continue to call 'our bank' the incumbent bank, and use ν_I for its technology and ν_C for the technology of the other banks. If the incumbent bank competes for the borrower of another bank with monitoring technology ν_C, the value that it derives from the possibility of getting this new borrower is

$$V(\nu_I|\text{new borrower}) = \max(0, \frac{-S + [\nu_I - \nu_C]X}{\rho N}). \tag{7}$$

The expression (7) is very similar to (6), but note that the incumbency advantage now works against 'our bank'.

An useful result relates to the expected number of other borrowers that a bank can make an offer to:

Lemma 1 *The expected number of other borrowers that a bank can make an offer to is q/N.*

To see this, observe that there are $[N-1]$ other banks in the economy. The incumbent bank has a probability $q/[N-1]$ that it can compete for the borrower of any one of these banks.[13] Recall that each of these banks has $1/N$ borrower. Thus the expected number of other borrowers that the incumbent bank can make an offer to is $[N-1] \times \frac{q}{N-1} \times \frac{1}{N} = \frac{q}{N}$.

This lemma highlights that there is a degree of symmetry in our model. That is, the way that we have structured the competition between banks implies that any incumbent

[13]Note that a borrower gets a competing offer with probability q and there are $[N-1]$ banks that could get the opportunity to make this competing offer.

bank faces a probability q that others will bid for its $1/N$ borrower. Thus, the fraction q/N of its borrower is in expected value sense at risk. However, Lemma 1 shows that the flip side is that any incumbent bank can bid in expected value for the fraction q/N of borrowers of other banks.[14] The actual outcome will depend on the quality differentials between banks and their potentially different levels of (investment in) monitoring technology.

3.2.2 Optimal Choice of Monitoring Technology

At $t = 1$, the N banks first learn their types, and then individually choose their levels of investment in the monitoring technology. We consider a simultaneous move game, and derive a separating Nash equilibrium in pure strategies. In choosing their individual levels of investment in monitoring technology, each bank makes a conjecture about the choices of the other banks. In deriving this separating Nash equilibrium we need to put some constraints on the incumbency advantage S. More specifically, we assume,

Assumption 1: $\frac{X^2}{c\rho N} < S < [\underline{\nu}_G - \underline{\nu}_B]X$.

This assumption can be explained as follows. The lower bound on the incumbency advantage ensures that when an incumbent bank competes with a bank of equal quality its incumbency advantage prevails. That is, this competing bank of equal quality will not find it optimal to overcome the incumbency disadvantage by choosing a much higher investment in monitoring technology. Without incumbency advantage this could be optimal because capturing the incumbent bank's borrower offers scale advantages justifying the higher investment in monitoring technology. The incumbency advantage makes this strategy too costly and ensures that banks of the same type will choose identical strategies, i.e. they will choose the same level of investment in monitoring technology. Thus banks of the same type will not grab market share at each others expense.

The upper bound on the incumbency advantage ensures that quality matters in competition; i.e. a good bank can overcome the incumbency advantage of a bad bank, and grab its borrower.[15]

We now proceed as follows. Each bank chooses its investment in monitoring technology ν holding the strategy of other banks fixed. We continue to analyze the problem from the perspective of the incumbent bank. Its investment in monitoring technology is ν_I. The

[14] In Section 6 we will also analyze how competition will evolve if there is only one-sided competition. What we mean by this is that a bank may face competition from other banks, but the borrowers of these other banks might be shielded from competition (or vice versa).

[15] Note that the lower bound on S, $\frac{X^2}{c\rho N} < S$, effectively puts a lower bound on c. This is important because this lower bound ensures that it is prohibitively costly for a bank to overcome its intrinsic lower quality ($\underline{\nu}_B < \underline{\nu}_G$) by choosing a (much) higher level of investment in monitoring technology.

other banks choose ν_C^j, where j refers to one of the other $[N-1]$ banks. We can now write the expected value of the incumbent bank τ, $\tau \in \{B, G\}$, net of funding costs, as

$$\begin{aligned} V_\tau(\nu_I) &= \frac{1-q}{N}[-k + \frac{\nu_I X}{\rho}] + \frac{q}{\rho N}\sum_{j=1}^{N-1}\frac{1}{N-1}\max(0, S + [\nu_I - E(\nu_C^j)]X) + \\ &+ \frac{q}{\rho N}\sum_{j=1}^{N-1}\frac{1}{N-1}\max(0, -S + [\nu_I - E(\nu_C^j)]X) - c\frac{[\nu_I - \underline{\nu}_\tau]^2}{2} \end{aligned} \tag{8}$$

In (8), the first expression is the bank's profitability when there is no competition, see (5). This happens with probability $[1-q]$. The second expression is the expected profit on its initial borrower when there is competition, see (6). The summation is over all $[N-1]$ competing banks. The third expression is the incumbent bank's profit from successfully attracting borrowers away from other banks, as given in (7). The last expression is the cost of investing in monitoring technology.

Each bank maximizes its analogous expression (8). We now have the following result.[16]

Proposition 2 *There exists a separating Nash equilibrium consisting of the strategies ν_B^* for the bad banks and ν_G^* for the good banks, where ν_G^* and ν_B^* equal*

$$\nu_B^* = [1 - q\gamma]\frac{X}{c\rho N} + \underline{\nu}_B, \tag{9}$$

$$\nu_G^* = \{1 + q[1-\gamma]\}\frac{X}{c\rho N} + \underline{\nu}_G. \tag{10}$$

From this proposition it readily follows that in equilibrium good banks choose a strictly higher level of monitoring than bad banks.[17] That is, when comparing (10) and (9) we see that good banks have a higher intrinsic monitoring ability than bad banks ($\underline{\nu}_G > \underline{\nu}_B$), and invest more in additional monitoring because of their anticipated gains in market share due to competition. To see this, observe that ν_G^* is positively affected by competition q, while ν_B^* is negatively affected.

We can now derive a corollary that relates to the effect of capital requirements on monitoring incentives.

[16] We impose restrictions to guarantee that the monitoring choices are in the interior and the borrowers' projects are sufficiently attractive that all banks are willing to provide funding. These restrictions are shown to be compatible with Assumption 1 (see the proof of Proposition 2).

[17] When good and bad banks are very similar to each other and the incumbency advantage is very high (note that this would violate Assumption 1), there exists another – pooling – Nash equilibrium in which all banks focus only on their incumbent borrowers. Neither the good nor the bad banks try to win borrowers from other banks, simply because the high incumbency advantage prevents any type of bank from profiting from non-incumbent borrowers. In absence of an incumbency advantage (again a violation of Assumption 1), no equilibrium exists in pure strategies.

Corollary 1 *Higher capital requirements improve the monitoring incentives of both good and bad type banks.*

Capital requirements favourably affect monitoring incentives in our model because higher capital forces banks to internalize more risk which in turn reduces risk taking incentives, implying more monitoring. This is a typical result, and follows from the objective function of banks in our analysis; i.e. banks maximize the value of capital.

4 Competition and the Effectiveness of Capital Regulation

4.1 Introduction

We continue to hold the number of banks N fixed; in Section 5, we will allow for entry. Our focus for now is on the competition between banks in (partially) segmented markets. The key question analyzed is how relaxing barriers between existing banks (e.g. opening up geographically segmented markets) affects the strategies of banks and the effectiveness of capital regulation.

The type of competition that we analyze in this section could be interpreted as opening up national markets to foreign competitors. Across the globe, we increasingly see that banks are challenged in their home markets by foreign players, but also themselves challenge other banks in their home markets. The reasons for this include globalization, developments in information technology and deregulation. In particular, the developments in information technology could potentially allow banks to enlarge their geographic area of operations without having a local presence in those markets; this possibly reduces the competitive advantage of local players (see for example Petersen and Rajan (2002)).

In our model, these developments positively impact q, the probability that borrowers have access to a competing second offer. We continue to assume symmetry in the structure of competition. That is, in the model that we have developed so far, an incumbent bank faces competition for its own $1/N$ borrower with probability q, but it also gets access to an equal number of borrowers (in expectation) from other banks, see Lemma 1. Thus, in expected value sense, the number of borrowers at risk equals the number it could gain. A bank's actual success with competition depends both on its inherent quality and on its investment in monitoring technology relative to that of its competitors.

4.2 Analysis

We will now analyze how relaxing barriers to competition between existing banks, i.e. increasing q, affects monitoring incentives and the effectiveness of capital regulation. Following this, we analyze how capital requirements affect the values of good and bad banks.

We first analyze the effect of competition on monitoring incentives. From Proposition 2 we can directly show that

Corollary 2 *Increased competition (higher q; holding the number of banks N fixed) decreases the optimal level of monitoring of bad banks (ν_B^*) but increases the optimal level of monitoring of good banks (ν_G^*).*

The intuition for this corollary is as follows. Higher competition reduces the probability that bad banks can hang on to their own borrowers. This diminishes their anticipated market share and hence lowers their incentives to invest in monitoring technology. Good banks, however, benefit from a higher q in that they can steal more borrowers from bad banks. Hence, they expect to gain market share, effectively increasing their returns on investing in monitoring technology.

This differential impact of competition on monitoring incentives highlights an interesting property of our model.[18] For bad banks, competition implies losing market share and hence higher per unit costs due to the presence of fixed costs in the monitoring technology. For good banks, this is precisely the reverse: competition allows for an increase in market share, and effectively helps to lower the per unit costs.

A related question is what happens to the effectiveness of capital requirements when competition heats up. From Corollary 1 we know that higher capital requirements increase the investments in monitoring technology by both types. What we show next is that competition *strengthens* this positive effect of capital requirements for good banks, but weakens it for bad banks.

Proposition 3 *Higher competition (higher q) negatively affects the effectiveness of the capital requirements for bad banks, but it increases the effectiveness of capital regulation for good banks.*

The intuition for this is directly related to that of Corollary 2. Competition reduces the marginal benefit of investing in monitoring technology for bad banks but increases that for good banks. Not surprisingly then, the favorable impact that capital regulation has on monitoring incentives is strengthened for good banks but not for bad banks.

