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Banking regulation and competition with product differentiation

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Abstract

The main motivation for prudential regulation is to increase the solvency of the banking sector. However, it is usually understood that tighter regulation also leads to more concentration and higher spreads. Thus, these prudential measures are seen as implying a trade-off between solvency and competition. In this paper we argue that this trade-off does not necessarily exist. We present a model in which tighter capital requirements lead banks to choose a lower degree of product differentiation, potentially inducing more intense competition and lower spreads. The model is motivated by the recent evolution of the Argentine banking sector.

JEL classification: L51; G21; E44
Keywords: Banking competition; Regulation; Product differentiation

1. Introduction

The main motivation for prudential regulation is to increase the solvency of the banking sector. Specifically, the regulation of banks' capital structure intends to reduce the risk of bank failures and banking crises.[1] However, as it increases the costs of operating in the industry, prudential regulation may also reduce the

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[1] See, for example, Dewatripont and Tirole (1994), and Hellmann et al. (1998).

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number of firms. Therefore, while better prudential regulation may deliver a benefit in terms of increased solvency, it is usually understood that it has a cost in terms of competition as, with fewer financial institutions, the industry becomes less competitive. Thus, these prudential measures are seen as implying a trade-off between solvency and competition. We call this the *traditional view*, which has been discussed in much of the banking literature.[2]

In this paper we present a challenge to this *traditional view*. Our challenge is motivated by the recent evolution of the financial sector in Argentina. Figs. 1–3 illustrate the main points. Fig. 1 shows the growing stringency of capital requirement regulation in the Argentine banking sector. Fig. 2 depicts the growing concentration in the local financial sector. Starting in 1993, Argentina experienced a significant reduction in the number of banks, which fell from 166 in June 1993 to 102 in January 1999. During the same period, the concentration index $C(10)$ grew from less than 25% to more than 40%. Fig. 3 measures the return to financial intermediation for Argentina's 20 largest banks. As can be seen in the figure, margins have decreased over the last 5 years, dropping from about 11% to about 6% per year. The facts show that, in spite of the increase in concentration, financial intermediation margins have fallen substantially, suggesting that other effects have offset the increase in market power. In this new scenario, the Argentine banking sector is characterized by fewer banks and more competition.[3]

Bankers, policymakers and private analysts agree that the financial sector in Argentina has been moving towards higher concentration with more intense competition. Horacio Chighizola, President of Banco de la Ciudad de Buenos Aires, in assessing the outlook for the Argentine financial sector in early 1998 states:[4,5]

> Consequently, in the new scenario there will be *fewer banks and more competition*. Nobody anticipates a traumatic situation but a process of mergers and acquisitions with the incorporation of foreign capitals and the participation of new players strengthening a trend which already begun to manifest itself (Emphasis added).

Motivated by this experience, our paper questions the traditional view. We present a model in which more stringent regulation does not necessarily imply

[2] See, for example, Mishkin's (1986) classical textbook on money and banking or, more recently, Yellen (1995) and Mishkin (1996). For an application to Argentina, see Rozenwurcel and Blejer (1997).

[3] Zahler and Budnevich (1998) present evidence which suggests a similar negative relationship between margins and concentration for several Latin American countries.

[4] See Chighizola (1998).

[5] For similar statements by the Central Bank authorities and private analysts, see Ambito Financiero (11/25/98) and La Nación (10/3/99), respectively.

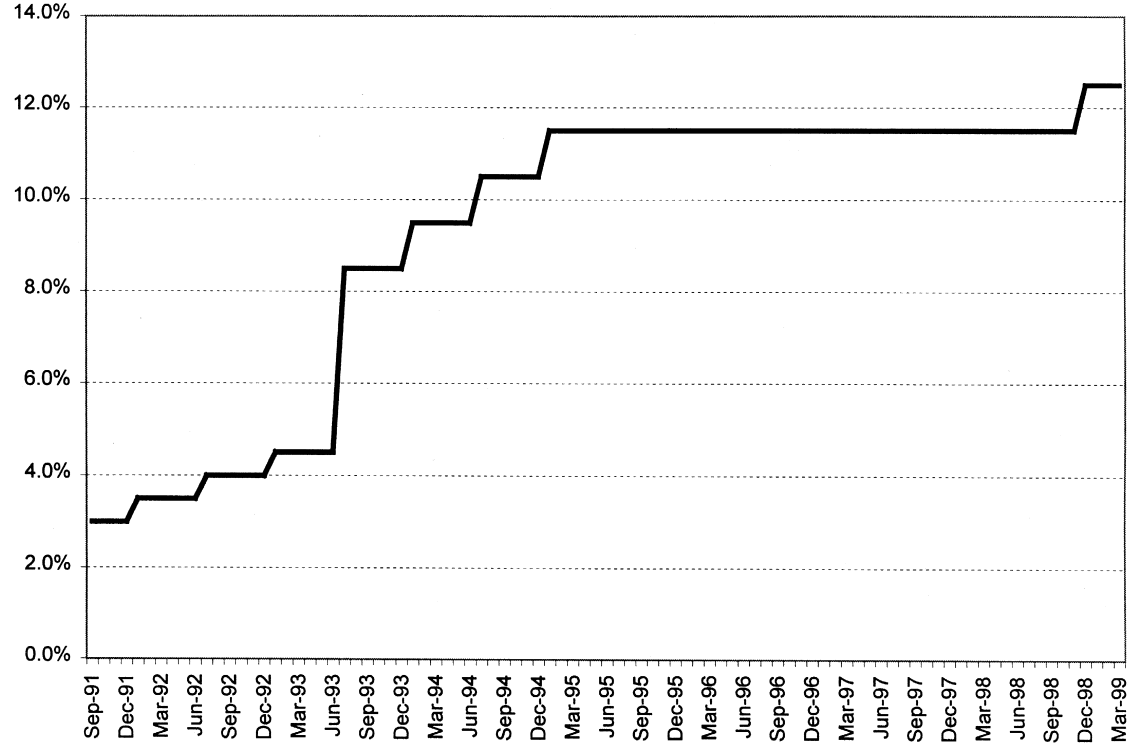

Fig. 1. Capital requirements. Source: BCRA. The figure shows the required risk-weighted asset/equity ratio. Prior to September 1991, capital requirements were not defined in terms of a risk-weighted asset/equity ratio requirement following BIS standards, but just fixed in absolute amounts.

