Last Bank Standing: What Do I Gain If You Fail?*

Enrico C. Perotti[†]
University of Amsterdam

Javier Suarez[‡]
CEMFI

March 2002

Abstract

Banks attitude towards speculative lending is typically regarded as the result of trading-off the short-term gains from risk-taking against the risk of loss of charter value. We study the trade-off between stability and competition in a dynamic setting where charter value depends on future market competition. Promoting the takeover of failed banks by solvent institutions results in greater market concentration and larger rents for the surviving incumbents. This converts banks' speculative lending decisions into strategic substitutes, granting an additional incentive to remain solvent. Entry policy may subsequently serve to fine-tune the trade-off between competition and stability.

*We would like to thank the editors (Bruno Bias and Xavier Vives), three anonymous referees, Xavier Freixas, Cornelia Holthausen, Gerard Llobet, Alan Morrison, Rafael Repullo, Emanuela Sciubba, and the audience in the Manresa Conference in Finance, the Workshop on 'Moral Hazard Issues in Banking' in Helsinki, and the Conference on 'The Regulation of Financial Institutions' in Tenerife, and participants at seminars at LBS and Tilburg, for helpful comments and suggestions.

[†]Department of Financial Management, Universiteit van Amsterdam, Roeterstraat 11, 1018 WB Amsterdam, The Netherlands. Phone +31 20 525 4159, fax +31 20 525 5285, e-mail enrico@fee.uva.nl.

[‡]CEMFI, Casado del Alisal 5, 28014 Madrid, Spain. Phone +34 91 429 0551, fax +34 91 4201056, e-mail suarez@cemfi.es.

1 Introduction

Economists appreciate competition as a powerful source of efficiency, a principle which applies to the banking sector as well as any other industry. Increasing competition has historically played a large role in reducing the costs of financial intermediation. Global financial integration has led to the entry of foreign banks in previously closed and concentrated banking markets, offering better diversification opportunities and reducing the cost of capital. However, in many countries the process of liberalization and deregulation, which leads to greater competition and entry, has frequently been followed by banking crises.[1] This experience has resuscitated a classic theme: the trade-off between stability and competition.

Highly levered firms have incentives to expropriate their lenders by undertaking excessive risks (Jensen and Meckling, 1976). Among banks, these incentives are strengthen by two facts. First, their main asset, credit, is very opaque and can be easily misallocated, with consequences visible only in the medium and long term. Second, their main lenders, depositors, are too passive and dispersed to exert effective discipline on banks. In fact, the presence of deposit insurance leaves depositors with little or no incentive to monitor the banks and, perhaps more importantly, gives the banks access to virtually unlimited funding at risk-free rates.[2] So banks can take excessive risks without being detected or suffering increased funding costs. In addition, excessive risk taking is especially costly in banking since bank failures have important external costs.[3]

[1] Examples during the 1990s include Sweden, Finland, Russia, Bulgaria, as well as many countries in South East Asia and Latin America. Caprio and Klingebiel (1997) document a recent increase in the frequency of banking crisis.

[2] Implicit or explicit deposit insurance is a policy response to the underlying risk of potentially self-fulfilling bank runs (Diamond and Dybvig, 1983).

[3] Bank failures disrupt the payments system, hurt investor confidence in other banks,

Historically, the restriction of competition has been used almost everywhere as a tool to enhance banking stability, possibly as a response to authorities' limited capability to directly monitor banks' lending policies.[4] Academic research has identified two channels through which banks' market power and risk-taking interact. First, market power affects the pricing of deposits and loans, and has implications for banks' incentives to monitor and to gather information on borrowers, and thus for the probability of failure (Matutes and Vives, 1996 and 2000, Anand and Galetovic, 1997; Schnitzer, 1998; Caminal and Matutes, 2000). Second, market power increases the value of bank charters, whose loss in case of failure constitutes a deterrent for risk-taking (Keeley, 1990; Suarez, 1994; Hellmann, Murdock, and Stiglitz, 2000).[5]

While the literature has long recognized the dynamic trade-off between the short term gains from speculative lending and the future rents lost in case of failure, it has so far treated the intensity of competition as exogenous and constant over time. In other words, it has ignored the possibility that bank failures modify the market structure of the banking sector. Yet, if banks that fail are either closed or merged, concentration is likely to rise, at least temporarily, until the entry of new banks restores the long-run level of competition.[6] Surviving banks may then profit (at least temporarily) from

and dissipate information capital on borrowers (Mailath and Mester, 1994).

[4]Bank monopolies were common in the early years of banking in countries such as France, the UK, and the US. Even at the beginning of the 19th century, there were just four chartered banks in the US and the general view was that limited competition was essential for stability. Even when the early oligopolistic structure was relaxed, local banking markets and products were strongly segmented. Liberalization is a recent phenomenon which comes together with the introduction of new and more sophisticated tools of regulation and supervision (such as risk-based capital requirements and public ratings).

[5]Closure is a way to punish the managers and owners of a failed bank, but replacing them can achieve a similar disciplinary effect. The common practice is not to close a failed bank but to merge it with a healthy bank (Hawkins and Turner, 1999).

[6]Shull (1996) argues that the high levels of concentration in local areas observed in the US in the post-war era were "established by the bank failures of the early 1930s and guaranteed by the 'needs test' for new charters" (pp. 285) that existed at the time.

their competitors' failure, introducing an additional dynamic trade-off for risk-taking: the *last bank standing* effect.

The last bank standing effect strengthens the standard *charter value* effect and enhances banks' incentives for prudence. We show that its main consequence is to make the speculative lending decisions of competing banks strategic substitutes: in other words, it makes a bank's incentive to take risk decrease as the risk taken by its competitor increases. Prudence is stimulated by banks' expectation of obtaining larger rents if their competitors fail. This expectation may be justified by the temporary increase in concentration following the exit of the failed banks. An active merging policy by bank authorities, which allows the survivors to take over the business of the failed banks on concessionary terms provides exactly this effect.

We analyze the enhancement of the charter value effect caused by merger policy in an explicit dynamic model in which the level of concentration in the banking industry is endogenous, and fluctuates between higher and lower levels of competition.[7] Concentration is driven by exit and entry, which in turn depend on bank failures, and the policy of bank authorities on mergers and entry.[8] An important result is that high current concentration does not necessarily imply less speculative lending; it may actually aggravate it. The reason is that, since higher market power is temporary (due to entry), charter value under a more concentrated market structure may only be moderately

[7]In the model we explicitly focus on competition in the (insured) deposit market. While competition in lending is also important, its effects are very model-sensitive, as they depend on assumptions about the informational barriers to entry and the appropriability of information itself. Yet our results are robust as long as lower competition in lending leads to an increase in banks' expected profits.

[8]Merger policy is embedded in the intervention practices that determine whether a failed bank is put in hands of an entrant or merged with a healthy bank. The policy on entry reflects the explicit entry requirements set by bank regulation as well as other factors, such as the tolerance of competition authorities towards the entry-deterrence strategies of incumbent banks.

higher than in normal market conditions, while the temporarily larger market share increases the scale of the short-term gains from speculative lending. Consequently, the temptation to gamble can be stronger than under more competition.

Instead, a higher level of concentration in the future, *contingent* on remaining solvent while other banks fail, has a non-ambiguous dampening effect on the incentives for speculative lending. This provides a rationale, based on prudential concerns, for the common practice among bank authorities of encouraging takeovers of failed banks by healthy institutions, rather than keeping the failed banks as independent entities. While this practice reduces competition, it may be appropriate for countries with weak regulatory frameworks, such as Russia (Perotti, 2001). Actually, we are convinced that the underlying motivation explains also, in part, the established practice in developed countries.[9]

An active merging policy for failed banks, together with a restrictive entry policy, increases the level of concentration in the aftermath of a crisis. An optimal policy must trade off the deadweight losses due to such reduced competition against the efficiency gain due to reduced speculative lending. We find that when banks are inclined towards speculative lending, it is always optimal to maximize concentration after a crisis, and to fine-tune the trade-off between competition and stability by adjusting the rate of subsequent entry. The intuition is that, increasing the probability of high concentration after the crisis and reducing the entry rate are equally cost-effective means to reward the banks that survive a possible crisis. However, the indifference breaks if the welfare criterion assigns positive probability to the possibility of

[9] The regulatory problem would become trivial under sufficiently large or fully risk-based capital requirements. Yet, given the difficulties to assess the true value of bank capital and the quality of untraded bank assets in a weak institutional context, it may not possible to monitor compliance with capital requirements.

starting up with high concentration. In such a case, reducing the entry rate has the additional cost of slowing down the transition to a more desirable low concentration state, so it is always optimal to maximize the probability of high concentration after the crisis and thereby minimize the required reduction in the entry rate.[10]

Our analysis complements the existing literature on optimal intervention of banks in trouble, which has focused on the optimal form of bailout for an individual troubled bank.[11] We assume that limited liability limits the punishment for managers and owners of a failed bank, and focus on the potential reward for solvency introduced by an active merging policy. Considering the strategic interaction between the risk-taking decisions of competing banks allows us to identify a prudential motive for relying on mergers (rather than rescues directed to refloat the failed banks as independent entities) in the resolution of banking crisis.