The results so far show that competition has a positive impact on the monitoring incentives of good banks, but undermines those of bad banks both directly and indirectly

[18] An analogy can be made to the analysis of Boot and Thakor (2000). They show that competition could encourage banks to invest more in relationship lending. In similar spirit, Corollary 2 shows that banks may choose to invest more in monitoring technology when competition heats up. But, as Corollary 2 shows, this only applies to high(er) quality banks. Lower quality banks reduce their investments in monitoring technology and become more risky, reminiscent of the potential adverse effects of capital requirements in Hellmann, Murdock, and Stiglitz (2000).

via reducing the effectiveness of capital regulation. This has implications for regulatory policy. Most importantly, the understandable policy by regulators to impose higher capital requirements in a more competitive environment is not as effective as one would like it to be. That is, competition undermines the effectiveness of capital regulation precisely for those banks for which it is needed most, i.e. the bad banks. Thus, for lower quality banks increasing competition has both a direct negative impact on monitoring incentives, and an indirect negative impact via a reduced effectiveness of capital requirements. For higher quality banks the direct and indirect effects typically both positively impact monitoring incentives.

A caveat needs to be made. In a sense matters are worse than sketched here. While we show that competition in our setting increases monitoring incentives for good banks (see Corollary 2), one could say that we overestimate the positive effects of competition on stability in a good banking system. This is because in our model all borrowers of any one bank are perfectly correlated, and we have not taken into account diversification effects across banks. Consequently, only the success probability matters for stability. This success probability is positively affected by competition via an increase in monitoring incentives. But competition will generally reduce rents and this could negatively affect stability when we take into account diversification effects. Bank stability would then not only depend on the failure probability of one borrower, but also on diversification effects across borrowers and hence the level of rents the bank earns on borrowers that succeed. Similarly, taking into account diversification effects across banks would lend importance to the level of rents. Since competition reduces rents, diversification is less effective, and hence mitigates (part of) the favorable effect that competition has on stability for the good banks via the higher monitoring incentives. What this means is that if diversification effects are considered competition has a smaller positive effect on stability for good banks. For bad banks things would become even worse.

The qualitative conclusions remain intact however. That is, bad banks unequivocally suffer from competition and could also become less receptive to capital regulation, while good banks gain. This differential impact of capital regulation on good and bad banks is further highlighted when we look at the effect of capital regulation on the values of good and bad banks. We can derive the following proposition.

Proposition 4 *Higher capital requirements* always *reduce the value of a bad bank* $V_B(\nu_B^*)$*, but increase the value of a good bank* $V_G(\nu_G^*)$ *as long as competition is sufficiently strong (high* q*) and the quality of banking industry is sufficiently low (low* γ*).*

The key to understanding this result is that capital regulation has two effects on the industry. The first effect is that capital imposes a cost on each bank because capital is more expensive than deposits. This, in isolation, reduces the value of each bank, and is the result we are familiar with. However, a second more subtle effect is at work as well: capital regulation reduces the deposit insurance subsidy that goes to low quality banks. That is, flat-rate deposit insurance is most valuable to bad banks, and this gives them an artificial competitive advantage. Capital regulation reduces this, and helps good banks restore their competitive advantage. Good banks are then able to capture higher rents when competing with bad banks. This has a positive impact on the value of good banks, and reduces the value of bad banks.

Proposition 4 shows that the positive effect of capital regulation on the value of a good bank depends crucially on q and γ. Good banks can only gain from higher capital requirements when q is high, meaning that the banking system is rather open and competitive, such that much is gained by weakening the competitive strength of bad banks. This effect is most important when many bad banks are present, i.e. γ is low.

To understand this further, let's reexamine the competition between good and bad type banks. We focus on the case where an incumbent good bank faces competition from a bad bank. The rents that the good bank earns equal, see (6), $\frac{1}{\rho N}[S + [\nu_G^* - \nu_B^*]\{Y - [1 - k]r_D\}]$. Observe that these rents are increasing in the capital requirement k. This is the consequence of the negative effect that capital requirements have on the rents that a bad bank derives from the flat-rate deposit insurance; this reduces its competitive strength and benefits the good banks. To see this, note that a good bank faces a net cost of deposits equal to $\nu_G^*[1-k]r_D$ while this is for a bad bank $\nu_B^*[1-k]r_D$. Since $\nu_G^* > \nu_B^*$ deposits are effectively subsidized for bad banks. This mispricing of flat-rate deposit insurance thus unfairly helps bad banks, and makes them fiercer competitors for good banks. Higher capital requirements partially eliminate this distortionary effect.

Proposition 4 gives an intriguing perspective on the impact of capital requirements. Capital requirements, despite their costs (capital is costly), could benefit good banks under well defined circumstances. In section 5 we explore this further, and focus in particularly on the impact of capital requirements on entry, i.e. we endogenize N.

4.3 Further Discussion

The competition that we have analyzed so far involves opening up (partially) segmented markets. In the model this means increasing q, while keeping the number of players N fixed. As we have discussed, this could be interpreted as opening up previously closed domestic markets to foreign competitors. Alternatively, the increase in q could be interpreted as an increase in *within-market* competition, for example due to developments in information technology.

In the context of two countries that introduce cross border competition, our results show that the country with low quality banks will become even riskier and the country with high quality banks gains and becomes safer. The direct consequence is that opening up borders is bad for the stability of a low quality banking system and good for the stability of a high quality banking system.

Similarly, the effectiveness of capital regulation is typically negatively affected in a low quality system, while favorably affected in a high quality system. The impact of capital regulation on the valuation of banks is different as well. Low quality banks lose value while high quality banks gain value as long as the quality of the banking system is sufficiently low and q, the parameter of within market competition, is sufficiently high.

5 Endogenous Entry

5.1 Modelling Entry

We will now allow for entry in banking by endogenizing the number of banks N. The probability that a borrower finds a competing bank, q, now also depends on the number of banks N operating in the banking system. In particular, we assume that the probability of finding a competing bank is increasing in N, i.e. $\frac{\partial q}{\partial N} > 0$.[19]

5.2 Analysis

We first analyze how monitoring choices and bank values are affected by N, the number of banks in the economy. Subsequently, we let N be determined by endogenous entry. We can derive the following result.

Lemma 2 *An increase in the number of banks N decreases both the investments in monitoring, ν_G^* and ν_B^*, and the values of banks, $V_G(\nu_G^*)$ and $V_B(\nu_B^*)$.*

This lemma is intuitive. A higher number of banks reduces the market share of each bank. This makes each bank less valuable, and also discourages investments in monitoring technology.

We now endogenize N, and hence allow for entry. The entry decision is made at $t = 0$. At that moment, each prospective bank does not yet know its own (future) type, but assesses its expected quality based on the cross sectional probability distribution $\{\gamma, [1 - \gamma]\}$. Each bank computes whether its expected profits from entering exceed the cost of

[19] Note that q can still be largely determined by local institutional arrangements. We also let $\frac{\partial [q/N]}{\partial N} < 0$. This is a quite natural property that implies that the probability that a borrower gets his competing (second) offer from any one particular bank is decreasing in N. Alternatively (see also Lemma 1), it just implies that with more banks around the market share of each bank is less and the number of other borrowers that can be made an offer to is smaller in expectation.

entry F, anticipating the competitive environment (including the number of banks already present).[20]

To prevent complexity due to discreteness in the number of banks, we let N be a continuous variable, such that N^* is determined by the equilibrium condition:

$$[1-\gamma]\hat{V}_B^* + \gamma\hat{V}_G^* = F, \tag{11}$$

The values $\hat{V}_B^*$ and $\hat{V}_G^*$ are the equilibrium valuations of the bad, respectively good banks at the point where $N = N^*$.

We are particularly interested at how capital regulation affects entry. The next proposition shows that higher capital requirements could encourage entry. The competition parameter q is the one that obtains in equilibrium before we change the level of capital requirements.

Proposition 5 *The effect of capital regulation on entry is as follows:*

1. *When competition is low ($q < \bar{q}$), higher capital requirements decrease entry.*
2. *When competition is high ($q \geq \bar{q}$), higher capital requirements:*
   (a) increase entry for $\gamma \in [\gamma_1(q), \gamma_2(q)]$.
   (b) decrease entry for $\gamma \in [0, \gamma_1(q)) \cup (\gamma_2(q), 1]$.

This proposition points at a striking feature of capital regulation: higher capital requirements could – despite their costs – induce more entry into the industry. This happens when the banking industry is of intermediate quality, $\gamma \in [\gamma_1(q), \gamma_2(q)]$, and competition is sufficiently high ($q \geq \bar{q}$). To see this note from Proposition 4 that higher capital requirements can only induce more entry when these requirements positively affect the value of good banks (otherwise both the bad and the good banks' valuations would be decreasing in the level of capital requirements which would for sure lead to less entry). Proposition 4 then tells us that the level of competition should be sufficiently high (high q), and γ should be sufficiently low. What Proposition 5 shows is that for higher capital requirements to induce more entry, we need a lower bound on γ as well. This can be easily understood. If γ is too low, a prospective entering bank believes that it will turn out to be of low quality as well. In that case, it expects its value to be negatively affected by higher capital requirements (see Proposition 4), which discourages it from entering.

We can now analyze what happens to the effectiveness of capital regulation as an instrument to encourage monitoring when entry is endogenous. Observe that in the absence

[20] We just consider the following simple entry procedure: banks decide on entering sequentially in random order. Note that the order does not matter because all prospective entering banks are identical, and assess their quality based on the cross sectional probability distribution $\{\gamma, [1-\gamma]\}$.

of endogenous entry (see Corollary 1) capital regulation always has a positive impact on monitoring incentives. We are now ready to prove the following corollary that shows that this positive impact could be dampened by endogenous entry.