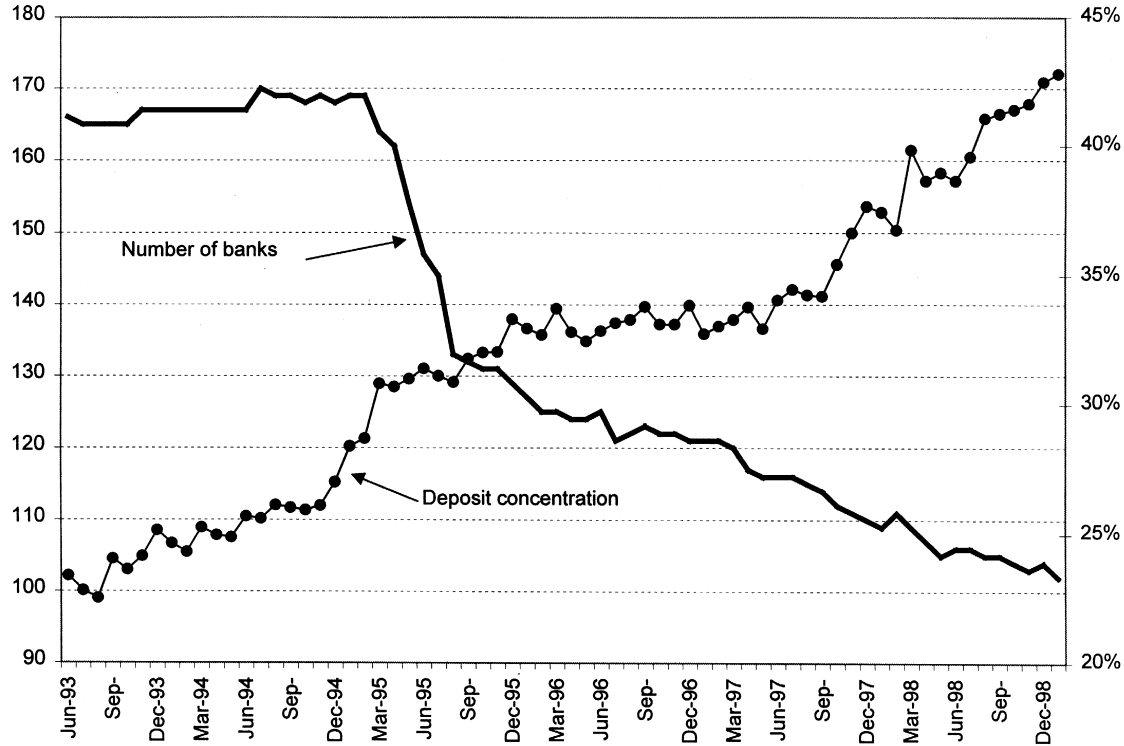

Fig. 2. Banking concentration. Source: BCRA. The left axis measures the number of banks and the right axis measures the proportion of total deposits held by the 10 largest banks (by deposits).

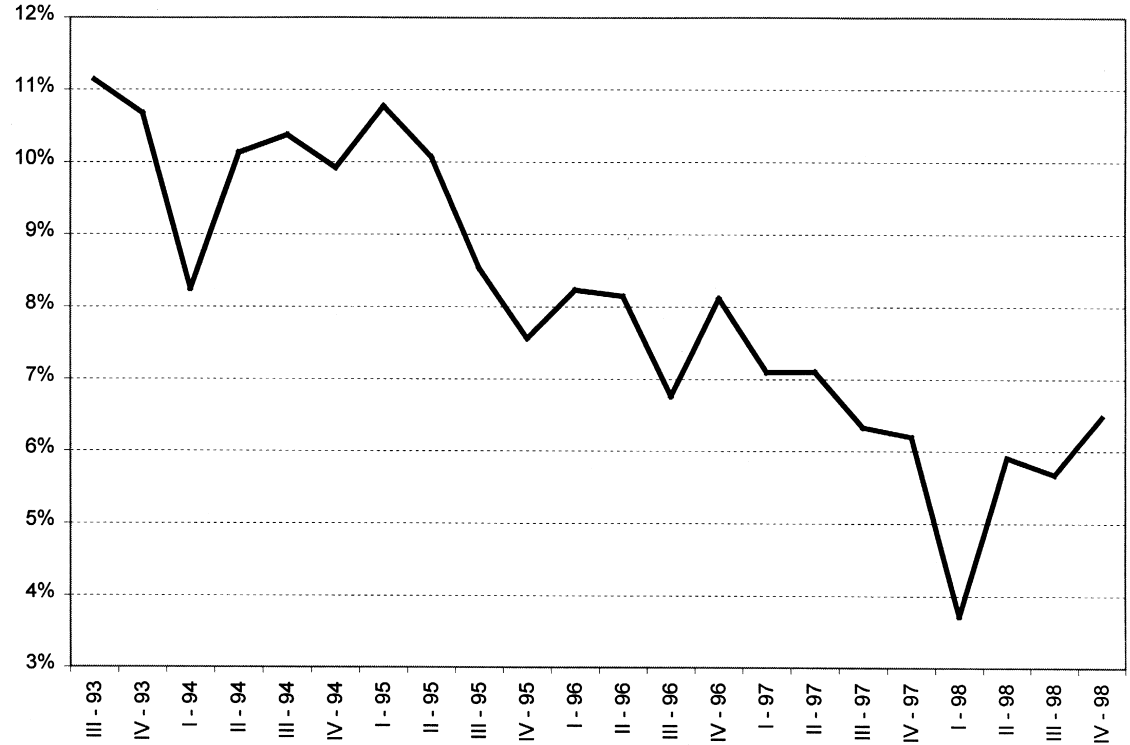

Fig. 3. Financial intermediation margin. Source: BCRA. The margin is obtained as net financial and service income (annualized) as a percentage of total assets for the largest (by deposits) 20 banks as of January 1999.

higher financial intermediation margins. Tighter capital requirements induce banks to choose a lower degree of product differentiation, allowing for more competition even with a smaller number of banks.