Our paper also complements the discussion on bank mergers. For fear of destabilizing consequences of a too fierce competition in banking, competition authorities have been more lenient towards consolidation in banking than in other industries.[12] We add a dynamic qualification to this discussion:

[10] Our normative results presume that supervisory authorities can commit to a long-term intervention and entry policy. From the perspective of the ex ante welfare trade-offs, a certain sacrifice of competition for stability always makes sense. Yet, ex post, authorities may have a temptation to increase competition. This time-inconsistency problem is one more of the policy commitment problems faced by central banks and regulatory agencies. In general, the solutions given to these problems consist in appointing policymakers whose links to the industry, fiduciary duties, reputation or, perhaps, explicit remuneration bias their policy preferences towards long-term stability –although some of these choices may increase the risk of regulatory capture.

[11] Both Aghion et al. (1998) and Mitchell (1998a) obtain an optimum degree of regulatory intervention in a context of asymmetric information: a tough intervention policy leads banks to hide their difficulties, causing deterioration of collateral, while a soft approach weakens the incentives for prudence. Freixas (1999) argues that the optimal policy should be characterized by "constructive ambiguity", i.e. the authorities should follow a mixed strategy.

[12] See Vives (2001) and the references therein for a discussion of anti-trust policies in

tolerating temporary consolidation in the aftermath of a crisis has the ex ante desirable effect of promoting stability by rewarding those banks that remained solvent during the crisis. Thus the optimal policy trade-off between stability and competition is not static, but state-contingent.

The structure of the paper is as follows. Section 2 describes the basic model. Section 3 characterizes the symmetric equilibrium in the banks' lending game. Section 4 examines its comparative statics. Section 5 focuses on the design of the optimal regulatory policy. Section 6 contains a brief discussion of asymmetric equilibria and the regulator's commitment problem. Section 7 concludes. The proofs of all the formal results appear in the Appendix.

2 The model

Time is continuous and indexed by t. All agents are risk neutral and infinitely lived, and discount time at the rate r. There exists a banking industry made up of two *bank branches.* At any point in time, each of these branches may be owned and managed by a different banker or by the same one. The banking industry is a *duopoly* in the first case and a *monopoly* in the second. Active bankers come out from a large population of potential bankers.

Each bank branch takes one unit of insured deposits either from some local depositors, on which they can exert market power, or from depositors at some financial center, who require some given interest rate. These funds are invested in either *prudent lending* or *speculative lending.* Under prudent lending, the flow of profits per branch and unit of time is π in a duopoly and of $(1+\rho)\pi$ in a monopoly, where $\rho > 0$ captures the existence of rents due to the absence of competition in the local deposit market. Importantly for

banking.

the policy analysis, these rents come at a cost $(1+\tau)\rho\pi$ per branch and unit of time in terms of local depositors' surplus.[13]

Under both market structures, speculative lending adds an extra flow return of $\gamma\pi$ per branch and unit of time, but leaves the bank exposed to *solvency shocks.* Solvency shocks occur randomly according to a Poisson process with arrival rate λ and produce capital losses on speculative lending equivalent to a fraction $\sigma < 1$ of the managed funds. We assume that

$$\gamma\pi - \lambda\sigma < 0, \tag{1}$$

so the expected net return from speculative lending (relative to prudent lending) is negative.

We also assume that σ is large relative to the perpetuity value of a branch's future profits so that bankers hit by a solvency shock are unwilling to restore the solvency of their banks through a voluntary recapitalization.[14] Thus, whenever a bank becomes insolvent, a banking authority intervenes, replaces the failed banker, and contributes $1-\sigma$ to each failed branch so as to fully pay back to its depositors.

The banking authority must also decide who will own and manage the branches of the failed bank from that point onwards. We assume that when *all the incumbent banks* fail, the authorities opt for two new bankers, giving raise to a duopoly, since in this case there is no reason to reward any of the previous bankers and competition produces a higher social return. In contrast, we consider the possibility that when *only one duopolist bank* fails, its competitor is allowed to take over the failed branch as a reward for being solvent.[15] The probability that such a policy converts the survivor into

[13] The Appendix shows how the parameters ρ and τ of our reduced form can be related to the primitives of an explicit model of competition in the local deposit market.

[14] In terms of the notation used below, we assume that σ exceeds a banker's value of being a duopolist, v_D, and also a half of the value of being a monopolist, v_M.

[15] This can take the form of either a (free) merger through which the branch of the failed

a (temporary) monopolist is denoted by μ. We want to analyze whether the prospects of becoming a monopolist is a useful "carrot" for encouraging duopolist bankers to lend prudently.

We think of duopoly as the stable (or *long-run*) market structure of the banking industry: one in which rents are low enough for no further entry to take place. We think of monopoly, instead, as a market structure in which extra profits call for further *entry.* We model this entry as a Poisson process with arrival rate δ. When a new banker enters, the incumbent loses one of the bank branches in favor of the entrant and the industry becomes a duopoly again. Thus market structure will evolve in response to the exits due to bank failure, the merging policy applied by the authorities when only one duopolist fails, μ, and the rate at which the entry of a competitor makes bank monopolies arrive to an end, δ.

We consider that both μ and δ are determined by a long-term regulatory and supervisory framework set up at some ex ante date by a benevolent social planner.[16] Arguably the merging rate μ relates to crisis resolution practices. In particular, to the attitude of supervisors towards competition and concentration during episodes of bank failure. We think that either by developing a reputation for rewarding the solvent incumbents or just by delegating the supervisory function to an agent close to the interests of the banking industry, it is possible to implement the desired μ. On the other hand, if potential new bankers face random time-varying entry costs, the entry rate δ can be controlled through the stringency of regulatory entry requirements or through the tolerance of bank competition authorities towards incumbents' entry de-

bank is formally transferred to the solvent bank or a (temporary) closure of the competing branch. What matters is that the solvent banker obtains the gains from becoming a monopolist.

[16]The importance of commitment for the implementation of the optimal policy is discussed in Section 6.

terrence strategies.

3 Equilibrium

The ingredients described above define a stochastic game in continuous time. At any date t there are two possible states, depending on whether the banking industry is a monopoly, $s_t = M$, or a duopoly, $s_t = D$. In monopoly dates, a single banker plays against nature, deciding how to lend the deposits managed by his two branches. In duopoly dates, there are two bankers, one at each branch, deciding how to lend their respective deposits. These simple stage games are repeated until the arrival of a solvency shock, at any date, or an entrant, in a monopoly date, produces the failure of one of the existing banks and/or modifies the market structure of the banking sector. When a bank fails, the corresponding banker is dismissed and exits the game. But the game continues with the survivor banker and/or the new bankers who replace the failing ones.

In the analysis of the bankers' game, we restrict attention to Markov strategies, that is, we assume that the past influences current play only through the state variable s_t, which summarizes the effect of history on payoff functions and action spaces. For tractability, we also impose symmetry in bankers strategies.[17] Accordingly, we describe the Markov lending strategy of a representative banker as a pair $(m, d) \in [0, 1] \times [0, 1]$ that, allowing for mixed strategies, specifies the probability that he gets involved in speculative lending while in monopoly and duopoly, respectively.

Adopting the notion of Markov Perfect Equilibrium, an equilibrium strategy would be a pair (m, d) involving an instantaneous best response to com-

[17] In Section 6 we briefly discuss the asymmetric Markov Perfect Equilibria that the model may support in some regions of the parameter space.

peting bankers who, by symmetry, follow the same strategy. To characterize these reciprocal best responses we can use dynamic programming. Given the time-invariant nature of the problem, we hereafter drop all time indices.