Corollary 3 *The effect of capital requirements on the investments in monitoring technology for both good and bad banks is weakened when capital regulation encourages entry and strengthened when capital regulation induces less entry.*

Corollary 3 in combination with Proposition 5 offers some intriguing challenges for regulators. Capital regulation has a direct positive effect on the investments in monitoring technology (see Corollary 1), but this positive effect is mitigated by the higher entry that capital regulation could induce. If capital regulation discourages entry (cases 1 and 2b in Proposition 5), the effectiveness of capital regulation is actually enhanced.

6 Model Extensions

In this section, we analyze two extensions. First, we allow for one-sided competition. What we mean by this is that one country opens up its banking system to banks from another country, but this other country keeps its own market closed. Second, we analyze a de novo bank, without current borrowers, that seeks to enter an established banking market. The de novo bank has no incumbency advantage, but all existing competitors have. This extension highlights the problems that a start-up bank faces.

6.1 One Sided Competition

So far our analysis has focused on symmetric competition. All banks are at equal footing, and the expected gain in market share (stealing borrowers from other banks) equals in expected value sense the loss they face in their own market (losing 'own' borrowers to competitors), see the discussion following Lemma 1. We are now going to focus on one-sided competition. We focus on two countries, where the first opens its domestic banking market, but the second country keeps its market closed. In this setting, we analyze how our previous symmetric competition results are affected. In particular, we seek to answer the question whether countries should single-handedly free up their banking markets or whether this should only be done on a reciprocal basis.

We proceed as follows. The country that opens up its market we call the 'open' country (country O). The country that keeps its banking market closed is the 'attacking' country A. This means that a bank from country A can enter country O, but not vice versa. Since we want to analyze later whether domestic mergers are an effective response to the threat of competition from foreign banks, we assume that there are two domestic banks in country O, but just one in country A. To make matters interesting, the bank in country A is of the good type. We let all banks be of equal size. We distinguish two cases. In Case 1, both banks in country O are of the bad type; in Case 2, the banks are good.

Proposition 6

Case 1 **– The domestic banks in country** O **are good:** *The banks in country O hold on to their market share, but their values decrease because of competition. The banks in country O do not change their investments in monitoring technology. For the banks in country A nothing changes.*

Case 2 **– The domestic banks in country** O **are bad:** *The domestic banks in country O lose market share and value; the good bank from country A now gains market share and value. Anticipating the reduction in market share, the banks in country O reduce their investments in monitoring technology while the bank in country A increases its investments.*

The results in this proposition are quite straightforward. When the domestic banks in the country that opens up are good (Case 1) they can hold on to their market, and also their investments in monitoring technology remain intact. If the banks are bad (Case 2), they will lose out to the foreign competitor and market share is lost. As a result, their levels of investment in monitoring will decrease.

We analyze next what impact capital requirements have on the results in Proposition 6. We focus on the effects that capital requirements could have on the profitability of entering country O when that country's banks are bad (Case 2 in Proposition 6).

Corollary 4 *The attractiveness of entering country O when the banks in that country are bad is increasing in the level of the capital requirements.*

Recall that we are focusing on a good bank from country A that enters country O. For that bank, the choice of entering country O versus not entering is *always* positively affected by higher capital requirements. This corollary contrasts to the results in Proposition 5. There we showed that higher capital requirements encourages de novo entry only when q is high enough and γ takes on interior values. This corollary shows that an *existing* bank finds it always more profitable to enter a new market when capital requirements are higher. Thus raising capital requirements can have very different effects on *de novo* entry versus entry coming from existing banks.[21]

[21]The careful reader may object to this conclusion, because entry in Proposition 5 was analyzed from the perspective of a de novo bank that did not yet know its type, while in Corollary 4 the existing bank knows that it is good. This, however, does not invalidate our conclusions. If the de novo bank in Proposition

Corollary 4 provides interesting empirical implications when compared to Proposition 5. In particular, we predict that in countries with relatively weak banks increasing capital requirements facilitates entry of higher quality foreign banks. Whether higher capital requirements also encourage de novo entry depends crucially on the openness of the banking markets, i.e. the parameter q (see Proposition 5). Only when this parameter is sufficiently high, can more de novo entry be expected.

We show next that domestic banks may choose to merge to protect their market against foreign competition. The following corollary establishes that – given the fixed costs in the monitoring technology – merging indeed helps protect market share.

Corollary 5 *A merger between (bad) domestic banks helps defend them against the threat of foreign entry if incumbency advantage exceeds some minimum level, i.e.*

$$S > [\underline{\nu}_G - \underline{\nu}_B]X - \frac{X^2}{c\rho N}, \tag{12}$$

and if competition is not too high, i.e. $q < \hat{q}$.

The condition (12) puts a potentially stricter lower bound on the incumbency advantage S than Assumption 1 does. The corollary reflects the scale advantage that comes from merging. That is, the merged bank is prepared to make a bigger (ex ante) investment in monitoring technology which elevates its added value in lending. This helps the merged bad bank mitigate its quality disadvantage. The restriction on q follows because the lower q, the more difficult for an entrant to grab market share.

Next, we ask the question whether opening up borders encourages domestic merging incentives. That is, does opening up borders make it more valuable for domestic banks to merge? And if so, are merging incentives elevated more for good or bad domestic banks? We can prove the following.

Corollary 6 *For any small positive entry cost to the foreign entrant the threat of entry (weakly) increases the value of merging for weak domestic banks, but has no effect on the merger incentives of high quality domestic banks.*

Key to this corollary is the positive entry cost. With such cost, entry does never occur in a market with good banks. Hence such market is not affected by the threat of entry.[22]

5 knows that it was good for sure, it would only be more likely to enter in response to higher capital requirements when q is sufficiently high (see also Proposition 4). In Corollary 4 we do not need this restriction. A potentially more important consideration is that we (implicitly) assume that the fixed-cost based monitoring technology of any bank is equally useful across borders. If this technology is country specific, we are effectively in a situation of late entry where the entering bank needs to build up capacity without having the benefit of incumbent borrowers. This situation is analyzed in Section 6.2.

[22] Note that without entry costs the foreign entrant would not obtain market share upon entry, but would affect the valuations of good domestic banks (see Proposition 6). The latter effect is not present when there is an entry cost.

In a weak domestic market entry is profitable as long as the entry cost is not prohibitive. However, following a merger between these weak domestic institutions entry may no longer be profitable because of scale economies in the merged entity. This deterrence effect of merging explains the extra gain in merging incentives for weak domestic institutions.

Several policy implications readily follow from our analysis. What our results in this section show is that opening up a weak domestic banking sector to foreign competitors weakens the domestic institutions, i.e. they lose market share, reduce monitoring and hence become riskier. Increasing capital requirements makes entry even more likely, and using similar arguments as in Corollary 3, could undermine monitoring incentives further. The liberalization then does not help improve the quality of the domestic banking sector. This would suggest that the opening of such domestic market should allow for takeovers of weak domestic institutions by foreign entrants. Allowing domestic institutions to merge helps them protect market share, possibly favorably affecting the weak banks' monitoring incentives, but simultaneously could prevent the influx of higher quality banks. Again, allowing for takeovers could be better.

6.2 Asymmetric Competition with Late Entrants

Until now, all banks were (initially) allocated the same number of borrowers $1/N$. Now we extend our model to incorporate the possibility that banks may enter late and have no initial (incumbent) borrowers; their established competitors however do.

Banks are again either good or bad. Assume that all established banks consider the number of banks N to be fixed. Thus, late entry is not anticipated and, hence, the existing banks have chosen the levels of monitoring as given in Proposition 2. Starting from this equilibrium, a de novo bank may consider late entry. However, this bank misses an incumbency advantage. It can only get borrowers by luring them away from the existing banks. As before, the late entering bank does not know its own type, yet knows the cross-sectional distribution $\{\gamma, [1-\gamma]\}$.

We can now analyze which factors affect the profitability of late entry. We can establish the following result.

Proposition 7 *Late entry occurs if the incumbency advantage is sufficiently small, i.e. if*

$$S < [\underline{\nu}_G - \underline{\nu}_B]X - \frac{X^2}{c\rho N}, \tag{13}$$

and q is sufficiently high and the existing banking market is of intermediate quality, i.e. $\gamma \in [\underline{\gamma}(q), \bar{\gamma}(q)]$.

Observe that the restriction (13) puts a stricter upper bound on S than Assumption

1 does.[23] This is intuitive. With late entry, the new entrant is at a distinct competitive disadvantage because it has no incumbent borrowers. Consequently, a substantial scale advantage needs to be overcome. Hence, the incumbency advantage S should be small. The other conditions in the proposition mimic those in our earlier results. That is, the banking market needs to sufficiently open such that the new entering bank has access to borrowers (i.e. q needs to be sufficiently high). The restrictions on γ guarantee that the entering bank has a sufficiently favorable image about its own quality (lower bound $\underline{\gamma}(q)$); only then it can expect to grab market share. The upper bound $\bar{\gamma}(q)$ guarantees that (in expectation) it can expect to encounter some weaker banks to grab market share from.

Like Proposition 5 we can also show that higher capital requirements always make late entry more profitable whenever the conditions in Proposition 7 are satisfied. We have:

Corollary 7 *In the region where late entry is profitable (i.e. condition* (13) *holds, q sufficiently high and $\gamma \in [\underline{\gamma}(q), \bar{\gamma}(q)]$), higher capital requirements enhance the profitability of late entry, and hence induce more late entry.*

Corollary 7 is similar to Proposition 5. However, observe that the potential beneficial effect of capital regulation is less restrictive. That is, strengthening capital regulation helps encourage late entry whenever late entry is feasible.

7 Empirical Predictions

Our analysis produces several predictions that should be brought to the data. Various pieces of existing empirical evidence are available and will be discussed where applicable. An important step in testing the various predictions related to competition is distinguishing between the two competition measures, q and N. The openness measure q, i.e. the degree of segmentation between banks or between local banking markets, reflects the intensity of competition between existing banks. The other measure of competition is the number of banks N in the market. Observe that in the model q is the probability with which borrowers can get a competing offer. This is affected by the number of banks N in the market, but might be largely determined by institutional factors like the degree of the stringency of anti-trust enforcement. The number of banks N also measures bank size and concentration in our analysis.