In our model, banks choose the degree of differentiation of their financial services. The higher the degree of differentiation, the softer the competition among banks. Yet, the higher the degree of differentiation, the smaller the client base for which the bank's services are appropriate. If a tightening of the regulatory environment induces exit from the industry, we show that it also induces banks to choose a lower degree of differentiation, making banks more similar from the viewpoint of the user of financial services. Thus, two opposing forces operate upon spreads. The higher degree of concentration provides firms with enlarged market power. However, the lower degree of differentiation forces banks to compete more intensively in prices. As a result, spreads may either increase or decrease.

Our model explains the coexistence of the stylized facts that we observe in Argentina: more stringent prudential regulation, higher concentration, and lower spreads. Because the result relies on a reduction in product differentiation, we provide evidence of a lowering degree of specialization in the Argentine financial sector. We measure product differentiation along both geographical and sectorial dimensions. On a geographical dimension, we show a reduction in the participation of local and regional banks in favor of national banks. We also analyze the geographical distribution of bank branches in three cities in Argentina. We show that the average distance from a branch to the closest rival branch decreased during the period of analysis. On a sectorial dimension, our evidence shows a reduction in the participation of cooperative banks as well as a lower presence of personalized financial intermediaries -brokers and public notaries- relative to banks in the mortgage market. The study of bank loan portfolios also shows a lower degree of specialization. We find a convergence in the loan structure of the major financial institutions by type of loan.

Other hypotheses have also been suggested to explain the negative relationship between concentration and competition observed in Argentina: the elimination of high-risk financial institutions, a reduction in banks' risk taking, the process of financial liberalization and a reduction in banks' costs. Although these factors might have had an effect, the data indicate that they cannot explain all the stylized facts that we describe. Yet, the evidence on product specialization suggests that tougher competition induced by a reduction in product differentiation has played an essential role in explaining the recent developments in the Argentine financial sector.

Our paper contributes to the literature by considering the effect of prudential regulation on market structure. Research on the effects of prudential regulation has mostly concentrated on the impact of regulation on solvency. Following the seminal contribution of Diamond and Dybvig (1983), there has been an extensive body of work studying the impact of regulation on banks' risk-taking behavior and

banking crises.[6] However, it is surprising the limited attention the literature has given to the impact of regulation on market structure, given the relevance of this issue in policy discussions and considering the substantial body of work studying the empirical relationship between banking concentration and spreads. Gilbert (1984), for example, surveys 45 empirical studies on this relationship.[7]

There has also been relatively little work on the endogenous choice of product differentiation in banking. While models of spatial competition have been frequently utilized (see, for example, Chiappori et al., 1995; Ali and Greenbaum, 1997), banks do not control the degree of product differentiation in those models. Bouckaert and Degryse (1995) and Degryse (1996) study a duopoly in which banks decide whether or not to introduce remote access, choosing, therefore, how much to differentiate their products. Matutes and Padilla (1994) describe the trade-off introduced by ATM networking. On the one hand, networking allows banks to pay lower deposit rates because they provide better service. On the other hand, the loss of product differentiation resulting from networking increases competition. However, as these models assume a fixed number of banks, they are not suitable for studying the effect of regulation on market structure. In fact, we assume free entry because we want to concentrate on the effect of regulation on market structure. Allowing for a larger number of banks is not only appropriate for our purpose, but also realistic, considering that, even after consolidation, most financial sectors remain fairly competitive with a substantial number of players. In addition, our treatment of product differentiation is more general than networking decisions, making our model appropriate to analyze changes in product characteristics in several dimensions.

The paper is organized as follows. Section 2 presents the model of banking competition with endogenous product differentiation. Section 3 discusses the appropriateness of our model for explaining the stylized facts of the Argentine experience. Section 4 presents our conclusions and directions for future research.

2. The model

Consider a Salop circular city with a perimeter equal to one, and a unitary density of entrepreneurs located uniformly around the circle. Entrepreneurs have

[6] Mark Gertler (1987) presents a review of the literature and provides extensive references. Recent aplications to emerging markets include Goldstein and Turner (1996), Bery and Garcia (1996) and Caprio (1998).

[7] The traditional view that higher concentration leads to higher spreads has come under increasing pressure. Shaffer (1994), studying the link between concentration and monopoly power, concludes that the relationship is not uniform as the hypothesis of competitive behavior cannot be rejected even in concentrated markets. In fact, Shaffer (1993) finds that the banking sector is competitive in the most concentrated markets within a sample of 15 developed economies.

available the possibility of undertaking an investment project. In order to undertake their projects entrepreneurs need to borrow resources from financial intermediaries which we call banks.[8] Banks are located symmetrically around the circle. The financial services provided by banks are locationally specialized. They are more valuable to entrepreneurs located close to the bank location than to clients located further away. There is free entry into the banking industry but banks are forced by a regulatory body to maintain a capital requirement. Due to limited liability, increasing this capital requirement increases the cost of operating a financial institution.

The distribution of banks around the Salop circular city can be interpreted as spatial product differentiation. This fits naturally with the intuition of bank branching and regional location of financial institutions. However, the model is equally applicable to financial institutions that concentrate their lending in specific economic sectors. In this case, location in the circular city will correspond to particular activities and these would be changing smoothly around the circle.