Let v_M and v_D denote the values of a monopolist bank and a duopolist bank, respectively. The instantaneous return from being a monopolist is thus given by the Bellman equation:

$$rv_M = \max_{m\in[0,1]} \left[2\left(1+\rho+\gamma m\right)\pi - \lambda v_M m - \delta(v_M - v_D)\right]. \tag{2}$$

The first term in its RHS collects the stage profits from prudent or speculative lending, the second represents the expected capital losses due to dismissal if the bank is hit by a solvency shock, and the third accounts for the expected capital loss from becoming a duopolist if an entrant arrives. The multiplication by two in the first term reflects that the monopolist banker owns the two branches.

To derive a similar expression for a duopolist, let d^* denote the lending strategy followed by his competitor duopolist. Then

$$rv_D = \max_{d\in[0,1]} \left[\left(1+\gamma d\right)\pi - \lambda v_D d + \lambda d^*(1-d)\mu(v_M - v_D)\right], \tag{3}$$

where the first and second terms in the RHS can be interpreted exactly as in (2), whereas the third accounts for the expected capital gain that the duopolist obtains if, at the arrival of a solvency shock, he survives his competitor and gets control of the failed branch, becoming a monopolist.

An equilibrium is a lending strategy (m, d) that solves the Bellman equations (2) and (3) for $d^* = d$.

3.1 Individual incentives for speculative lending

The contribution of speculative lending to the value of a monopolist bank is captured by the terms multiplied by m in (2). The trade-off is between the instantaneous excess return $2\gamma\pi$ and the expected capital loss λv_M that associate with speculative lending:

$$2\gamma\pi - \lambda v_M \gtreqless 0 \tag{4}$$

The monopolist will get involved in speculative lending if this expression is positive. Its second term captures the usual effect of charter values on a bank's attitude towards risk: the incentives for prudence given by the fear to lose the bank's future rents in case of failure.

The contribution of speculative lending to the value of a duopolist bank is measured by the terms multiplied by d in (3):

$$\gamma\pi - \lambda v_D - \lambda d^* \mu(v_M - v_D) \gtreqless 0. \tag{5}$$

Again, there is a trade-off between the excess return $\gamma\pi$ and the expected capital loss λv_D that associate with speculative lending. The third term relates to the bank authority's merging policy during solvency crises. When there is a positive probability that, if only one duopolist fails, the surviving bank becomes a monopolist, a strategic substitutability between the lending decisions of the duopolists emerges:

Proposition 1 *Since the value of a monopolist bank,* v_M*, is no lower than the value of a duopolist bank,* v_D*, the lending decisions of duopolists* (d, d^*) *are strategic substitutes.*

The strategic substitutability is due to the combination of an active merging policy, $\mu > 0$, and the gains from becoming a monopolist, $v_M - v_D \geq 0$. This combination produces what we call the *last bank standing effect*, which allows a bank to profit from surviving its competitors. At the arrival of a solvency shock, the more involved in speculative lending the competitor is, the more likely is the prudent duopolist to become a monopolist. So the greater are his incentives to lend prudently.

3.2 Solving for equilibrium

We now account for the simultaneous determination of the individual strategies (m, d) and the endogenous variables d^*, v_M, and v_D. Our task is simplified by the fact that v_D will take one of two values. In particular, it follows from (3) that, if $d = d^* = 0$, then

$$v_D = v_D^0 \equiv \frac{\pi}{r}, \tag{6}$$

while, if $d = d^* = 1$, then

$$v_D = v_D^1 \equiv \frac{(1+\gamma)\,\pi}{r+\lambda}. \tag{7}$$

Moreover, from the linearity of the maximand in (3), if a duopolist finds optimal some $d \in (0,1)$, then any other d would also be optimal. Since this includes $d = 1$, any mixed strategy equilibrium with $d = d^* \in (0,1)$ would also associate with $v_D = v_D^1$.

Our next result shows that duopolists have a propensity to lend speculatively whenever the parameter that captures the importance of the gains from speculative lending, γ, exceeds the critical value

$$\gamma^0 \equiv \frac{\lambda}{r}. \tag{8}$$

Lemma 1 *For modest speculative gains, $\gamma \leq \gamma^0$, the equilibrium involves $d = 0$ and $v_D = v_D^0$, while for large speculative gains, $\gamma > \gamma^0$, it involves $d > 0$ and $v_D = v_D^1$.*

This intuitive result suggests a separate discussion of the cases with modest and large speculative gains.

3.2.1 Modest speculative gains

With $\gamma \leq \gamma^0$, duopolists lend prudently and the value of a duopolist bank is v_D^0. Completing the characterization of the equilibrium simply requires substituting $v_D = v_D^0$ in (2) so as to recursively determine the values of m and v_M:

Proposition 2 *Suppose speculative gains are modest, $\gamma \leq \gamma^0$. Then:*

1. *If $\delta \leq 2r\rho$, the equilibrium features $(m, d) = (0, 0)$.*
2. *Otherwise, there is a critical value*

$$\alpha \equiv \frac{2r + 2r\rho + \delta}{2r + 2\delta} < 1 \tag{9}$$

such that the equilibrium features $(m, d) = (0, 0)$ for $\gamma \leq \alpha\gamma^0$ and $(m, d) = (1, 0)$ for $\gamma > \alpha\gamma^0$.

The novel part of this result is the characterization of a monopolist's lending decision. It turns out that a banker who lends prudently as a duopolist may speculate as a monopolist. This seems strange in light of the conclusions of previous studies based on static market structures. They have familiarized us with the idea that market power capitalizes in charter values which, in turn, discourage risk taking. Actually such logic still applies and explains why we get $m = 0$ if the entry rate δ is sufficiently small. However, if δ is large, monopoly states do not last long, so v_M may be very close to v_D. In contrast, a monopolist's short-term gains from speculative lending are twice as large as those of a duopolist, since it temporarily manages two bank branches rather than one. With a large entry rate, this *scale effect* dominates the *charter value effect*, making a monopolist more inclined towards risk than a duopolist.

3.2.2 Large speculative gains

If speculative gains are large, lending prudently while in duopoly, $d = 0$, ceases to be an equilibrium and the value of a duopolist bank is v_D^1. Yet, because of the strategic substitutability between duopolists lending decisions, the equilibrium does not necessarily feature $d = 1$.[18] Specifically, when γ is close to γ^0, the last bank standing effect invites the duopolist to choose $d = 0$ if $d^* = 1$, while its absence invites him to choose $d = 1$ if $d^* = 0$.[19] As shown below, in a case like this, the unique symmetric equilibrium involves a mixed strategy $d \in (0, 1)$.

To articulate the discussion, we study sequentially the cases with a prudent monopolist and with a speculative monopolist. As proved in the Appendix, the monopolist bank lends prudently if and only if $\delta \leq 2r\rho$ and $\gamma^0 < \gamma \leq \beta\gamma^0$, where

$$\beta \equiv \frac{(2r + 2r\rho)(\lambda + r) + r\delta}{(2r + \delta)(\lambda + r) + r\delta}, \tag{10}$$

which is decreasing in δ. Hence, with the same intuition as above, the involvement of a monopolist in speculative lending depends on confronting the *double* gains from speculative lending with the likely loss of a charter whose value decreases with the entry rate δ.

The following proposition characterizes the equilibrium for the case in which the entry rate is low enough to make the monopolist bank unwilling to speculate:

Proposition 3 (Prudent monopolist) *Suppose $\delta \leq 2r\rho$ and $\gamma^0 < \gamma \leq \beta\gamma^0$. Then, there is a critical value*

$$x = \frac{(r + \delta)(r\gamma - \lambda)}{\lambda\mu\,[2\lambda(1 + \rho) + 2\rho + r - r\gamma]} \tag{11}$$

such that the equilibrium lending strategy is $(m, d) = (0, \min\{x, 1\})$.

[18] Notice that the fact that (5) is positive for $d^* = 0$ and $v_D = v_D^0$ does not imply that it is non-negative for $d^* = 1$ and $v_D = v_D^1$.

[19] As we further discuss in Section 6, this opens the possibility of sustaining asymmetric Markov Perfect Equilibria.