The predictions are as follows:

[23] In the proof of Proposition 7 we show that there is a non-empty set of parameter values for which late entry can occur. Interestingly, note that the conditions in Corollary 5 and Proposition 7 are the mirror image of each other that can never be jointly satisfied. Since Corollary 5 refers to foreign entry of existing banks and Proposition 7 to de novo entry, they are not fully comparable. However, these results do show that in circumstances where merging is effective in defending against foreign entry, also late entry is not feasible (even without merging).

i. Increasing the openness/competition measure q shifts market share from bad to good banks. This follows from the discussion surrounding Proposition 2. Good banks benefit from a higher q and gain market share, while bad banks lose market share. This prediction is supported by Stiroh and Strahan (2003) who observe that competition reallocates assets from badly performing banks to good ones.

ii. Competition (increasing q) undermines stability in a low quality banking market but strengthens it in high quality banking markets. This prediction follows from the results in Corollary 2. There is some supporting evidence in the recent literature, in particular Boyd and De Nicolo (2005) and Beck, Demirgüç-Kunt, and Levine (2005) contemplating that competition and stability could go hand in hand. Our analysis points at the importance of the quality of the banking system for this to hold.[24]

iii. The effectiveness of capital regulation in discouraging risk taking is negatively affected by competition (q) for low quality banks but not so for high quality banks. This follows from Proposition 3 that shows that for bad (good) banks capital is less (more) effective in encouraging investments in monitoring technology when competition heats up.

iv. Raising capital requirements positively affects the values of good banks when competition (q) is sufficiently high, and the average quality of the banking system is not too high (see upperbound on γ in Proposition 4). The value of bad banks is always negatively affected. A way of testing this prediction is by looking at the valuation effects of the introduction of higher capital requirements.

v. Strengthening capital requirements encourages entry in banking markets of *intermediate* quality that are sufficiently competitive (high q), otherwise it discourages entry. This prediction follows from Proposition 5.

vi. Increasing the number of players N in the industry (such that average market share is diluted) reduces investments in monitoring technology and reduces the effectiveness of capital regulation for all banks. This prediction follows from Lemma 2 and Corollary 3 and comes from the scale economies in the monitoring technology. What this prediction implies is that augmenting competition via the number of players N differs radically from augmenting competition via the openness parameter q. As predictions ii. and iii. show, increasing q has favorable effects on high quality banks.

vii. Strengthening capital requirements helps existing banks enter weak foreign banking markets and also encourages (late) entry by de novo banks. This prediction directly

[24] Also our results on asymmetric competition (Section 6.1) point at the importance of focusing on the quality of the banking system when analyzing the effect of competition.

follows from the results in Corollaries 4 and 7, and complements the positive effects of capital requirements identified in prediction v. A way of testing this prediction is to see whether the adoption of tougher capital standards has encouraged entry.

viii. The threat of foreign entry encourages mergers between domestic institutions in weak banking systems, but not in high quality banking systems. This result follows from Corollary 6, and applies whenever foreign entrants face a positive entry cost. Observe that this prediction is not about the value of merging in general, but about the extra value created by the threat of foreign entry.

8 Conclusion

Our analysis of competition between banks of different quality shows that capital regulation has substantial impact on the competitive dynamics. The most striking conclusion from our analysis is that increasing costly capital requirements could encourage entry in markets that are sufficiently open for interbank competition. This result comes from the distortions that flat-rate deposit insurance introduces in banking. Implicitly such deposit insurance benefits lower quality banks most, and makes them fiercer competitors than they otherwise would have been. Capital requirements are an effective regulatory tool that mitigates this distortion. This points at a complementarity between capital regulation and deposit insurance that goes further than the typical insight that capital regulation mitigates the risk taking incentives induced by deposit insurance. Capital requirements also help mitigate the competitive distortions that deposit insurance brings about. That is, capital has a 'cleansing' effect mitigating the artificial competitive advantage of low quality banks that is induced by deposit insurance.

This insight also addresses a potential criticism of our analysis. We have assumed that capital requirements are binding, however, in the real world we often see banks operate at levels of capital significantly above the regulatory minimum (see Flannery and Rangan (2004)). Note however that in our analysis capital plays a crucial role in disciplining lower quality banks, and arguably precisely for these riskier banks capital regulation should be most binding. What our analysis shows is that capital regulation protects higher quality banks – and the financial system at large – from low quality 'fly by night' operators.

An arguably less surprising insight from our analysis is that competition weakens low quality banking systems even further (and the effectiveness of capital regulation in such systems), while strengthening high quality banking systems. This result confirms the anxiety that domestic regulators may have about opening up their weak banking markets to foreign competition; the stability consequences could be quite negative. However, it would be wrong to use this as an argument against opening up domestic markets. Rather, it points at the way in which domestic markets should be opened to competition. Our paper shows that having low quality domestic banks compete with higher quality foreign banks will cause substantial instability in the domestic market. Anticipating loss in market share the weak domestic banks will cut back on investments in monitoring and in doing so elevate their riskiness. This would not happen if foreign entry leads to takeovers of domestic institutions. Such takeovers would not cause a reduction in monitoring because for the newly (merged) institutions market share is not at risk.

We believe that this paper adds some key insights to understanding the interaction between competition and regulation. The heterogeneity of the banking industry and the fixed costs of monitoring technology are important building blocks for understanding banking. We have shown that these lead to drastic shifts in market shares between banks when competition heats up.

In future work, the optimality of capital regulation and deposit insurance deserves further study. The optimality of these instruments in face of the even more competitive environment of banking is a key public policy issue. This paper has taken these arrangements as given, and focused on their impact on the competitive dynamics. The good news that we have uncovered is that capital requirements help mitigate the competitive distortions that deposit insurance induces.

9 Appendix

Proof of Proposition 1

To prove part *1.* note that at $R^{\max}(\nu_I|\text{no competition}) = Y$ the incumbent bank absorbs all surplus of the borrower, and that for any $R < R^{\max}(\nu_I|\text{no competition})$ the bank's revenue is lower. Hence $R = R^{\max}(\nu_I|\text{no competition})$.

Part *2.* follows directly from the arguments in the text leading up to Proposition 1. For $S + [\nu_I - \nu_C]X \geq 0$, the incumbent and competing banks will (as Bertrand competitors) compete, where the lowest offer acceptable to the competing bank is given in (1). The incumbent bank needs to offer $R \leq R^{\max}(\nu_I|\nu_C)$, and maximizes its profit at $R = R^{\max}(\nu_I|\nu_C)$, where $R^{\max}(\nu_I|\nu_C)$ is given in (2).

For $S + [\nu_I - \nu_C]X < 0$, similar arguments lead to $R^{\min}(\nu_I)$ as given in (1) as best offer of the incumbent bank. The competing bank now prevails by offering $R^{\max}(\nu_C|\nu_I)$ as given in (3). ■

Proof of Lemma 1

Observe that there are $[N-1]$ other banks in the economy. The incumbent bank has a probability $q/[N-1]$ that it can compete for borrowers of any one of these banks. Recall that each of these banks has $1/N$ borrower. Thus the expected number of other borrowers that the incumbent bank can make an offer to is $[N-1] \times \frac{q}{N-1} \times \frac{1}{N} = \frac{q}{N}$. ■

Proof of Proposition 2

Conjecture that good banks prevail over incumbent bad banks, and when banks of the same type compete, the incumbency advantage prevails. Using (8) we have

$$V_B = \frac{1-q}{N}[-k + \frac{\nu_B X}{\rho}] + \frac{q}{\rho N}[1-\gamma]\{S + [\nu_B - \nu_B^*]X\} - c\frac{[\nu_B - \underline{\nu}_B]^2}{2}, \tag{14}$$

$$V_G = \frac{1-q}{N}[-k + \frac{\nu_G X}{\rho}] + \frac{q\gamma}{\rho N}\{S + [\nu_G - \nu_G^*]X\} + \frac{2q}{\rho N}[1-\gamma][\nu_G - \nu_B^*]X - c\frac{[\nu_G - \underline{\nu}_G]^2}{2} \tag{15}$$

The first terms in (14) and (15) represent the profits of the incumbent bank from its borrower without a competing offer. This happens with probability $[1-q]$. With a probability q, the borrower finds a competing bank. A bad incumbent bank only retains its borrower when he gets the second offer from another bad bank. This happens w.p. $q[1-\gamma]$, see the second term in (14). A good bank can retain its incumbent borrower when he gets an offer from another good bank. This occurs w.p. $q\gamma$, see the second term in (15). In addition, a good bank retains its incumbent borrower when he receives an offer from a bad bank. This happens w.p. $q[1-\gamma]$. Moreover, it can grab new borrowers from other bad banks, also with the same probability $q[1-\gamma]$, see the third term in (15).

Implicitly in (8), (14) and (15), we have used the assumption that banks are always willing to bid for borrowers. That is, the borrowers' projects are sufficiently profitable such that banks are willing to lend. Whether a bank succeeds in holding on to, or acquiring, a borrower depends on its own strength (quality and investment in monitoring technology), the strength of its competitor, and the incumbency advantage. A sufficient condition for this is

$$-k + \frac{\underline{\nu}_B X}{\rho} - \frac{S}{\rho} > 0. \tag{16}$$

The condition in (16) implies that a bad bank at its minimum intrinsic monitoring level $\underline{\nu}_B$ could profitably lend to a borrower of another bank (but loose out in the competition!). We further use this condition in the proof of Lemma 2.