The timing of the model is as follows. Given the level of capital requirements, banks decide to enter or not in the industry. Once they have chosen to participate, they simultaneously decide what rate to charge for their loans and the degree by which they will specialize as providers of financial intermediation services. After banks have set these two characteristics, entrepreneurs borrow from their bank of preference in order to undertake their projects. After loans have been assigned, banks are subject to shocks, which may turn some of their credits non-performing. If shocks are severe enough, the credits repaid may be insufficient to return all deposits. In this case, banks are forced to draw from the capital requirement to honor their deposits. If these funds are not enough the bank is forced into bankruptcy.

2.1. Product differentiation and entrepreneurs' utility

Entrepreneurs are located uniformly around the circle. Each entrepreneur has the option of undertaking or not a project of a common fixed size (normalized to one).[9] Entrepreneurs need a financial intermediary in order to obtain the funds to undertake their projects. Consider an entrepreneur l that decides to borrow from bank i which is located at a distance x_{li} from her location. Bank i charges a rate

[8] We do not provide a justification as to why the entrepreneur needs to use a financial institution rather than borrowing directly from the providers of funds. In the literature, there are many justifications for the need of financial intermediaries (see Freixas and Rochet, 1997). Instead, we take financial intermediation as given, as our focus is not to understand why we have financial intermediaries but how these institutions react to changes in the regulatory environment.

[9] We assume that the entrepreneurs' outside opportunity is sufficiently unattractive that they always choose to undertake the project, i.e. that the market is covered.

a_i for its loans and has a degree of specialization θ_i. The entrepreneur's utility if she borrows from this bank will be equal to:

$$U_{li}(\theta_i, x_{li}, a_i) = V(\theta_i) - \theta_i x_{li} - a_i,$$

where $V(\theta_i)$ satisfies $V'(\theta_i) > 0$ and $V''(\theta_i) < 0$. The first term represents the entrepreneurs' gross returns from undertaking the project. The second term represents the "transportation cost" of "travelling" the distance x_{li}. The last term represents the interest rate payment. This utility function implies that the higher θ_i, the higher the degree of specialization, the better will the bank satisfy the needs of the consumers located close to its own location. However, this improved appeal to closer clients implies that the bank will be a poorer intermediary for entrepreneurs located farther away, as the utility of entrepreneurs decreases linearly with distance from the bank at a rate given by the bank's degree of specialization.

Fig. 4 shows the utility of entrepreneurs, describing how it depends on the degree of specialization chosen by the bank. For $\theta_2 > \theta_1$, the curve $H(\theta_2)$ shows the entrepreneurs' utility obtained when the bank chooses a high degree of specialization, providing high utility for entrepreneurs located close to the bank and very little utility for those located farther away. Conversely, the curve $L(\theta_1)$ depicts the utility obtained from a bank which chooses a low level of differentiation. It does not provide such a good service to those entrepreneurs located close to its location but, at the same time, entrepreneurs' utility does not decrease as quickly with distance from the bank.

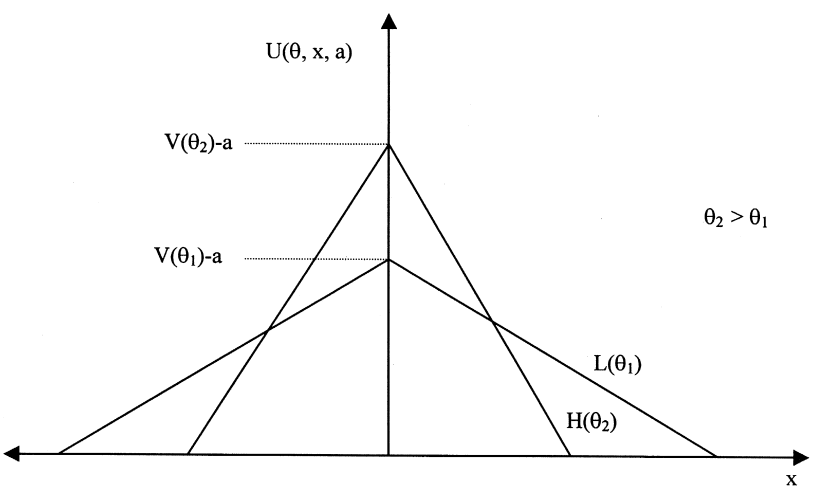

Fig. 4. Entrepreneurs' utility.

The entrepreneur l observes θ_i and a_i for every bank and chooses the bank that maximizes her utility:

$$i^* = \arg\max_{\{i\}} U_l(\theta_i, x_{li}, a_i).$$

As we said above, our characterization of product differentiation is appropriate for both the interpretation of regional and sectorial specialization. The bank caters its service to the characteristics of customers in a certain region or line of activity, investing resources and building expertise, so that transaction costs, valuation of collateral, evaluation of projects, monitoring, etc. are more appropriate to serve the entrepreneurs in this region or line of business. The higher the degree of specificity in the bank's activities, the lower the transaction costs or the better the project or collateral evaluation for the group of entrepreneurs belonging to the target group of the bank and, therefore, the higher their utility, but the lower the return for those not included in that group.

For example, each entrepreneur may have a portfolio of investment projects. Some of them may be very profitable but their evaluation requires specific knowledge; the others are less profitable, but easier to evaluate. If a bank builds expertise in evaluating project returns in a very particular line of business or geographical area, this will provide a high return for entrepreneurs in that area or sector, who will be able to get funding to undertake their specific projects, but it will be damaging to other entrepreneurs, who will have to resort to their less profitable projects to get funding.

2.2. Banks' profits

Banks are located symmetrically around the Salop circle. Each bank is allowed to locate in only one location. If a bank decides to enter the market, it has access to a pool of deposits at an interest rate p.[10] Then, it sets its lending rate a_i and the degree of specialization of its banking services θ_i. Jointly, these two variables determine the demand faced by the bank.