The critical value x is the unique value of d^* for which (5) equals zero given the equilibrium value of the difference $v_M - v_D$ when $m = 0$. Notice that x equals zero if $\gamma = \gamma^0$ and increases as the gains from speculative lending increase. If x becomes larger than one, then duopolists lend speculatively with probability one. But whether that occurs or not, as well as the incidence of speculative lending among duopolist when $d = x < 1$, depends on the various parameters of the model, including μ and δ.

Along the same lines, we characterize the equilibrium for the case in which the entry rate is large enough to make the monopolist bank willing to speculate.

Proposition 4 (Speculative monopolist) *Suppose* $\gamma > \max\{\gamma^0, \beta\gamma^0\}$. *Then, there is a critical value*

$$y = \frac{(r + \lambda + \delta)(r\gamma - \lambda)}{\lambda\mu(r + \lambda)(1 + 2\rho + \gamma)} \tag{12}$$

such that the equilibrium lending strategy is $(m, d) = (1, \min\{y, 1\})$.

Qualitatively y behaves like x. We discuss the determinants of these two variables in the next section.

3.3 Summing up

Figure 1 depicts the regions of the parameter space in which each of the identified equilibrium regimes arises. The $\delta - \gamma$ space is horizontally divided by the line $\gamma = \gamma^0$, which separates the areas with $d = 0$ and $d > 0$. According to Proposition 2, the area with $d = 0$ is then obliquely divided by the curve $\gamma = \alpha\gamma^0$, giving raise to the regions where the equilibrium strategies are $(0, 0)$ and $(1, 0)$, respectively. Similarly, the area with $d = 1$ is divided by the curve

$\gamma = \beta\gamma^0$, delimiting the regions where the equilibrium strategies are $(0, x)$ (Proposition 3) and $(1, y)$ (Proposition 4), respectively.[20]

4 The impact of policy on the equilibrium

When speculative gains are modest ($\gamma \ll \gamma^0$) duopolist banks lend prudently and, consequently, never fail. Hence, irrespectively of the values of μ, δ, and the lending decision of a monopolist bank m, the banking industry converges to a duopoly state in which both lending decisions and the level of competition attain their first best values. Clearly there is no role for policy in this case.

In contrast, when speculative gains are large ($\gamma > \gamma^0$), duopolists get involved in speculative lending with positive probability. The first best is no longer implementable, and the policy parameters μ and δ have an influence on the equilibrium outcomes. A trade-off between the prudence of lending decisions and the level of competition in the banking industry may then arise. We henceforth focus on this case.

Table 1 reports the impact of the various parameters of the model on the equilibrium lending decisions of monopolists and duopolists, m and d. For m, we study the shifts in the line $\gamma = \beta\gamma^0$ and report a positive, negative or zero sign depending on whether the corresponding parameter expands, reduces or produces no change in the region where $m = 1$. For d, we report the (coinciding) sign of the partial derivatives of x and y with respect to each parameter.

[20] It is easy to prove using (11) and (12) that, at the boundary between the two areas, $x = y$, so d is continuous.

Table 1
Comparative statics

Parameter	Effect on m	Effect on d	Direct effect on ϕ
Merging rate μ	0	$-$	$+$
Entry rate δ	$+$	$+$	$-$
Speculative gains γ	$+$	$+$	0
Insolvency risk λ	$-$	$-$	$+$
Monopoly rents ρ	$-$	$-$	0
Discount rate r	$+$	$+$	0

The behavior of d reflects the operation of the last bank standing effect. The merging rate μ increases the probability that a safe duopolist bank becomes a monopolist in reward for being solvent and, thus, encourages duopolist banks to lend prudently. On the other hand, the entry rate δ reduces the expected duration of the monopoly state and, thereby, the size of the capital gains from becoming a monopolist; so increasing δ encourages duopolists to lend more speculatively.

The behavior of m reflects the conventional charter value effect. The merging rate μ happens to have no impact on monopolists' lending decisions because the value of a monopoly bank does not depend on μ, neither directly nor through the value of a duopolist bank.[21] In contrast, the entry rate δ reduces the expected duration of the monopoly state and, hence, the value of a monopolist bank. So increasing the entry rate makes monopolists more inclined towards speculative lending.

By and large, the results indicate that restricting competition may pro-

[21] Together with the fact that γ^0 is independent of the policy parameters, this result implies that the regions described in Figure 1 are invariant to μ.

duce gains in terms of prudence.[22] To rigorously examine this trade-off, we must account for the endogenous dynamics of market structure. Entry, failures, and mergers produce recurrent transitions between monopoly and duopoly states. The monopoly state M may terminate because the monopolist becomes insolvent or because a competitor enters, so the arrival of the duopoly state D follows a Poisson process with intensity $\varphi_M = \lambda m + \delta$. The expected duration of a monopoly state is thus φ_M^{-1}. State D terminates when just one of the two duopolists fails and the bank authorities grant the failing branch to the survivor. So state M arrives at a Poisson rate $\varphi_D = 2\mu\lambda(1-d)d$ and the expected duration of state D is φ_D^{-1}.

The relative frequency of monopoly states along the history of the banking industry can then be computed as the *relative* duration of monopoly states:

$$\phi = \frac{\varphi_M^{-1}}{\varphi_M^{-1} + \varphi_D^{-1}} = \frac{2\mu\lambda(1-d)d}{2\mu\lambda(1-d)d + (\lambda m + \delta)}. \tag{13}$$

Model parameters may affect this frequency both directly and through the equilibrium values of m and d. The direct effects appear in the last column of Table 1. As for the indirect effects, notice that ϕ is decreasing in m since a speculative monopolist tends to endure shorter than a prudent one. In contrast, since mergers require that duopolists' lending decisions diverge, ϕ is increasing in d if $d < 1/2$ and decreasing if $d > 1/2$.[23] When the direct and indirect effects are put together, the trade-off between prudence and competition arises, except possibly when $d < 1/2$.

[22] The effects of the remaining parameters of the model follow a similar pattern: prudent (speculative) lending is always encouraged by those factors that increase (reduce) the value of a bank charter or the gains from becoming a monopolist bank.

[23] Divergence is the most likely when $d = 1/2$. In equilibria without divergence ($d = 1$ or $d = 0$), it is never the case that a duopolist survives its competitor, so monopoly never arises and we have $\phi = 0$.

5 Optimal policies

We have already argued that when speculative gains are modest, there is no room for policy: the banking industry converges to an absorbing duopoly state in which banks lend prudently. In contrast, with large speculative gains, increasing the merging rate μ or reducing the entry rate δ favors prudent lending and, thus, reduces the social losses due to speculative lending. However, these policies tend to increase the relative frequency of monopoly states and, thus, the deadweight losses due to the lack of competition.

In general, the present value of the total social losses as estimated in a monopoly state, L_M, does not coincide with the present value of the total social losses as estimated in a duopoly state, L_D. Both can be obtained from the following system of Bellman equations:

$$rL_M = 2[(\lambda\sigma - \gamma\pi)m + \tau\rho\pi] + \varphi_M(L_D - L_M)$$

and

$$rL_D = 2(\lambda\sigma - \gamma\pi)d + \varphi_D(L_M - L_D),$$

where $\lambda\sigma - \gamma\pi$ accounts for the net social losses per branch and unit of time due to speculative lending and $\tau\rho\pi$ accounts for those due to the lack of competition. The solutions for L_M and L_D show that each of these measures puts extra weight on the losses occurring in its corresponding initial state. So L_M and L_D are generally minimized at different choices of μ and δ.

To focus our discussion, we can consider the problem of a social planner who must fix μ and δ without knowing the state in which his policy will first be applied. He might then reasonably use the relative frequency of monopoly states, ϕ, as an estimate of the probability that the policy starts to be applied in a monopoly date and minimize $\phi L_M + (1 - \phi)L_D$. Ignoring innocuous constants, this is equivalent to minimizing the criterion:

$$C = \phi[\tau\rho\pi + (\lambda\sigma - \gamma\pi)\, m] + (1-\phi)\,(\lambda\sigma - \gamma\pi)\, d, \tag{14}$$

which is a weighted average of the flow of losses per branch and unit of time expected in each of the states of the banking industry.[24]

The optimal policy could then be found by minimizing C after taking into account the dependence of m, d, and ϕ with respect to the regulatory parameters μ and δ. The problem for characterizing this policy is, however, that the underlying optimization program is not convex. Specifically, shifts in monopolists' lending decision m (which occur on the $\gamma = \beta\gamma^0$ curve in Figure 1) may produce a discontinuity in C. If δ is low enough to guarantee $\gamma \leq \beta\gamma^0$ and thus $m = 0$, the equilibrium is characterized by long periods of prudent monopolistic banking combined with short periods of more speculative and competitive banking. In contrast, if δ is high enough to induce $m = 1$, short periods of speculative monopolistic banking alternate with longer periods of more prudent competitive banking. Which of these alternatives dominates lastly depends on the relative sizes of $\tau\rho\pi$ and $\lambda\sigma - \gamma\pi$. In general the solution must be found numerically.