Each type maximizes its value holding the strategy of the other type fixed. Use (14) and (15) to get

$$\frac{\partial V_B}{\partial \nu_B}(\nu_B^*) = \frac{1-q}{\rho N}X + \frac{q}{\rho N}[1-\gamma]X - c[\nu_B^* - \underline{\nu}_B] = 0, \tag{17}$$

$$\frac{\partial V_G}{\partial \nu_G}(\nu_G^*) = \frac{1-q}{\rho N}X + \frac{q}{\rho N}\gamma X + 2\frac{q}{\rho N}[1-\gamma]X - c[\nu_G^* - \underline{\nu}_G] = 0, \tag{18}$$

which imply (9) and (10). Note from (17) and (18) that $\frac{\partial V_B}{\partial \nu_B}(\nu_B = 0) > 0$ and $\frac{\partial V_G}{\partial \nu_G}(\nu_G = 0) > 0$. This shows that each bank's investment in monitoring technology is positive. Note also that the second order conditions are negative. Thus, the optimal levels of monitoring are (9) and (10). Insert $\nu_B = \nu_B^*$ and $\nu_G = \nu_G^*$ from (9) and (10) in (14) and (15) to get

$$V_B^* = \frac{1-q}{N}[-k + \frac{\underline{\nu}_B X}{\rho}] + q[1-\gamma]\frac{S}{\rho N} + \frac{X^2}{2c[\rho N]^2}\{1 - 2q + q^2[2-\gamma]\gamma\}, \tag{19}$$

$$\begin{aligned} V_G^* &= \frac{1-q}{N}[-k + \frac{\underline{\nu}_B X}{\rho}] + q\gamma\frac{S}{\rho N} + \frac{1+q[1-2\gamma]}{\rho N}[\underline{\nu}_G - \underline{\nu}_B]X \\ &\quad + \frac{X^2}{2c[\rho N]^2}\{[1-q]^2 - q^2\gamma^2\}. \end{aligned} \tag{20}$$

Now we check that (9) and (10) indeed satisfy our conjectures. Assumption 1 guarantees that $[\underline{\nu}_G - \underline{\nu}_B]X > S$. Use this and (9) and (10) to get $[\nu_G^* - \nu_B^*]X > S$, hence

$$\nu_G^* X - S > \nu_B^* X. \tag{21}$$

The expression in (21) implies that a good bank prevails over an incumbent bad bank; obviously then an incumbent good bank prevents over a competing bad bank.

We show next that for a good bank it is not profitable to increase its level of monitoring sufficiently to steal borrowers from other good banks, i.e. to deviate from ν_G^* to $\hat{\nu}_G \gg \nu_G^*$. Use (8) to compute the value of a good bank which chooses the level of monitoring $\hat{\nu}_G$,

$$\hat{V}_G = \frac{1-q}{N}[-k + \frac{\hat{\nu}_G X}{\rho}] + 2\frac{q}{\rho N}\gamma[\hat{\nu}_G - \nu_G^*]X + 2\frac{q}{\rho N}[1-\gamma][\hat{\nu}_G - \nu_B^*]X - c\frac{[\hat{\nu}_G - \underline{\nu}_G]^2}{2}. \tag{22}$$

Maximizing (22) w.r.t. $\hat{\nu}_G$ gives,

$$\hat{\nu}_G^* = \underline{\nu}_G + [1+q]X/c\rho N. \tag{23}$$

Insert $\hat{\nu}_G = \hat{\nu}_G^*$ from (23) in (22) and use (9) and (10) to get

$$\hat{V}_G^* = \frac{1-q}{N}\{-k + \frac{\underline{\nu}_B X}{\rho}\} + \frac{1+q[1-2\gamma]}{\rho N}[\underline{\nu}_G - \underline{\nu}_B]X + \frac{X^2}{2c[\rho N]^2}[1-q]^2. \tag{24}$$

To show that the deviation to $\hat{\nu}_B^*$ is not profitable, observe from (24) and (20) that

$$V_G^* - \hat{V}_G^* = \frac{q\gamma}{\rho N}S - \frac{X^2}{2c[\rho N]^2}q^2\gamma^2. \tag{25}$$

Since $\frac{X^2}{c\rho N} < S$ (see Assumption 1), it immediately follows that the expression in (25) is positive, hence a good bank will not steal borrowers from other good banks.

We now show that a bad bank does not have an incentive to increase its investment in monitoring from ν_B^* to $\hat{\nu}_B \gg \nu_B^*$ to attract borrowers from other bad banks. From (8) we have

$$\hat{V}_B = \frac{1-q}{N}[-k + \frac{\hat{\nu}_B X}{\rho}] + 2\frac{q}{\rho N}[1-\gamma][\hat{\nu}_B - \nu_B^*]X - \frac{c}{2}\hat{\nu}_B^2. \tag{26}$$

Maximizing (26) with respect to $\hat{\nu}_B$ gives

$$\hat{\nu}_B^* = \{1 + q[1-2\gamma]\}X/c\rho N + \underline{\nu}_B. \tag{27}$$

Insert $\hat{\nu}_B = \hat{\nu}_B^*$ from (27) in (26) and use (9) to get

$$\hat{V}_B^* = \frac{1-q}{N}\{-k + \frac{\underline{\nu}_B X}{\rho}\} + \frac{X^2}{2c[\rho N]^2}[1-q]^2. \tag{28}$$

Observe that the deviation to $\hat{\nu}_B^*$ is not profitable (use (19) and (28)):

$$V_B^* - \hat{V}_B^* = q[1-\gamma]\frac{S}{\rho N} - \frac{X^2}{2c[\rho N]^2}q^2[1-\gamma]^2. \tag{29}$$

Since $\frac{X^2}{c\rho N} < S$ (see Assumption 1), it follows that (29) is positive, and a bad bank will not steal borrowers from other bad banks.

We now show that an incumbent bad bank has no incentive to increase its investment in monitoring technology to $\tilde{\nu}_B \gg \nu_B^*$ to hold on to its borrower when competing with a good bank. If a bad bank chooses $\tilde{\nu}_B$, we have (use (8)),

$$\tilde{V}_B = \frac{1-q}{N}[-k + \frac{\tilde{\nu}_B X}{\rho}] + \frac{q}{\rho N}\gamma\{S + [\tilde{\nu}_B - \nu_G^*]X\} + 2\frac{q}{\rho N}[1-\gamma][\tilde{\nu}_B - \nu_B^*]X - c\frac{\tilde{\nu}_B^2}{2}. \tag{30}$$

Maximizing (30) with respect to $\tilde{\nu}_B$ gives

$$\tilde{\nu}_B^* = \{1 + q[1-\gamma]\}X/c\rho N + \underline{\nu}_B. \tag{31}$$

Insert $\tilde{\nu}_B = \tilde{\nu}_B^*$ from (31) in (30) and use (9) and (10) to get

$$\tilde{V}_B^* = \frac{1-q}{N}\{-k + \frac{\underline{\nu}_B X}{\rho}\} + q\gamma\frac{S - [\underline{\nu}_G - \underline{\nu}_B]X}{\rho N} + \frac{X^2}{2c[\rho N]^2}\{[1-q]^2 - q^2\gamma^2\}. \tag{32}$$

Use (19) and (32) to see that,

$$V_B^* - \tilde{V}_B^* = q\gamma\frac{[\underline{\nu}_G - \underline{\nu}_B]X - S}{\rho N} + q[1-\gamma]\frac{S}{\rho N} - \frac{X^2}{2c[\rho N]^2}q^2[1-2\gamma]. \tag{33}$$

Since $\frac{X^2}{c\rho N} < S$ and $S < [\underline{\nu}_G - \underline{\nu}_B]X$ (see Assumption 1), we see that (33) is positive, and hence an incumbent bad bank will not try to hold on to its borrower when competing with a good bank.

Finally, note from (9) and (10) that the following condition guarantees that ν_G^* and ν_B^* are in the interior for all $q, \gamma \in [0,1]$:

$$2X/c\rho N + \underline{\nu}_G < 1. \tag{34}$$

This condition, the restriction (16) and Assumption 1 are easily simultaneously satisfied (e.g. choose X high enough to satisfy (16), and then choose sufficiently high N to satisfy Assumption 1 and (34)). This completes the proof. ■

Proof of Corollary 1

Differentiate (9) and (10) w.r.t. k and recall that $X \equiv Y - [1-k]r_D$, to get

$$\frac{\partial \nu_B^*}{\partial k} = \frac{[1-q\gamma]r_D}{c\rho N} \quad \text{and} \quad \frac{\partial \nu_G^*}{\partial k} = \frac{\{1 + q[1-\gamma]\}r_D}{c\rho N}, \tag{35}$$

which are both positive. ■

Proof of Corollary 2

Differentiate (9) and (10) with respect to q, to get

$$\frac{\partial \nu_B^*}{\partial q} = -\frac{\gamma}{c\rho N}X < 0 \quad \text{and} \quad \frac{\partial \nu_G^*}{\partial q} = \frac{1-\gamma}{c\rho N}X > 0. \tag{36}$$

Thus, competition increases the investment in monitoring technology for a good bank, but not for a bad bank. ■

Proof of Proposition 3

Differentiate both expressions in (35) with respect to q to get

$$\frac{\partial^2 \nu_B^*}{\partial q \partial k} = -\frac{\gamma}{c\rho N}r_D < 0 \quad \text{and} \quad \frac{\partial^2 \nu_G^*}{\partial q \partial k} = \frac{1-\gamma}{c\rho N}r_D > 0.$$

Hence, competition elevates the effectiveness of capital regulation for a good bank, but not for a bad bank. ■

Proof of Proposition 4

Differentiating (19) with respect to k and rearranging gives

$$\frac{\partial V_B^*}{\partial k} = [\underline{\nu}_G - \underline{\nu}_B]\frac{r_D}{\rho}\{-[1-q]\alpha - \zeta[1-q^2[2-\gamma]\gamma]\}, \tag{37}$$

where we have used the following definitions

$$\alpha \equiv \frac{1-r_D\underline{\nu}_B/\rho}{[\underline{\nu}_G-\underline{\nu}_B]r_D/\rho} - \frac{2X}{c\rho N[\underline{\nu}_G-\underline{\nu}_B]} \quad \text{and} \quad \zeta \equiv \frac{X}{c\rho N[\underline{\nu}_G-\underline{\nu}_B]} > 0. \tag{38}$$

Rewrite α as $\alpha = 1 + \frac{1-r_D\underline{\nu}_G/\rho-2Xr_D/c\rho^2N}{[\underline{\nu}_G-\underline{\nu}_B]r_D/\rho}$. Substitute for $\underline{\nu}_G$ from (34) to get

$$\alpha > 1 + \frac{1-\frac{r_D}{\rho}[1-2X/c\rho N]-\frac{2Xr_D}{c\rho^2N}}{[\underline{\nu}_G-\underline{\nu}_B]r_D/\rho}. \tag{39}$$

Rearrange (39) to get $\alpha > 1 + \frac{1-r_D/\rho}{[\underline{\nu}_G-\underline{\nu}_B]r_D/\rho} > 1$. Note from the definition of ζ in (38) and the fact that $\frac{X^2}{c\rho N} < [\underline{\nu}_G-\underline{\nu}_B]X$ (see Assumption 1) that $\zeta < 1$. Thus,

$$\alpha > 1 \quad \text{and} \quad 0 < \zeta < 1. \tag{40}$$

Note that $\gamma[2-\gamma]$ is maximized for $\gamma = 1$. Use this and (40) in (37) to see that $-[1-q]\alpha - \zeta[1-q^2[2-\gamma]\gamma] \leq -[1-q]\alpha - \zeta[1-q^2] < 0$. This implies that $\frac{\partial V_B^*}{\partial k} < 0$, and proves that the value of a bad bank is always negatively affected by stricter capital requirements.