Consider an entrepreneur located between banks i and j. If the distance to bank i is $\hat{x}$ and the total number of banks is n, the distance to bank j equals $1/n - \hat{x}$, because the distance between the two banks in a symmetric equilibrium is $1/n$. The entrepreneur will be indifferent between using bank i and bank j if both give her the same utility level:

$$V(\theta_i) - \theta_i \hat{x} - a_i = V(\theta_j) - \theta_j \left[\left(\frac{1}{n} \right) - \hat{x} \right] - a_j.$$

[10] This fixed deposit rate, which does not depend on the bank's riskiness, can be viewed as the result of a deposit insurance scheme. Besanko and Thakor (1992) use a similar simplifying assumption.

Thus, bank i will provide loans to all entrepreneurs located from its location through $\hat{x}$, where:

$$\hat{x} = \frac{V(\theta_i) - V(\theta_j) - a_i + a_j + \left(\frac{\theta_j}{n}\right)}{\theta_i + \theta_j}.$$

Using symmetry, total demand for bank i is twice that amount:

$$D_i(\theta_i, \theta_{-i}, a_i, a_{-i}) = 2\hat{x}.$$

Banks are subject to shocks, which turn some of their assets non-performing. These shocks are described by a uniform distribution $s_i \sim U[0, \bar{S}]$. These shocks capture regional or sectorial specific shocks. If a bank concentrates in a particular line of business, lower demand or lower productivity will make many of its clients insolvent. If a bank concentrates in a particular region, any local negative shock will also imply a lower rate of repayment.[11] If the bank does not generate enough revenues from its assets to repay deposits, it has to draw from its own capital to return them. If this is not enough, the bank is declared bankrupt and the deposit insurance scheme takes responsibility for the residual fraction of depositors yet unpaid.

The use of capital requirements can be justified in our model from the fact that, with limited liability, banks will find convenient to transfer as much of the losses in unfavorable states of nature to the deposit insurer by choosing low levels of capitalization. If there are social bankruptcy costs, the government has an incentive to reduce the frequency of bankruptcies by imposing a minimum level of capital that banks have to commit in order to participate in the banking industry.

We denote this requirement by K, and we assume that its opportunity cost is precisely the deposit rate p. As no restrictions are imposed on the use of this capital requirement, banks will lend it. Thus, without bankruptcy, bank i's earnings equal:

$$\begin{aligned}&(1 + a_i) D_i(.) - \left[D_i(.) - K\right](1 + p) - K(1 + p) - s_i \\ &\quad = D_i(.)(a_i - p) - s_i.\end{aligned}$$

Bank i's profits equal the return on its loans $(1 + a_i)D_i$ minus the sum of the cost of deposits $(D_i - K)(1 + p)$, the opportunity cost of its capital $K(1 + p)$, and the shock faced by the bank s_i. This reduces to the mark-up on lending minus the shock, as in the last term above.[12]

[11] For simplicity we assume that the shocks affect the banks rather than the individual projects, representing a positive interdependence for the individual shocks suffered by the entrepreneurs of the same bank.

[12] We assume that the choice of the degree of specialization θ_i has no effect on banks' costs. Our results are robust to more general specifications in which supplying a specialized service has different costs than offering a more standard product.

These will be the bank's profits as long as it has the resources to pay depositors, i.e. as long as:

$$(1+a_i)D_i(.) - s_i \geq \left[D_i(.) - K\right](1+p),$$

which can also be written as:

$$(a_i - p)D_i(.) + K(1+p) \geq s_i.$$

If this condition is not satisfied, the bank is declared bankrupt and it loses the opportunity cost of having invested those resources in the banking activity, i.e. $K(1+p)$. Bank i's profit function can then be written as:

$$\pi_i = \begin{Bmatrix} (a_i - p)D_i(.) - s_i \\ -K(1+p) \end{Bmatrix} \quad \text{if} \quad \begin{Bmatrix} (a_i - p)D_i(.) + (1+p)K \geq s_i \\ (a_i - p)D_i(.) + (1+p)K < s_i \end{Bmatrix}. \tag{1}$$

Within this setup, we have to consider two possible scenarios. As specified in Eq. (1), a bank will go bankrupt if the shock faced is larger than $(a_i - p)D_i(.) + K(1+p)$. Thus, bankruptcy can arise if $(a_i - p)D_i(.) + K(1+p) < \bar{S}$. In this case, bank i's expected profits equal:

$$\begin{aligned} E(\pi_i) &= \int_0^{D_i(.)(a_i - p) + (1+p)K} \left(\frac{D_i(.)(a_i - p) - s}{\bar{S}} \right) \mathrm{d}s \\ &\quad + \int_{D_i(.)(a_i - p) + (1+p)K}^{\bar{S}} \left(\frac{-K(1+p)}{\bar{S}} \right) \mathrm{d}s \\ &= \frac{\left[D_i(.)(a_i - p) + (1+p)K\right]^2}{\bar{S}} - K(1+p). \end{aligned} \tag{2}$$

On the contrary, if $(a_i - p)D_i(.) + K(1+p) \geq \bar{S}$, shocks in the economy are so small in relative terms that no bank ever goes bankrupt. From Eq. (1), in this case bank i's expected profits equal:

$$E(\pi_i) = \int_0^{\bar{S}} \left(\frac{D_i(.)(a_i - p) - s}{\bar{S}} \right) \mathrm{d}s = D_i(.)(a_i - p) - \frac{\bar{S}}{2}. \tag{2'}$$

Whether there is a positive probability of bankruptcy depends on the relative size of K, p and $\bar{S}$. Appendix B shows that a necessary and sufficient condition for having a positive probability of bankruptcy is $K(1+p) < \bar{S}/2$. On the contrary, if $K(1+p) \geq \bar{S}/2$, banks never go bankrupt. Thus, depending on the size of the shocks faced by the financial sector relative to the capital requirements, we have two possible scenarios to consider: the *small-capital requirement* and the *large-capital requirement* economies. In general, if capital requirements impose a cost, it would be suboptimal for the regulator to set them at a level such that the probability of bankruptcy is zero. In fact, even in the most solid financial systems we observe frequent bank failures. Therefore, we concentrate here on the interest-

ing case of the *small-capital requirement* economy, leaving the analysis of the *large-capital requirement* economy for Appendix C.