A relevant case in which we can go further in characterizing the social ranking of the various combinations of μ and δ arises when policy choices are restricted to the region where monopolist banks lend speculatively.[25]

Proposition 5 *When policy choices are restricted to the region where monopolist banks lend speculatively, it is always optimal to set* $\mu = 1$ *and to*

[24] The criteria for the minimization of L_M (or L_D) would be equivalent to C except for the weighting factor ϕ which should be replaced by $\phi_M \equiv \frac{r+\varphi_D}{r+\varphi_M+\varphi_D}$ (or $\phi_D \equiv \frac{\varphi_D}{r+\varphi_M+\varphi_D}$) in order to give proper extra weight to the losses incurred in the corresponding initial state. Importantly, the differences between the alternative criteria tend to vanish when the discount rate r is small, since $\lim_{r\to o}\phi_M = \lim_{r\to o}\phi_D = \phi$.

[25] Either because $m = 1$ is globally optimal or because some exogenous lower bound to the entry rate δ impedes the implementation of $m = 0$.

implement the preferred mix of prudence and competition through an adequate choice of δ.

In the region where monopolist banks lend speculatively, our regulatory parameters have a marginal impact on social losses only through the incidence of speculative lending among duopolists, d, and through the relative frequency of monopoly dates, ϕ. Inducing any given d requires guaranteeing certain capital gains to the duopolist that survives his competitor when a solvency shock arrives. These gains (and hence d) can be kept constant by increasing the merging rate μ as the entry rate δ decreases and vice versa. From a social point of view, both increasing μ and lowering δ has a cost in terms of a greater frequency of monopoly states. If social losses are evaluated from the perspective of an initial duopoly state (that is, via L_D), μ and δ turn out to be perfect substitutes for the inducement of any given d. If the initial state is, however, a monopoly with some positive probability, choosing a large δ has the advantage, in terms of the relevant measure of social losses, of speeding up the transition to a (more desirable) duopoly state, while μ is irrelevant for determining such a transition. Therefore it is preferable to guarantee the required capital gains to the duopolists through a high merging rate rather than a low entry rate.[26]

We now numerically analyze how the entry rate δ should respond to changes in the environment. Inspired by the explicit model of competition described in the Appendix, we set $\rho = 1/8$ and $\tau = 5/2$. For the remaining parameters, we consider different scenarios centered on baseline values ($\pi = 0.03$, $\gamma = 1.4$, $\lambda = 0.06$, $\sigma = 0.8$, and $r = 0.06$) which yield within plausible ranges of variation but are not intended to provide a realistic calibration of the model; rather, they are chosen so as to illustrate qualitative, theoretically

[26]The same result applies if L_M is taken as the relevant measure of social losses.

possible results in a visible way. The results are summarized in Figures 2-5.

Each figure depicts, as a function of one of the parameters, the socially optimal value of the entry rate, δ, the induced frequency of monopoly states, ϕ, and the average "exposure" of a bank branch to solvency shocks, $\phi m + (1-\phi)\, d$. We briefly comment on them:

Profitability. Figure 2 is generated by varying π and γ simultaneously so as to keep the expected gains from speculative lending (i.e., $\gamma\pi$) constant. So this exercise captures the effects of an increase in bank profitability. It shows how banks become more and more prudent as the value of their future rents increases. The social planner resolves the more favorable trade-off between prudence and competition by allowing higher entry. The frequency of monopoly decreases both because duopolists fail less frequently and because monopoly states last shorter.

Private cost of speculative lending. Figure 3 is produced by varying λ and σ simultaneously so as to keep the social cost of speculative lending (i.e., $\lambda\sigma - \gamma\pi$) constant. This captures the effects of altering the private cost of speculative lending (bankers' risk of suffering a solvency shock if they lend speculatively).[27] As one might expect, bankers react to a larger cost by getting less involved in speculative lending, which explains the dramatic fall in their exposure to solvency shocks, as well as the inverted-U shape of the curve describing the frequency of monopoly states (recall that, ceteris paribus, monopolies are the most likely to emerge when $d = 1/2$). The most surprising finding in this exercise is the flatness of the optimal regulatory response. In the case depicted in

[27] Not surprisingly, the picture obtained is the mirror image of the one that arises when we consider the private gains from speculative lending. That is, when γ and σ are simultaneously changed, keeping the social cost of speculative lending constant.

the figure, the entry rate δ gets reduced as λ increases.[28] Our explanation for this is that the entry rate has a greater impact on duopolists' lending decisions when speculative lending is less obviously profitable, so it is then when it makes more sense to socially sacrifice competition for prudence.

Social cost of speculative lending. Figure 4 is generated by varying σ, which captures the social cost of speculative lending. When σ is sufficiently low, the trade-off between prudence and competition gets resolved at a corner: the entry rate is set at a high value, duopolists get not discouraged to lend speculatively, and the frequency of monopoly is zero (since duopolists never fail separately). As σ increases, entry is restricted so as to induce more prudent lending strategies. The cost is a higher frequency of monopoly states.

Discount rate. Figure 5 is produced by changing r. A larger discount rate makes both the bankers and the social planner to put less weight on future rents or losses. On bankers side, this weakens the charter value effect as well as the last bank standing effect, which explains the dramatic increase in their exposure to solvency shocks and, once again, the inverted-U shape of the curve describing the frequency of monopoly states. On the social planner's side impatience means giving more weight to a likely initial monopoly state from which a higher δ guarantees a quicker exit. Somewhat surprisingly, instead of trying to moderate bankers' speculative lending, the optimal policy response in the case depicted in Figure 5 is to give priority to competition, slightly increasing δ and, hence, bankers' speculative tendencies.

[28] To enhance the visibility of the effects we have chosen $\sigma = 0.75$ as a benchmark in this exercise.

6 Discussion

6.1 Asymmetric equilibria

The possibility of asymmetric Markov perfect equilibria arises in the region of the parameter space where duopolists' mixed strategy is non-degenerated, i.e., $0 < d < 1$. The candidate equilibrium involves a duopolist who lends prudently ($d = 0$) while his subsequent competitors lend speculatively ($d^* = 1$). The prudent duopolist reaches a value greater than v_d^1 and never fails, while its speculative competitors reach a value of just v_d^1 and fail whenever a solvency shock arrives. In terms of exposure to solvency crises, this equilibrium is equivalent to a mixed strategy equilibrium with $d = 1/2$ although, because duopolists here always take divergent lending decisions, the solvency shock leads to monopoly with probability μ rather than $\mu/2$.

Starting from this type of asymmetric equilibria, policy can only affect the incidence of speculative lending by modifying the equilibrium regime, that is, either by altering m or by leading to an area where duopolists play symmetric strategies. Policy can, however, affect the frequency of the monopoly state in a more continuous fashion. If policy choices are restricted to the region where monopolist banks lend speculatively, it would be optimal to set $\mu = 1$ and to fix δ at the maximum value compatible with the most desirable regime in terms duopolists' average d.[29]

It is possible to check that when speculative gains are larger than but arbitrarily close to γ^0, the equilibrium with mixed strategies involves $d < 1/2$ and a frequency of monopoly arbitrarily close to zero. Hence there exists a region of the parameter space in which the above asymmetric equilibrium is strictly dominated in welfare terms by our symmetric mixed strategy equi-

[29] Notice that it is always possible to induce an equilibrium with $d = d^* = 1$ by choosing a sufficiently large δ.

librium. Consequently, focusing on symmetric equilibria implies no obvious loss in terms of either economic intuition or socially desirable outcomes.

6.2 The importance of commitment

Commitment is indispensable to implement $d < 1$ when speculative gains are large. A myopic or uncommitted policy-maker would always fix $\mu = 0$ at the point of intervening in a crisis and $\delta \to \infty$ once in a monopoly.