For a good bank, use (20) to see that

$$\frac{\partial V_G^*}{\partial k} = [\underline{\nu}_G-\underline{\nu}_B]\frac{r_D}{\rho}\{-[1-q]\alpha + 1 + q[1-2\gamma] - \zeta[1-q^2[1-\gamma^2]]\}, \tag{41}$$

Observe that for $q = 0$, the expression (41) simplifies to $\left.\frac{\partial V_G^*}{\partial k}\right|_{q=0} = -\alpha + 1 - \zeta$, which (using (40)) is always negative. In addition, note that

$$\left.\frac{\partial V_G^*}{\partial k}\right|_{q=1,\gamma=0} = 2[\underline{\nu}_G-\underline{\nu}_B]\frac{r_D}{\rho} > 0.$$

Observe that $\frac{\partial V_G^*}{\partial k}$ is monotonically increasing in q and decreasing in γ. Hence by continuity we have that capital regulation increases the value of a good bank for q sufficiently high and γ sufficiently low. This completes the proof. ■

Proof of Lemma 2

We need to show that ν_B^* and ν_G^* are decreasing in N. Differentiate (9) and (10) with respect to N, to get

$$\frac{\partial \nu_B^*}{\partial N} = -\frac{[1-q\gamma]X}{c\rho N^2} - \frac{\gamma X}{c\rho N^2}\frac{\partial q}{\partial N}, \tag{42}$$

$$\frac{\partial \nu_G^*}{\partial N} = -\frac{\{1+q[1-\gamma]\}X}{c\rho N^2} - \frac{1-\gamma}{c\rho N}[\frac{q}{N} - \frac{\partial q}{\partial N}]. \tag{43}$$

Note that the ratio q/N is subject to the regularity condition, $\frac{\partial[q/N]}{\partial N} < 0$, implying that the expected number of other borrowers that the incumbent bank can make an offer to is decreasing in N. This should hold because, while q is increasing in N, the market – with a higher N – has to be shared among more competing banks reducing each bank's share. Transform $\frac{\partial[q/N]}{\partial N} < 0$ to get $\frac{q}{N} - \frac{\partial q}{\partial N} > 0$. Use this and $\frac{\partial q}{\partial N} > 0$ together with (42) and (43) to see that $\frac{\partial \nu_B^*}{\partial N} < 0$ and $\frac{\partial \nu_G^*}{\partial N} < 0$.

Now we prove that V_B^* and V_G^* are decreasing in N. Differentiate (19) and (20) w.r.t. N to get

$$\begin{aligned}\frac{\partial V_B^*}{\partial N} &= -\frac{1-q}{N^2}[-k+\frac{\underline{\nu}_B X - S}{\rho}] - [1-q\gamma]\frac{S}{\rho N^2} - \frac{X^2}{2c\rho^2 N^3}\{1-2q+q^2[2-\gamma]\gamma\}, &(44)\\ \frac{\partial V_G^*}{\partial N} &= -\frac{1-q}{N^2}[-k+\frac{\underline{\nu}_B X - S}{\rho}] - \{1-q[1-\gamma]\}\frac{S}{\rho N^2} - \frac{\{1+q[1-2\gamma]\}}{\rho N^2}[\underline{\nu}_G - \underline{\nu}_B]X \\ &\quad -\frac{X^2}{2c\rho^2 N^3}\{1-2q+q^2[1-\gamma^2]\}. &(45)\end{aligned}$$

We now make the following substitutions. First, recall from (16) that $-k+[\underline{\nu}_B X - S]/\rho > 0$. We will use the substitution $S < -\rho k + \underline{\nu}_B X$. Second, use Assumption 1, in particular substitute for S and $[\underline{\nu}_G - \underline{\nu}_B]X$ the expression $\frac{X^2}{c\rho N}$. All these substitutions in (44) and (45) give

$$\begin{aligned}\frac{\partial V_B^*}{\partial N} &< -\frac{X^2}{2c\rho^2 N^3}\{2[1-q\gamma]+1-2q+q^2[2-\gamma]\gamma,\\ \frac{\partial V_G^*}{\partial N} &< -\frac{X^2}{2c\rho^2 N^3}\{2[1-q[1-\gamma]]+1+q[1-2\gamma]+1-2q+q^2[1-\gamma^2]\}.\end{aligned}$$

This can be further rearranged to

$$\begin{aligned}\frac{\partial V_B^*}{\partial N} &< -\frac{X^2}{2c\rho^2 N^3}\{1-q\gamma+[1-q][2-q\gamma]+q^2\gamma[1-\gamma]\}, &(46)\\ \frac{\partial V_G^*}{\partial N} &< -\frac{X^2}{2c\rho^2 N^3}\{1-q[1-\gamma]+1-q\gamma+2[1-q]+q^2[1-\gamma^2]\}. &(47)\end{aligned}$$

Because q and γ are limited to the interval $[0, 1]$, the expressions in (46) and (47) are always negative. This concludes the proof. ■

Proof of Proposition 5

Differentiating (11) with respect to k we get

$$-\{[1-\gamma]\frac{\partial V_B^*}{\partial N} + \gamma\frac{\partial V_G^*}{\partial N}\}\frac{\partial N}{\partial k} = [1-\gamma]\frac{\partial V_B^*}{\partial k} + \gamma\frac{\partial V_G^*}{\partial k}. \quad (48)$$

We know from Lemma 2 that $\frac{\partial V_B^*}{\partial N} < 0$ and $\frac{\partial V_G^*}{\partial N} < 0$. Hence, the sign of $\frac{\partial N}{\partial k}$ equals the sign of the right hand side of (48), i.e. higher capital induces more entry iff

$$[1-\gamma]\frac{\partial V_B^*}{\partial k} + \gamma\frac{\partial V_G^*}{\partial k} > 0. \quad (49)$$

Use (37) and (41) to simplify (49) to get that higher capital induces more entry iff

$$DV(\gamma, q) > 0, \tag{50}$$

where $DV(\gamma, q) \equiv -[1-q]\alpha + \gamma\{1 + q[1-2\gamma]\} + \zeta[-1 + 3q^2\gamma[1-\gamma]]\}$, α and ζ as defined in (38), and conditions in (40).

We first observe what impact higher capital has on entry at a fixed q. Observe that for a fixed q the function $DV(\gamma, q)$ for γ is a downsided parabola. Note that $DV(\gamma = 0, q) = -[1-q]\alpha - \zeta < 0$. In addition, we have $DV(\gamma = 1, q) = -[1-q][\alpha - \gamma] - \zeta < 0$. This means that higher capital always reduces entry at $\gamma = 0$ and $\gamma = 1$. This and the parabolic shape of the function $DV(\gamma, q)$ implies the following for the intermediate values of γ. There exist solutions to the equation $DV(\gamma, q) = 0$ denoted by $\gamma_1(q) \in [0,1]$ and $\gamma_2(q) \in [0,1]$ iff $DV(\gamma, q) > 0$ for at least one $\gamma \in [0,1]$.

Now we show that $DV(\gamma, q) > 0$ for at least one $\gamma \in [0,1]$ iff competition q is high enough, i.e. $q \geq \bar{q}$. First, note that $DV(\gamma, q = 0) < -\alpha + \gamma - \zeta$, which is negative for all $\gamma \in [0,1]$. Second, observe that $DV(\gamma = 1/2, q = 1) = 1/2 + \zeta[-1 + 3/4] > 0$. These two facts and the monotonicity of $DV(\gamma, q)$, i.e.

$$\frac{\partial DV(\gamma, q)}{\partial q} = \alpha + \gamma[1-2\gamma] + 6\zeta q\gamma[1-\gamma] > 0,$$

imply that there exist a certain $\bar{q}$ such that $DV(\gamma, q) < 0$, i.e. higher capital discourages entry, for all $\gamma \in [0,1]$ if $q < \bar{q}$. For high competition, i.e. $q \geq \bar{q}$, we have two regions of γ. In first region, i.e. $\gamma \in [0, \gamma_1(q)) \cup (\gamma_2(q), 1]$ we have $DV(\gamma, q) < 0$ and higher capital discourages entry. In the second region, i.e. $\gamma \in [\gamma_1(q), \gamma_2(q)]$, we have $DV(\gamma, q) \geq 0$ and higher capital induces more entry. ■

Proof of Corollary 3

First, we compute an impact of entry on monitoring of bad banks. Partially differentiate (9) with respect to k to get

$$\frac{\partial \nu_B^*}{\partial k} = -\frac{X}{c\rho N}[\gamma \frac{\partial q}{\partial N} + \frac{1-\gamma q}{N}]\frac{\partial N}{\partial k} + \frac{1-q\gamma}{c\rho N} r_D. \tag{51}$$

Observe that (51) equals (35), except for the additional term

$$-\frac{X}{c\rho N}[\gamma \frac{\partial q}{\partial N} + \frac{1-\gamma q}{N}]\frac{\partial N}{\partial k}. \tag{52}$$

Observe that $\gamma\frac{\partial q}{\partial N} + \frac{1-q\gamma}{N} > \gamma\left[\frac{\partial q}{\partial N} - \frac{q}{N}\right]$, which is always positive because $\frac{\partial [q/N]}{\partial N} < 0$ (see Lemma 2). This means that (52) is positive as long as $\frac{\partial N}{\partial k} < 0$ and negative if $\frac{\partial N}{\partial k} > 0$. Thus, the monitoring incentives induced by additional capital are strengthened if capital discourages entry, and weakened if capital encourages entry.