2.3. Equilibrium in the small-capital requirement economy

If a bank decides to enter the market, it sets a_i and θ_i to maximize Eq. (2):

$$\underset{\{a_i,\theta_i\}}{\text{Max}} \frac{\left[D_i(\theta_i,\theta_j,a_i,a_j)(a_i-p)+(1+p)K\right]^2}{\bar{S}} - K(1+p).$$

Appendix A shows that the first order conditions in a symmetric equilibrium can be reduced to:

$$a^* = p + \frac{\theta^*}{n}, \tag{3}$$

and:

$$V'(\theta^*) = \frac{1}{2n}. \tag{4}$$

Appendix A also shows that $\varepsilon = (V''(\theta^*)\theta^*)/(V'(\theta^*)) < -1/2$ is sufficient for the second order conditions to be satisfied.

Eq. (3) shows that the optimal choice of a_i involves charging a mark-up over the deposit rate p. The mark-up charged by the bank is decreasing in the number of firms. As the number of banks rises, competition reduces market power. Notice, however, that the mark-up is increasing in the degree of specialization θ_i. When the degree of specialization rises, banking competition relaxes allowing the banks to charge higher mark-ups.

In turn, Eq. (4) solves for the optimal choice of θ_i, which, as shown in Appendix A, corresponds to the choice of θ_i that maximizes bank i's demand. At the optimum, the increase in demand from raising the entrepreneurs' gross return is exactly balanced by the demand loss from increasing the "transportation cost" to the marginal customer. The bank cannot increase demand any further by lowering or increasing θ_i. In this trade-off, when the rivals move further away, i.e. when the number of firms falls, banks can increase their demand by lowering θ_i. Thus, the optimal choice of differentiation depends on the distance to rivals. With a lower number of firms, banks compete for clients located further away choosing a lower degree of differentiation.

Combining Eqs. (3) and (4), it is unclear how the spread moves as the number of firms changes. There are two counter-balancing effects. A higher degree of concentration allows banks to increase interest rates. On the other hand, it induces lower specialization, and therefore, more competition and lower rates.

In order to close the model, we need to obtain the equilibrium number of firms. Substituting Eqs. (3) and (4) into Eq. (2), expected profits in equilibrium equal:

$$E(\pi^*) = \frac{K^2n^4(1+p)^2 - 2Kn^4\bar{S}(1+p) + 2Kn^2\theta^*(1+p) + \theta^{*2}}{2n^4\bar{S}}.$$

Using the free-entry condition which forces banks' expected profits to equal zero and ignoring the integer constraint, we obtain that for the only real positive root the equilibrium number of banks is equal to:

$$n^* = \sqrt{\frac{1+\sqrt{\dfrac{2\bar{S}}{(1+p)K}}}{2\bar{S}-K(1+p)}}\sqrt{\theta^*}. \tag{5}$$

Jointly with Eqs. (3) and (4), Eq. (5) completes a system of three equations with three endogenous variables.

2.4. The effects of capital requirements

We can now analyze the effect of capital requirements on our equilibrium variables a^*, θ^*, and n^*. Differentiating the systems (Eqs. 3–5) and evaluating it at the optimum we obtain:

$$\frac{\mathrm{d}n}{\mathrm{d}K} = \frac{V''(\theta^*)A}{J} < 0, \tag{6}$$

$$\frac{\mathrm{d}\theta}{\mathrm{d}K} = -\frac{A}{J2n^{*2}} < 0, \tag{7}$$

and:

$$\frac{\mathrm{d}a}{\mathrm{d}K} = -\frac{AV'(\theta^*)}{Jn^{*2}}\left[1+\frac{\theta^* V''(\theta^*)}{V'(\theta^*)}\right], \tag{8}$$

where:

$$A = \frac{\theta}{2n^*[2S-K(1+p)]} \times\left[\left(1+\sqrt{\frac{2\bar{S}}{K(1+p)}}\right)\frac{(1+p)}{\left[2\bar{S}-K(1+p)\right]}-\frac{1}{2K}\left(\frac{2\bar{S}}{K(1+p)}\right)^{1/2}\right],$$

and J, the Jacobian of the system:

$$J = V''(\theta^*)+\frac{V'(\theta^*)}{2\theta^*}.$$

It can easily be shown that A is negative as long as $K(1+p)<\bar{S}/2$, which is satisfied for the *small-capital requirement* economy, and that J is negative under our assumption of $\varepsilon=(V''(\theta^*)\theta^*)/(V'(\theta^*))<-1/2$.

Eq. (6) delivers the result that the larger the capital requirement, the lower the number of financial institutions. Intuitively, the more stringent the capital requirements, the higher the fixed cost of running a bank, and therefore, the lower the number of banks that can recover that cost. Eq. (7) shows that the higher the level of capital requirements, the lower the degree of differentiation chosen by the banks. This result is also intuitive. As discussed before, when concentration increases, banks compete to capture the demand of entrepreneurs located further away by lowering their degree of product specialization.

The effect of an increase of the capital requirement on the financial spreads is, however, ambiguous. An increase in capital requirements reduces the number of banks. On the one hand, the enlarged market power induces a higher a^*. On the other hand, the reduction in the number of banks reduces the level of product specialization strengthening competition and rendering a reduction of a^*. Which of these two effects predominates depends on the elasticity of the marginal value of product specialization. From Eq. (8), it is easy to see that $\mathrm{d}a/\mathrm{d}K$ is positive for $\varepsilon < -1$ and $\mathrm{d}a/\mathrm{d}K$ is negative for $-1 < \varepsilon < -1/2$.[13]

When $V'(\theta_i)$, the marginal utility of product specialization, is elastic, a small reduction in θ_i is enough to accommodate the fall in the number of firms (induced by an increase in capital requirements) in order to satisfy Eq. (4). In this case, the concentration effect predominates over the product differentiation effect in Eq. (3). However, when $V'(\theta_i)$ is inelastic, a large fall in θ_i is required to accommodate the reduction in the number of firms. In this case, the product differentiation effect predominates over the concentration effect rendering a negative total effect on a^*. The model shows that it is possible that a more stringent prudential regulation leads to lower spreads. In short, *fewer banks and more competition*.