Given the repeated nature of the game played by the policy-maker and the successive bankers, we might think of implementing the full commitment values of μ and δ on the basis of some "triggering" type of strategies on banks' side. The Folk Theorem suggests that commitment might certainly be obtained as an outcome if the discount rate is low enough. Yet triggering strategies would lead us out of the current Markovian environment, where agents are not allowed to condition their play on payoff-irrelevant features of history. Within the current environment, commitment should thus come from some type of legal mandate or reputation, or alternatively from the delegation of the relevant decisions to some properly chosen supervisors.

Perhaps authorities may commit to sustain a given policy only for some time. We might formalize this through a random arrival process that determines when the policy-maker has the opportunity to revise his policy. The revised policy would then be different if the revision took place in a monopoly state than in a duopoly state, so observed policies would fluctuate. Yet, when fixing μ and δ, the policy-maker would anticipate how his own future behavior might erode or increase the relevant bank charter values. He would then adjust μ and δ in order to sustain the charter values which would induce the desired mix of prudence and competition.

7 Conclusions

In this paper we have analyzed banks' incentives for prudence in an explicit dynamic model in which the level of concentration in the banking industry is endogenous. The levels of competition are driven by banks' exit and entry, which in turn depend on bank failures, and the policy of bank authorities on mergers and entry. We have shown that banks' expectation of obtaining larger rents if their competitors fail makes banks' speculative lending decisions strategic substitutes. Thus an active merging policy by bank authorities, which allows the survivors to take over the business of the failed banks on concessionary terms, can reinforce stability and reduce the risk of a systemic banking crisis.

This mechanism for the control of speculative behavior in banking is possibly most useful when the direct supervision of lending decisions is not feasible. We can thus rationalize the historical policy experience whereby bank supervisors promoted takeovers of weaker institutions by solvent banks. Consolidation and highly restrictive rules, leading to segmentation and limited entry in special products or local markets, have been often introduced after financial crises, such as in the 1930s. Only in the more stable financial systems this complex set of restrictions has been gradually dismantled, thanks in part to new control instruments, increasingly market-based (auditing, ratings, marking-to-market, et cetera). Proposals for limiting the pace of liberalization, especially in developing countries in which prudential regulation and legal enforcement are less established, seem implicitly to rely on this historical trade-off.

To a large extent, the logic of our results might be applied to the analysis of risk-taking in other oligopolistic industries in which the failure and exit of one of the competing firms does not immediately lead to its replacement by a new entrant. Yet the application to banking is the most natural for various reasons. First, because the opacity of bank loans and banks' high leverage makes asset substitution particularly attractive for bank shareholders, especially under deposit insurance (which reduces the ex ante cost of risk taking). Second, because of the systematic involvement of the regulator in the resolution of bank failures, which makes our policy implications more relevant when applied to the banking industry than to any other industry.

In future research we plan to consider forces that may make banks' speculative lending decisions strategic complements rather than substitutes. One such force is the ability of bankers to postpone the recognition of bad loans, which may lead them to keep renewing bad loans and to disclose them simultaneously to other banks in order to avoid being singled out for poor performance (Rajan, 1994). A second force is what Mitchell (1998) calls the "too many to fail" problem —a phenomenon studied in the context of transition economies by Perotti (1998) and Mitchell (2001). The basic idea is that when many banks (or many of their borrowers) face pressure for a costly restructuring, their incentive to comply may depend on the expected strategy of the others, since logistical limitations or political pressure may make the authorities unable to force a very large number of defaulters into bankruptcy.

APPENDIX

An explicit model of competition for deposits

Banks need to raise one unit of deposits per branch in order to finance their lending activity. For the purposes of this section, assume that banks plan to lend prudently and this yields a return r per unit of time. Assume also that deposits raised at some financial center cost r per unit of time, while the demand for local deposits is

$$D = a + bs,$$

where s is the interest rate paid on these deposits and the parameters a and b satisfy $a \geq 0$, $b > 0$, and $a + br < 3$. Thus

$$s(D) = \frac{D - a}{b} \tag{15}$$

is the associated inverse demand function.

A monopolist bank will choose its supply of deposits, D_M, so as to maximize the profit flow $[r - s(D)]D$. Given (15), the corresponding first order condition yields

$$D_M = \frac{a + br}{2},$$

which produces profits equal to

$$\Pi_M = \frac{(a + br)^2}{4b}. \tag{16}$$

Notice that $D_M < 3/2 < 2$ so the monopolist bank will complement its funding with deposits raised at the financial center.

Assuming that duopolist banks compete a la Cournot in the market for local deposits, each duopolist will find his best response, D_D, to its competitor's supply of local deposits, D^*, by maximizing $[r - s(D + D^*)]D$ with respect to D. From the first order condition of this problem, by symmetry, we obtain:

$$D_D = \frac{a + rb}{3},$$

under which each duopolist's profits are

$$\Pi_D = \frac{(a + rb)^2}{9b}. \tag{17}$$

Notice that $D_D < 1$ so duopolists will also complement their funding with deposits raised at the financial center.

In terms of the parameters of our model, the previous expressions imply:

$$\pi = \Pi_D = \frac{(a + rb)^2}{9b} \text{ and } \rho = \frac{\Pi_M}{2\Pi_D} - 1 = \frac{1}{8}.$$

To obtain a similar expression for τ, we can compute the difference between the areas of the triangles of deadweight losses (relative to perfect competition) that appear in monopoly and in duopoly:

$$\frac{b}{2}\{[r - s(D_M)]^2 - [r - s(D_D)]^2\} = \frac{5\,(a + rb)^2}{72b},$$

which corresponds to what we have denoted $2\tau\rho\pi$. Given the above values of π and ρ, this implies $\tau = \frac{5}{2}$.

Proofs

Proof of Proposition 1 Given (5) and the fact that d^* has no direct impact on v_M or v_D, we just need to show that $v_M - v_D \geq 0$. Suppose, on the contrary, that $v_M - v_D < 0$. Then, the signs of the third terms in the RHS of (2) and (3) imply

$$rv_M > \max_{m \in [0,1]} [2\,(1+\rho+\gamma m)\,\pi - \lambda v_M m] > \max_{m \in [0,1]} [(1+\gamma m)\,\pi - \lambda v_M m] \tag{18}$$

and

$$rv_D \leq \max_{d \in [0,1]} [(1+\gamma d)\,\pi - \lambda v_D d] < \max_{d \in [0,1]} [(1+\gamma d)\,\pi - \lambda v_M d]\,.$$

But this implies $rv_M > rv_D$, which is a contradiction.■

Proof of Lemma 1 From (6), one can immediately see that γ^0 is the maximum value of γ for which (5) is negative with $d = d^* = 0$ and $v_D = v_D^0$.■

The following intermediate result characterizes the solution to the decision problem of a monopolist under a given value of v_D:

Lemma A1 *There is a critical value*

$$v^* = \frac{2\pi\left[(r+\delta)\gamma - \lambda(1+\rho)\right]}{\lambda\delta} \tag{19}$$

such that the optimal lending strategy of a monopolist bank is $m = 0$ *if* $v_D > v^*$, $m = 1$ *if* $v_D < v^*$, *and any* $m \in [0,1]$ *if* $v_D = v^*$.

Proof For a given value of v_D, it follows from (2) that if $m = 0$ then

$$v_M = v_M^0(v_D) \equiv \frac{2(1+\rho)\pi + \delta v_D}{r+\delta}, \tag{20}$$

while if $m = 1$ then

$$v_M = v_M^1(v_D) \equiv \frac{2(1+\rho+\gamma)\pi + \delta v_D}{r+\delta+\lambda}. \tag{21}$$

Moreover, $2\gamma\pi - \lambda v_M^0(v_D) = 2\gamma\pi - \lambda v_M^1(v_D) = 0$ only at $v_D = v^*$. So (4) is negative if $v_D > v^*$, positive if $v_D < v^*$, and zero if $v_D = v^*$, which implies the optimality of the values of m proposed for each of these three cases.■

Proof of Proposition 2 By Lemma A1, determining m when speculative gains are modest requires comparing v_D^0 and v^*. It follows from (6) and (19) that $v_D^0 \geq v^*$ is equivalent to $\gamma \leq \alpha\gamma^0$. When $\delta \leq 2r\rho$ we have $\alpha \geq 1$ so $m = 0$ for all $\gamma \leq \gamma^0$. Otherwise, we have $\alpha < 1$ so $m = 0$ for $\gamma \leq \alpha\gamma^0$ and $m = 1$ for $\alpha\gamma^0 < \gamma \leq \gamma^0$.■

The following intermediate result characterizes the equilibrium lending decisions of a monopolist bank when speculative gains are large.