We proceed similarly for good banks. Differentiate (10) w.r.t. k, to get

$$\frac{\partial \nu_G^*}{\partial k} = \frac{X}{c\rho N^2}\{[N\frac{\partial q}{\partial N} - q][1-\gamma] - 1\}\frac{\partial N}{\partial k} + \frac{1+q[1-\gamma]}{c\rho N} r_D. \tag{53}$$

The expression in (53) is equal to (35), except for the additional term

$$\frac{X}{c\rho N^2}\{[N\frac{\partial q}{\partial N} - q][1-\gamma] - 1\}\frac{\partial N}{\partial k}. \tag{54}$$

As in the proof of Lemma 2, $\frac{\partial q/N}{\partial N} < 0$ implies $\frac{q}{N} - \frac{\partial q}{\partial N} > 0$, hence $N\frac{\partial q}{\partial N} - q < 0$. Thus, (54) is positive as long as $\frac{\partial N}{\partial k} < 0$ and negative if $\frac{\partial N}{\partial k} > 0$. This means that the effectiveness of capital requirements increases (decreases) when capital requirements induce less (more) entry. ■

Proof of Proposition 6

Note that all banks are (initially) of equal size. This implies that country O (with two banks) is twice as big as country A. In total we have 3 banks, each with $1/N = 1/3$ of total borrowers. We normalize the total borrowers (over the two countries) to one to provide symmetry with our earlier analysis.

Case 1: Proposition 2 establishes that banks do not gain market share from banks of equal type. This immediately implies that good banks in country O hold on to their market share. Banks do not change their levels of monitoring. To see this note that because there are only good banks in the market $\gamma = 1$, which implies that the optimal level of monitoring ν_G^* is not a function of q, see (10). One sidedly opening up borders, however, increases the competition parameter in country O. This reduces the value of banks in country O, i.e. observe that (20) is a decreasing function of competition parameter q, for $\gamma = 1$, i.e.

$$\left.\frac{\partial V_G^*}{\partial q}\right|_{\gamma=1} = -\frac{1}{N}[-k + \frac{\underline{\nu}_B X}{\rho}] + \frac{S}{\rho N} - \frac{1}{\rho N}[\underline{\nu}_G - \underline{\nu}_B]X - \frac{X^2}{2c[\rho N]^2}\{2[1-q]q + 2q\},$$

which is always negative (see that Assumption 1 guarantees that $S < [\underline{\nu}_G - \underline{\nu}_B]X$).

Case 2: Proposition 2 establishes that bad banks lose their market share to good banks. When the borders are closed, there are only bad banks in country O, i.e. $\gamma = 0$, and banks in country O invest $\nu_{BC}^* = X/c\rho N + \underline{\nu}_B$ (see (9)) in the monitoring technology. After opening up borders, a bad bank in country O competes with equal probability with a good or bad bank, this means that $\gamma = 1/2$. Bad banks in country O now invest $\nu_{BO}^* = [1 - q/2]X/c\rho N + \underline{\nu}_B$. Thus, summarizing we have,

$$\nu_{BC}^* = X/c\rho N + \underline{\nu}_B, \quad \nu_{BO}^* = [1 - q/2]X/c\rho N + \underline{\nu}_B. \tag{55}$$

Observe that $\nu_{BO}^* < \nu_{BC}^*$. From (19) it follows that opening borders decreases the country O bank values V_B^*, since V_B^* is decreasing in both q and γ; thus $V_{BO}^* < V_{BC}^*$. To compute the monitoring level of the good bank in country A before the borders of country O are opened insert $\gamma = 1$ and $q = 0$ in (10) to get $\nu^*_{GC} = X/c\rho N + \underline{\nu}_G$. After borders are opened the good bank has access to the borrowers from the bad banks in country O. Now $q > 0$ and $\gamma = 0$, from (10) we have $\nu^*_{GA} = [1+q]X/c\rho N + \underline{\nu}_G$. Summarizing we have,

$$\nu^*_{GC} = X/c\rho N + \underline{\nu}_G, \quad \nu^*_{GA} = [1+q]X/c\rho N + \underline{\nu}_G. \tag{56}$$

■

Proof of Corollary 4

Use adapted versions of (8) to compute the values of the good bank in country A before (V^*_{GC}) and after (V^*_{GO}) it gets access to country O. The adapted versions of (8) that take into account one-sided competition are

$$V^*_{GC} = \frac{-k + \nu^*_{GC} X/\rho}{N} - c\frac{[\nu^*_{GC} - \underline{\nu}_G]^2}{2} \tag{57}$$

and

$$V^*_{GA} = \frac{-k + \nu^*_{GA} X/\rho}{N} + \frac{q}{\rho N}\{-S + [\nu^*_{GA} - \nu^*_{BO}]X\} - c\frac{[\nu^*_{GA} - \underline{\nu}_G]^2}{2}. \tag{58}$$

Insert ν^*_{GA}, ν^*_{GC} and ν^*_{BO} from (55) and (56) in (57) and (58) to get

$$V^*_{GC} = \frac{-k + \underline{\nu}_G X/\rho}{N} + \frac{X^2}{2c\rho^2 N^2}, \tag{59}$$

and

$$V^*_{GA} = \frac{-k + \underline{\nu}_G X/\rho}{N} + \frac{[1+q]X^2}{c\rho^2 N^2} + \frac{q}{\rho N}\{-S + [\underline{\nu}_G - \underline{\nu}_B]X\} + \frac{3q^2 X^2}{2c\rho^2 N^2} - \frac{[1+q]^2 X^2}{2c\rho^2 N^2} \tag{60}$$

Now compute the difference between (59) and (60) to see what the value of entering country O is to the bank in country A. This gives

$$V^*_{GA} - V^*_{GC} = \frac{q}{\rho N}\{-S + [\underline{\nu}_G - \underline{\nu}_B]X\} + \frac{q^2 X^2}{c\rho^2 N^2}.$$

which is always increasing in X and therefore also increasing in k. This completes the proof. ■

Proof of Corollary 5

Assume that the domestic banks behave in a closed domestic market as monopolists, i.e. $q = 0$. Merging then does not change the level of competition between domestic banks. Opening up the border increases q to the level $q_O > 0$. Note that allowing for competition between domestic banks has no qualitative impact, it just elevates all values of q without changing the order. The investment in monitoring technology of a bad (B) merged (M)

bank with open (O) borders is ν_{BOM}. The merged bank can defend its borrowers from an entering good bank if

$$[\nu_{GA}^* - \nu_{BOM}^*]X < S, \tag{61}$$

where ν_{BOM}^* follows from maximizing,

$$V_{BOM} = \frac{2[1-q]}{N}[-k + \frac{\nu_{BOM}X}{\rho}] + 2\frac{q}{\rho N}\{S + [\nu_{BOM}^* - \nu_{GC}^*]X\} - c\frac{[\nu_{BOM} - \underline{\nu}_B]^2}{2}, \tag{62}$$

and ν_{GA}^* and ν_{GC}^* are given in (56). Maximizing (62) w.r.t. ν_{BOM} gives,

$$\nu_{BOM}^* = \frac{2X}{c\rho N} + \underline{\nu}_B. \tag{63}$$

Hence, the merged bank can defend its borrowers from an entering good bank if (insert (56) and (63) in (61))

$$[\underline{\nu}_G - \underline{\nu}_B]X - [1-q_O]X^2/c\rho N < S. \tag{64}$$

The condition in (64) is satisfied for low enough q_O because of the condition in (13). The left side of (64) is continuously increasing in q_O. Note from Assumption 1 that the condition in (64) is not satisfied for $q_O = 1$. Thus, there exists a $\hat{q}$ such that the condition in (64) is satisfied for all q_O for which we have $q_O < \hat{q}$. This concludes the proof. ■

Proof of Corollary 6

For simplicity, we assume as in the proof of Corollary 5 that the domestic banks behave in a closed domestic market as monopolists, i.e. $q = 0$. Opening up the border increases q to the level $q_O > 0$. The value of each domestic bad bank when the border is opened and there is no merger is (see (8))

$$V_{BO} = \frac{1-q_O}{N}[-k + \frac{\nu_{BO}X}{\rho}] - c\frac{[\nu_{BO} - \underline{\nu}_{BO}]^2}{2}. \tag{65}$$

Note that a bad bank loses its borrower to the good entering bank (this happens with probability q_O). Each bad domestic bank maximizes (65) by selecting the monitoring level $\nu_{BO} = \nu_{BO}^* = \frac{[1-q_O]X^2}{c\rho^2 N^2} + \underline{\nu}_B$ to get the value

$$V_{BO}^* = \frac{1-q_O}{N}[-k + \frac{\underline{\nu}_B X}{\rho}] + \frac{[1-q_O]^2}{2}\frac{X^2}{c\rho^2 N^2}. \tag{66}$$

Observe that the value of a merged bad bank facing $q = 0$ is

$$V_{BOM} = \frac{2}{N}[-k + \frac{\nu_{BOM}X}{\rho}] - c\frac{[\nu_{BOM} - \underline{\nu}_B]^2}{2}. \tag{67}$$

We now have the following. Assume (12) holds, then a potential entrant will abstain from entering. To save on the entry cost, it will not even pose any competitive threat.