2.5. Welfare

We can now use our model to analyze the solvency vs. competition trade-off faced by the regulator when choosing the optimal level of capital requirements. Capital requirements affect social welfare through two channels. On the one hand, higher capital requirements improve the solvency of the financial sector. The reduction in financial distress improves social welfare through a myriad of mechanisms: bailout costs, deposit insurance costs, and macro spill-over costs of bank-runs.[14] Although our partial equilibrium model does not allow us to analyze explicitly these social costs, Appendix D shows that, in our model, higher capital requirements induce lower probabilities of bankruptcy reducing the expected bankruptcy costs. On the other hand, the level of capital requirements affects

[13] The sign of the second factor in Eq. (8) depends on whether ε is smaller or larger than -1. However, the second order conditions restrict ε to be smaller than $-1/2$.

[14] See Dewatripont and Tirole (1994) and Freixas and Rochet (1997).

welfare in the financial intermediation market. We concentrate here on this partial equilibrium welfare effect, which should be added to the solvency welfare effect.

For evaluating welfare in the financial market, we only need to consider the welfare of entrepreneurs, as depositors always receive the deposit rate p and expected equilibrium banks' profits are always zero. For bank i's customers, welfare is given by:

$$w_i = 2\int_0^{\hat{x}} \left(V(\theta_i) - \theta_i x - a_i\right) \mathrm{d}x.$$

In the symmetric Nash equilibrium, total entrepreneurs's welfare is given by:

$$W = n^* w^* = 2n^* \int_0^{1/(2n^*)} \left(V(\theta^*) - \theta^* x - a^*\right) \mathrm{d}x$$

$$= V(\theta^*) - \frac{\theta^*}{4n^*} - a^*.$$

Therefore, the effect of capital requirements on entrepreneurs' welfare is:

$$\frac{\mathrm{d}W}{\mathrm{d}K} = \left[V'(\theta^*) - \frac{1}{4n^*}\right]\frac{\mathrm{d}\theta}{\mathrm{d}K} + \frac{\theta^*}{4n^{*2}}\frac{\mathrm{d}n}{\mathrm{d}K} - \frac{\mathrm{d}a}{\mathrm{d}K}$$

$$= \frac{AV'(\theta^*)}{Jn^{*2}}\left[\frac{3}{4} + \frac{5}{4}\varepsilon\right] > 0 \Leftrightarrow \frac{-3}{5} < \varepsilon.$$

For $\varepsilon < -1$, higher capital requirements increase solvency at the cost of higher spreads in the financial sector (the traditional result). For $-1 < \varepsilon < -3/5$, while capital requirements improve solvency and lower spreads, entrepreneurs' surplus is reduced because the benefits of enhanced competition are outweighted by the reduction in product specificity. Only in the range $-3/5 < \varepsilon < -1/2$, the effect of tougher competition dominates the loss in product specificity leading to larger surplus for the entrepreneurs. Thus, our welfare results say that for any $\varepsilon < -3/5$, the regulator faces a trade-off. By increasing capital requirements, social welfare increases due to improved solvency, but decreases through lower surplus in the financial markets. However, in the interval $-3/5 \leq \varepsilon < -1/2$, there is no trade-off. When increasing capital requirements, the social planner increases welfare through both channels: improved solvency and tougher competition.

3. Regulation, competition and product differentiation in the Argentine financial sector

Through a reduction in product differentiation, our model derives that a tightening in capital requirements may induce, simultaneously, tougher competition (lower spreads) and higher concentration. Thus, the model may help to understand the stylized facts occurred in the Argentine financial sector during the 1990s. In this section, we document the tightening in prudential regulation, the increase in concentration and the reduction in spreads experienced in Argentina.

We also present evidence of a reduction in product differentiation in the industry. Finally, we discuss the relevance of our explanation relative to competing hypotheses which may also account for the evidence.

Shortly after the launch of the Convertibility Plan in 1991, Argentina's capital markets were significantly deregulated, including the transformation of the Central Bank in a politically independent entity.[15] The independent Central Bank implemented a substantial tightening of prudential regulation.[16] In September 1991, the Central Bank adopted the recommendations of the Basle Committee on Banking Regulations and Supervisory Practices on capital adequacy.[17] Fig. 1 depicted the drastic increase in the risk-weighted asset/equity ratio established as capital requirement from 1991 through 1999. Moreover, a series of complementary measures have been implemented since. Starting in 1993, capital requirements were adjusted depending on the CAMEL classification of the financial institution. In September 1996, an additional requirement was implemented to take into account the market risk of bank assets with market valuation. In December 1998, the Central Bank eliminated the allowance to satisfy the capital requirement with loan provisions. Previously, banks were allowed to count complementary capital up to 1% of total assets to comply with the regulation.[18] Finally, in March 1999, the liability mismatch risk was also incorporated in the capital requirement regulation. As a result, Argentina's capital requirement regulation is now substantially tighter than the BIS standards.

Other prudential measures were also taken during this period. The Central Bank has imposed restrictions on the amount of credit granted to individual customers and implemented a loan classification system. Loan provisions are set on the basis of this classification. Non-interest earning reserve requirements have been substituted by requirements based on the liquidity of the liabilities. These funds must be invested in specific instruments, and a fraction must be held in highly liquid assets outside Argentina. Banks are required to have at least one rating from an internationally recognized rating agency. In some cases, two ratings are mandatory. A deposit insurance system was set up and the Central Bank forces banks to buy a collective contingent repo facility with foreign banks.[19] In short, there has been a substantial tightening in prudential regulation, and capital requirements have played an essential role in this process.[20]

[15] See Sturzenegger (forthcoming).