Lemma A2 *Suppose speculative gains are large, $\gamma > \gamma^0$. Then*

1. *If $\delta > 2r\rho$, the equilibrium features $m = 1$.*
2. *Otherwise, $\beta \geq 1$ and the equilibrium features $m = 0$ for $\gamma \leq \beta\gamma^0$ and $m = 1$ for $\gamma > \beta\gamma^0$.*

Proof By Lemma A1 determining m when speculative gains are large requires comparing v_D^1 and v^*. It follows from (7) and (19) that $v_D^1 \geq v^*$ is equivalent to $\gamma \leq \beta\gamma^0$. When $\delta > 2r\rho$ we have $\beta < 1$ so $m = 1$ for all $\gamma > \gamma^0$. Otherwise, we have $\beta \geq 1$ so $m = 0$ for $\gamma^0 \leq \gamma \leq \beta\gamma^0$ and $m = 1$ for $\gamma > \beta\gamma^0$.■

Proof of Proposition 3 From Lemmas 1 and A2, with $\delta \leq 2r\rho$ and $\gamma^0 < \gamma \leq \beta\gamma^0$, we necessarily have $d > 0$, $v_D = v_D^1$ and $m = 0$. To find the equilibrium value of d, let x denote the unique solution to the equation

$$\gamma - \lambda v_D^1 - \lambda x\mu[v_M^0(v_D^1) - v_D^1] = 0,$$

whose explicit expression appears in (11). Notice that $\gamma^0 < \gamma \leq \beta\gamma^0$ implies $\gamma\pi - \lambda v_D^1 > 0$ and $v_M^0(v_D^1) - v_D^1 \geq v_M^1(v_D^1) - v_D^1 > 0$, guaranteeing $x > 0$. Yet x can be greater or smaller than 1. If $x > 1$, we can substitute $d^* = 1$ in equation (5) and check that the resulting expression is positive, so the equilibrium is $(m, d) = (0, 1)$. Otherwise, the unique equilibrium is $(m, d) = (0, x)$, since neither $d = d^* = 0$ nor $d = d^* = 1$ produce a consistent sign in (5), while $d^* = x$ makes the duopolists indifferent towards any possible choice of d, including $d = x$.■

Proof of Proposition 4 From Lemmas 1 and A2, with $\gamma > \max\{\gamma^0, \beta\gamma^0\}$ we necessarily have $d > 0$, $v_D = v_D^1$ and $m = 1$. To find the equilibrium value of d, let y denote the unique solution to the equation

$$\gamma\pi - \lambda v_D^1 - \lambda y \mu [v_M^1(v_D^1) - v_D^1] = 0,$$

whose explicit expression appears in (12). Notice that $\gamma > \gamma^0$ implies $\gamma\pi - \lambda v_D^1 > 0$ which, together with $v_M^1(v_D^1) - v_D^1 > 0$, guarantees $y > 0$. Yet y can be greater or smaller than 1. If $y > 1$, we can substitute $d^* = 1$ in (5) and check that the resulting expression is positive so the equilibrium is $(m, d) = (1, 1)$. Otherwise, the unique equilibrium is $(m, d) = (1, y)$, since neither $d = d^* = 0$ nor $d = d^* = 1$ produce a consistent sign in (5), while $d^* = y$ makes the duopolists indifferent towards any possible choice of d, including $d = y$.■

Proof of Proposition 5 In the region with $m = 1$, μ and δ have a marginal impact on C only through the incidence of speculative lending among duopolists, d, and the relative frequency of monopoly dates, ϕ. One can check using the expression for d provided in Proposition 4 and (13) that all the combinations of μ and δ that induce a constant d are ranked in terms of ϕ, which decreases as the entry rate increases. But, with $m = 1$, the social losses measured in (14) are unambiguously increasing in ϕ, so the result follows.■

References

[1] Aghion, P., P. Bolton, and S. Fries. (1998), "Optimal Design of Bank Bailouts: The Case of Transition Economies", EBRD Working Paper no. 32, London.

[2] Anand, B. and A. Galetovic (1997), "Information, Non-Excludability, and Financial Market Structure", Yale SOM Working Paper no. 2.

[3] Caminal, R. and C. Matutes (2000), "Market Power and Banking Failures", *International Journal of Industrial Organization,* forthcoming.

[4] Caprio, G. and D. Klingebiel (1997), paper included in M. Bruno and B. Pleskovic, eds., *Annual World Bank Conference on Development Economics 1996,* World Bank, Washington.

[5] Dewatripont, M. and E. Maskin (1995), "Credit and Efficiency in Centralized and Decentralized Economies", *Review of Economic Studies*, 62, 541-555.

[6] Diamond, D. and P. Dybvig (1983), "Bank Runs, Deposit Insurance, and Liquidity", *Journal of Political Economy*, 91, 401-419.

[7] Freixas, X. (1999), "Optimal Bailout Policy, Conditionality and Constructive Ambiguity", working paper, Universitat Pompeu Fabra, Barcelona.

[8] Hawkins, J. and P. Turner (1999), "Bank Restructuring in practice: an overview", *BIS Policy Papers*, 6, 6-105.

[9] Hellmann, T., K. Murdock, and J. Stiglitz (2000), "Liberalization, Moral Hazard in Banking and Prudential Regulation: Are Capital Requirements Enough?", *American Economic Review*, 90, 147-165.

[10] Jensen, M. and W. Meckling (1976), "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure", *Journal of Financial Economics*, 3, 305-360.

[11] Keeley, M. (1990), "Deposit Insurance, Risk, and Market Power in Banking", *American Economic Review*, 80, 1183-1200.

[12] Mailath, G. and L. Mester (1994) "A Positive Analysis of Bank Closure", *Journal of Financial Intermediation*, 3, 272-99.

[13] Matutes, C. and X. Vives (1996), "Competition for Deposits, Fragility, and Insurance", *Journal of Financial Intermediation,* 5, 184-216.

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

[15] Mitchell, J. (1998), "Strategic Creditor Passivity, Regulation and Bank Bailouts", CEPR DP no. 1780, London.

[16] Mitchell, J. (2001), "Bad Debts and the Cleaning of Banks' Balance Sheets: An Application to Transition Economies", *Journal of Financial Intermediation*, 10, 1-27

[17] Perotti, E. (1998), "Inertial Credit and Opportunistic Arrears in Transition", *European Economic Review*, 42, 1703-1725.

[18] Perotti, E. (2001), "Lessons from the Russian Meltdown: The Economics of Soft Legal Constraints", working paper, University of Amsterdam.

[19] Petersen, M. and R. Rajan (1995), "The Effect of Credit Market Competition on Lending Relationships", *Quarterly Journal of Economics*, 110, 407-443.

[20] Rajan, R. (1994), "Why Bank Credit Policies Fluctuate: a Theory and Some Evidence", *Quarterly Journal of Economics*, 109, 399-441.

[21] Schnitzer, M. (1998), "On the Role of Banking Competition for Corporate Finance and Control in Transition Economies", CEPR DP no. 2013, London.

[22] Shull, B. (1996), "The Origins of Antitrust in Banking: A Historical Perspective", *The Antitrust Bulletin,* 41, 255-228.

[23] Suarez, J. (1994), "Closure Rules, Market Power, and Risk Taking in a Dynamic Model of Bank Behavior", LSE Financial Markets Group DP no. 196, London.

[24] Vives, X. (2001), "Competition in the Changing World of Banking", *Oxford Review of Economic Policy*, 17, 535-547.