Hence $q = 0$. The merged bank now maximizes (67) by investing $\nu_{BOM} = \nu^*_{BOM} = \frac{2X^2}{c\rho^2 N^2} + \underline{\nu}_B$. Inserting this in (67) gives

$$\frac{V^*_{BOM}}{2} = \frac{1}{N}[-k + \frac{\underline{\nu}_B X}{\rho}] + \frac{X^2}{c\rho^2 N^2}. \tag{68}$$

Compute the benefits of merging from (68) and (66) to get

$$MB_{BO} = \frac{V^*_{BOM}}{2} - V^*_{BO} = \frac{q_O}{N}[-k + \frac{\underline{\nu}_B X}{\rho}] + [1 - \frac{[1-q_O]^2}{2}]\frac{X^2}{c\rho^2 N^2}. \tag{69}$$

If the borders are closed, the value of a bad bank is

$$V_{BC} = \frac{1}{N}[-k + \frac{\nu_{BC} X}{\rho}] - c\frac{[\nu_{BC} - \underline{\nu}_{BC}]^2}{2}. \tag{70}$$

The optimal monitoring is $\nu^*_{BC} = \frac{X}{c\rho N} + \underline{\nu}_B$. Insert this in (70) to get

$$V^*_{BC} = \frac{1}{N}[-k + \frac{\underline{\nu}_B X}{\rho}] + \frac{1}{2}\frac{X^2}{c\rho^2 N^2}. \tag{71}$$

The value of a merged bad bank is the same as given in (68). The benefits of merging are (use (71) and (68))

$$MB_{BC} = \frac{V^*_{BCM}}{2} - V^*_{BC} = \frac{1}{2}\frac{X^2}{c\rho^2 N^2}. \tag{72}$$

Compute the difference between (72) and (69) to get

$$MB_{BO} - MB_{BC} = \frac{V^*_{BCM}}{2} - V^*_{BC} = \frac{q}{N}[-k + \frac{\underline{\nu}_B X}{\rho}] + \frac{1-[1-q_O]^2}{2}\frac{X^2}{c\rho^2 N^2}. \tag{73}$$

Note that (73) is always positive. Thus, for bad banks merging is more beneficial when borders are opened.

In the case of good domestic banks, opening up borders has no impact. The entry cost together with anticipating zero market share prevent entry even without a merger, and hence there is no valuation impact. This concludes the proof. ■

Proof of Proposition 7

The entering bank only knows its type, once it has entered. If it is bad, it cannot win any borrowers because of the incumbency disadvantage and its value is zero. If it turns out to be good, its only possibility is to overtake borrowers from bad banks. Its value is (use (8))

$$V_{G,\text{late}} = \frac{q[1-\gamma]}{\rho N}\{-S + [\nu_{G,\text{late}} - \nu^*_B]X\} - c\frac{[\nu_{G,\text{late}} - \underline{\nu}_G]^2}{2}. \tag{74}$$

The first part in (74) represents the profits from the borrowers that the entering bank grabs in expectation from bad banks (see (7)). The entering bank competes with a bad bank w.p. $q[1-\gamma]$. Maximizing (74), we get

$$\nu^*_{G,\text{late}} = q[1-\gamma]X/c\rho N + \underline{\nu}_G. \tag{75}$$

Now we show that the late entrant bank conditional on being good can overcome the incumbency advantage of the existing bad banks. For this we need $[\nu^*_{G,\text{late}} - \nu^*_B]X > S$. Use (9) and (75) to get

$$[\underline{\nu}_G - \underline{\nu}_B]X > S + [1-q]X^2/c\rho N. \tag{76}$$

Note that (13) assures that (76) is satisfied. Insert (9) and (75) in (74) to get

$$V^*_{G,\text{late}} = \frac{q[1-\gamma]}{\rho N}\{-S + [\underline{\nu}_G - \underline{\nu}_B]X\} - \frac{q[1-\gamma][2-q-q\gamma]X^2}{2c\rho^2 N^2}. \tag{77}$$

The expected value of the bank prior to entering is

$$V^*_{\text{late}} = \gamma \times 0 + [1-\gamma] \times V^*_{G,\text{late}}. \tag{78}$$

Use (74) to write (78) as

$$V^*_{\text{late}} = \frac{q\gamma[1-\gamma]}{\rho N}\left\{-S + [\underline{\nu}_G - \underline{\nu}_B]X - \frac{[2-q-q\gamma]X^2}{2c\rho N}\right\}. \tag{79}$$

Observe that (79) is zero for $q = 0$. The expression in (79) is continuous and increasing in q. Use Assumption 1 to see that the expression in curly brackets is strictly positive for $q = 1$. Thus late entry only occurs for sufficiently high q and an entry cost sufficiently small. In addition, it readily follows that (79) is maximized at an interior γ, and that for a sufficiently small entry cost and sufficiently high q, late entry is observed for $\gamma \in [\underline{\gamma}, \bar{\gamma}]$. ■

Proof of Corollary 7
Differentiate (79) with respect to k to get

$$\frac{\partial V^*_{\text{late}}}{\partial k} = \frac{q\gamma[1-\gamma]r_D}{\rho N}\left\{\underline{\nu}_G - \underline{\nu}_B - \frac{[2-q-q\gamma]X}{c\rho N}\right\}. \tag{80}$$

If late entry occurs we have $V^*_{\text{late}} > 0$. Observe from (79) that this implies that

$$[\underline{\nu}_G - \underline{\nu}_B]X - \frac{[2-q-q\gamma]X^2}{2c\rho N} > 0. \tag{81}$$

The expression (81) guarantees that if late entry occurs, (80) is positive. Because late entry is more profitable, the value of late entry (79) surpasses the entry cost for a larger range of parameter values, thus, $\frac{\partial \underline{\gamma}}{\partial k} < 0$ and $\frac{\partial \bar{\gamma}}{\partial k} > 0$. ■

References

Allen, F., E. Carletti, and R. Marquez, 2005, "Credit Market Competition and Capital Regulation," mimeo, University of Pennsylvania.

Beck, T., A. Demirgüç-Kunt, and R. Levine, 2005, "Bank Concentration and Fragility: Impact and Mechanics," NBER Working Paper 11500.

Berger, A. N., R. S. Demsetz, and P. E. Strahan, 1999, "The Consolidation of the Financial Services Industry: Causes, Consequences and Implications for the Future," *Journal of Banking & Finance*, 23, 135–194.

Boot, A. W. A., and A. V. Thakor, 2000, "Can Relationship Banking Survive Competition?," *Journal of Finance*, 55(2), 679–713.

Boyd, J. H., and G. De Nicolo, 2005, "Bank Risk Taking and Competition Revisited," *Journal of Finance*, 60(3), Forthcoming.

Diamond, D. W., and R. G. Rajan, 2000, "A Theory of Bank Capital," *Journal of Finance*, 55(6), 2431–2464.

Flannery, M. J., and K. P. Rangan, 2004, "Market Forces at Work in the Banking Industry: Evidence from the Capital Buildup of the 1990s," mimeo, University of Florida.

Focarelli, D., and F. Panetta, 2003, "Are Mergers Beneficial to Consumers? Evidence from the Market for Bank Deposits," *American Economic Review*, 93(4), 1152–1172.

Freixas, X., S. Hurkens, A. D. Morrison, and N. Vulkan, 2004, "Interbank Competition with Costly Screening," Oxford Financial Research Centre Working Paper.

Hellmann, T. F., K. C. Murdock, and J. E. Stiglitz, 2000, "Liberalization, Moral Hazard in Banking, and Prudential Regulation: Are Capital Requirements Enough?," *American Economic Review*, 90(1), 147–165.

Holmstrom, B., and J. Tirole, 1997, "Financial Intermediation, Loanable Funds, and the Real Sector," *Quarterly Journal of Economics*, 112(3), 663–691.

Kopecky, K. J., and D. VanHoose, forthcoming, "Capital Regulation, Heterogeneous Monitoring Costs, and Aggregate Loan Quality," *Journal of Banking & Finance*.

Matutes, C., and X. Vives, 2000, "Imperfect Competition, Risk Taking, and Regulation in Banking," *European Economic Review*, 44(1), 1–34.

Morrison, A. D., and L. White, 2005, "Crises and Capital Requirements in Banking," *American Economic Review*, 95(5), 1548–1572.

Ongena, S., and D. C. Smith, 2000, "Bank Relationships: A Review," in *Performance of Financial Institutions*, ed. by S. A. Zenios, and P. Harker. Cambridge University Press, Cambridge.

Petersen, M. A., and R. G. Rajan, 2002, "Does Distance Still Matter? The Information Revolution in Small Business Lending," *Journal of Finance*, 57(6), 2533–2570.

Repullo, R., 2004, "Capital Requirements, Market Power and Risk-Taking in Banking," *Journal of Financial Intermediation*, 13(2), 156–182.

Shaked, A., and J. Sutton, 1982, "Relaxing Price Competition Through Product Differentiation," *The Review of Economic Studies*, 49(1), 3–13.

Stiroh, K. J., and P. E. Strahan, 2003, "Competitive Dynamics of Deregulation: Evidence from U.S. Banking," *Journal of Money, Credit, and Banking*, 35(5), 801–828.

Vives, X., 2001, "Competition in the Changing World of Banking," *Oxford Review of Economic Policy*, 17(4), 535–547.

$t = 0$:

♠ The regulator sets the capital requirements k.

♠ Banks enter the banking industry (if applicable).

$t = 1$:

♠ Each borrower is matched with a bank.

♠ Each bank discovers its type.

♠ Banks invest in monitoring technology.

♠ Each borrower gets an initial offer from his bank.

$t = 2$:

♠ Each borrower searches for a competing bank.

♠ If a second bank materializes, the incumbent bank and the 'second bank' compete as Bertrand competitors. If no second bank is available, only the borrower's first offer is available.

♠ Each bank collects the necessary capital and deposits, and funds its borrowers.

♠ Borrowers undertake their projects.

$t = 3$:

♠ Payoffs are realized.

Figure 1: Time line