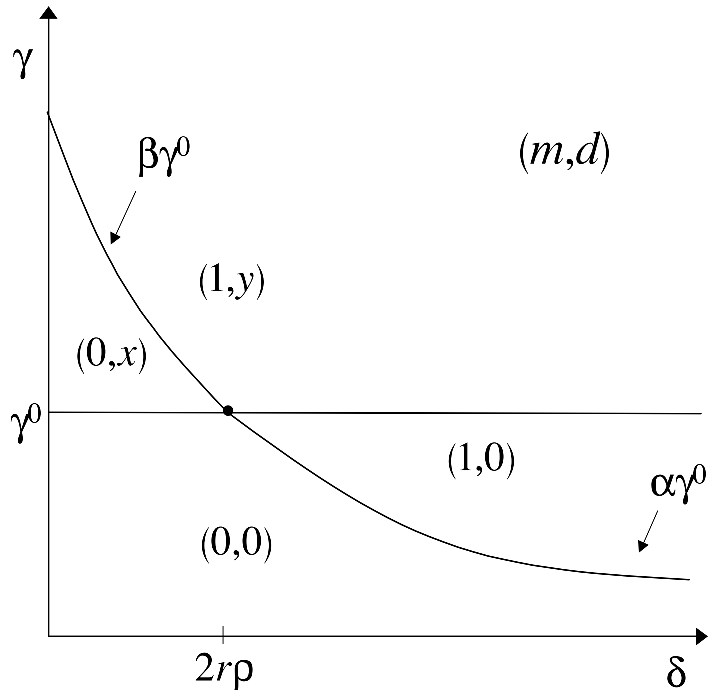

Figure 1. Equilibrium regimes

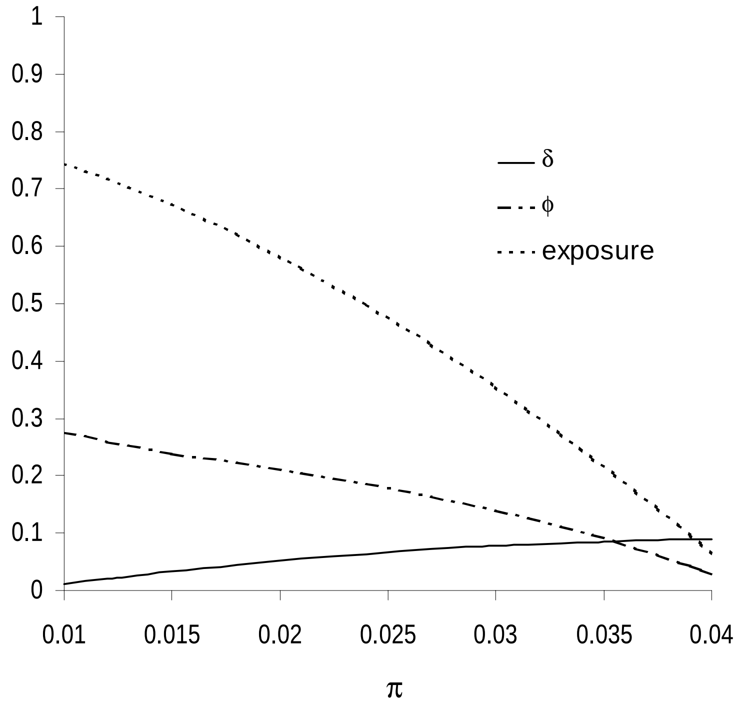

Figure 2. Profitability and the optimal policy

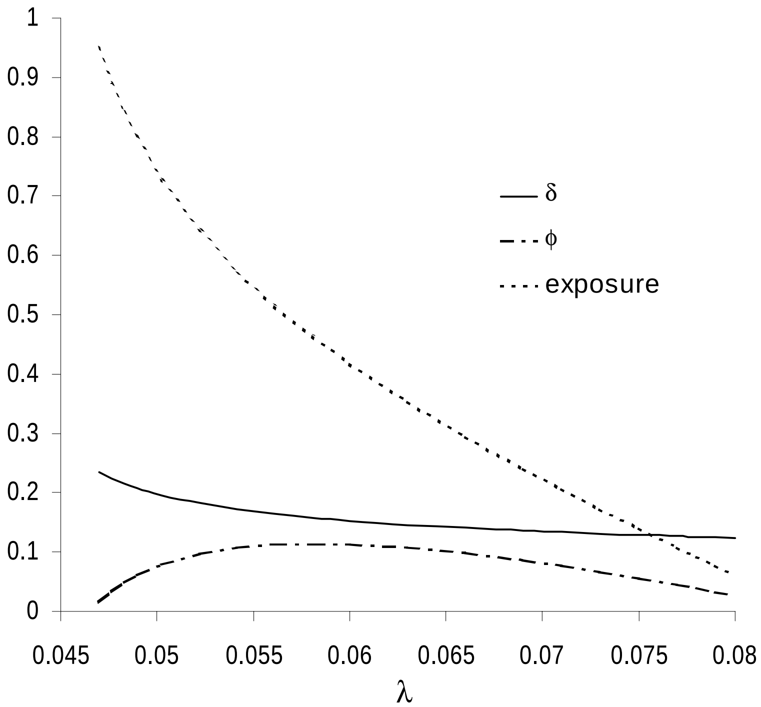

Figure 3. The private cost of speculative lending and the optimal policy

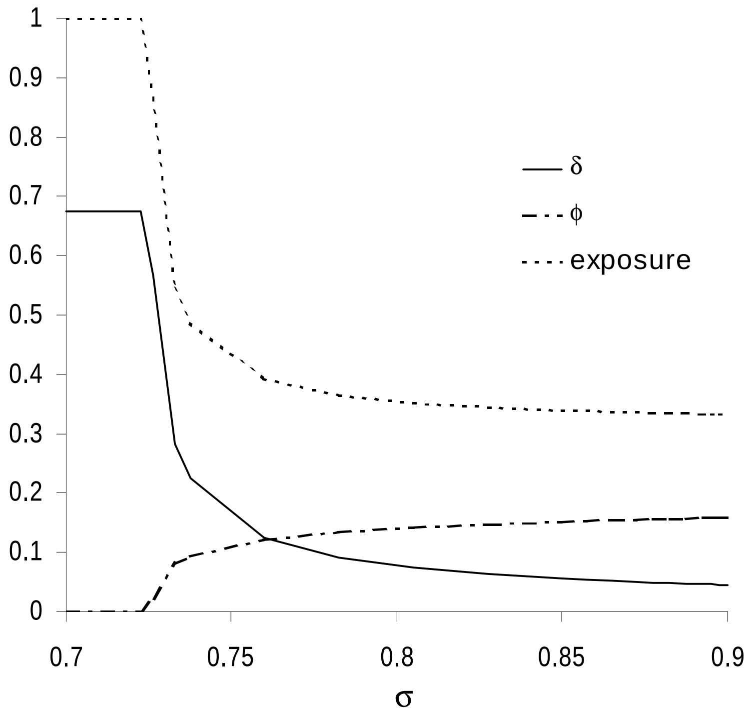

Figure 4. The social cost of speculative lending and the optimal policy

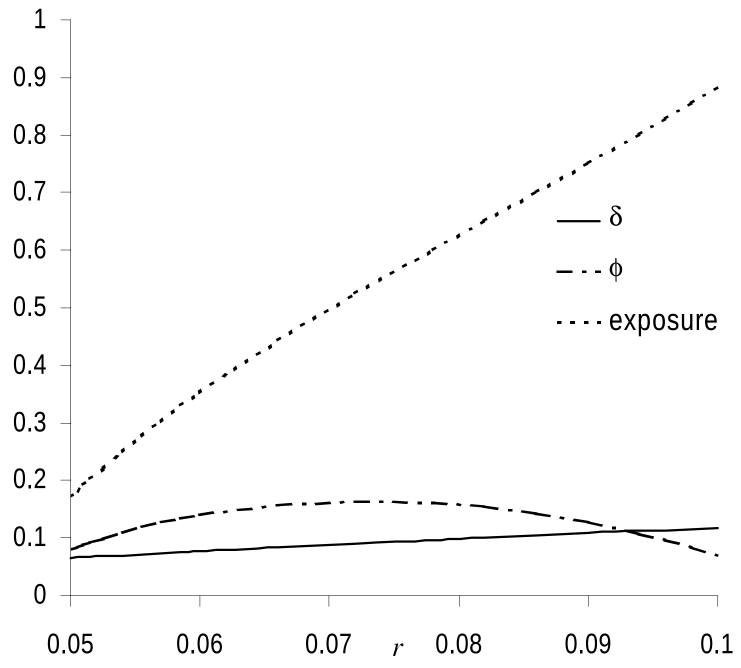

Figure 5. The discount rate and the optimal policy