[16] See BCRA (1997, 1998), Bankwatch® (1998) and Powell (1999).

[17] Prior to September 1991, capital requirements were not defined in terms of a risk-weighted asset/equity ratio, but just fixed in absolute amounts.

[18] Complementary capital includes loan provisions and some debt issues.

[19] For a review of this regulation see Bankwatch® (1998) and BCRA (1998).

[20] In 1994, policymakers were concerned about the fragility of the financial sector (Fernández and Guidotti, 1994). By 1998, Argentina tops the list, together with Singapore, in terms of prudential regulation in Caprio's (1998) classification.

Table 1
Participation of local, regional and national banks

	Participation in number of banks (in percentage)			Participation in deposits (in percentage)		
	Local	Regional	National	Local	Regional	National
1994	47.3	33.6	18.3	27.0	16.8	56.2
1999	40.0	30.0	30.0	19.5	11.2	69.3

Source: BCRA.

As discussed in the Introduction, the tightening of regulation came together with a significant reduction in the number of banks and a fall in spreads. Fig. 2 depicted the process of concentration in the local financial sector. The concentration index $C(10)$ grew from less than 25% in June 1993 to more than 40% in January 1999. The number of banks fell from 166 to 102 during the same period.[21] Fig. 3 measured the return to financial intermediation for Argentina's 20 largest banks as of January 1999. This rate of return is calculated as interest plus service income as a fraction of bank assets. Margins have decreased over the last 5 years, dropping from about 11% to about 6% per year.

Because our model relies on a reduction in product differentiation to explain the coexistence of the stylized facts that we observe in Argentina, we analyze the evolution of product specialization in the Argentine banking industry in recent years. In the case of the banking industry, product differentiation can be of two types: geographical or sectorial.

We measure geographical differentiation in two ways. First, by comparing the area of operation of different institutions. Table 1 compares the participation of local, regional and national banks in 1994 and 1999. Local banks are defined as those which operate in only one province, regional banks are those which operate in two to four provinces, and the remainder are classified as national banks.[22] The table shows a decrease in the participation of local and regional banks in favor of national banks, both in terms of the number of institutions as in deposit shares.

Second, we measure geographical differentiation at the micro level by the distance from each branch location to the closest branch of a rival bank within a

[21] The process of financial consolidation was substantially facilitated through the modification to the Law No. 21.526 (Financial Entities Law) enacted shortly after the Tequila crisis. In its new version, Law 21.526 allows the Central Bank to transfer assets and liabilities (including deposits) of a financial institution which was about to be liquidated to an acquiring bank, before bringing the remainder of assets and liabilities to the standard judicial bankruptcy process.

[22] We excluded for this computation branches located in the capital city of Buenos Aires as almost every bank has a branch in Buenos Aires.

Table 2
Average distance between branches

City	Average minimum distance (in blocks)	
	1994	1998
La Plata	3.83	3.14
San Isidro	2.06	1.97
Olavarría	1.72	1.08

Source: Calculated from BCRA "Guía de Entidades Financieras" 1994 and 1998.
Minimum distance is the distance between each bank branch and its nearest competitor's branch.

city. For this exercise, we chose three cities: a medium sized city (La Plata), a small town (Olavarría) and a suburb of Buenos Aires (San Isidro). Table 2 shows that, in all cases, bank branches are closer, indicating decreased geographical differentiation.

Regarding sectorial differentiation, we provide three measures of a decreasing degree of product specialization. First, Table 3 shows the participation of cooperative banks in the financial sector. Cooperative banks usually concentrate lending in the very narrow market niches in which their shareholders produce. The decrease in their participation indicates a standardization in lending practices. Second, evidence from the mortgage market presented in Table 4 shows that the participation of loans provided by brokers and public notaries has decreased between 1991 and 1999 from 55% of the total to only 13%. Brokers and public notaries provide loans to real estate purchasers with funds they intermediate for small investors. They operate on a personal basis, with direct knowledge of both lenders and borrowers. The decreased relevance of these financial intermediaries indicates the standardization of lending procedures. Finally, Table 5 shows the variation in

Table 3
Participation of cooperative banks

	Participation in number of banks (in percentage)	Participation in deposits (in percentage)
1993	21.0	7.8
1994	20.2	8.5
1995	7.1	3.2
1996	6.6	3.3
1997	4.5	2.5
1998	3.8	2.0

Source: BCRA.

Table 4
Participation in mortgage loans

	Brokers (in percentage)	Public notaries (in percentage)	Banks (in percentage)
1991	12	43	45
1993	5	33	62
1999	3	10	87

Source: Ernst and Young.

lending practices for the top 20 banks. The table measures the standard deviation across banks in the share of the main types of loans (advances, promisory notes, mortgages, lien notes and personal notes) in the banks' portfolios. The table shows a convergence in the loan structure of the major financial institutions, indicating a homogenization of lending practices.

While our model accounts for the stylized facts observed in Argentina, other explanations should also be considered. One possible hypothesis is that the tightening of prudential regulation may have reduced the number of financial institutions in a non-neutral way. If banks with lower capitalization are more likely to gamble because they have less equity at stake, they will earn on average higher returns. If, in addition, the increase in capital requirements was most binding for

Table 5
Portfolio dispersion across banks

	Standard deviation of portfolio shares by type of loan				
	Advances	Promisory notes	Mortgage notes	Lien notes	Personal loans
Jun 1993	0.183	0.170	0.209	0.055	0.069
Dec 1993	0.157	0.170	0.200	0.056	0.076
Jun 1994	0.154	0.157	0.203	0.053	0.075
Dec 1994	0.161	0.138	0.202	0.054	0.074
Jun 1995	0.165	0.180	0.202	0.046	0.077
Dec 1995	0.155	0.154	0.196	0.045	0.074
Jun 1996	0.165	0.167	0.186	0.041	0.075
Dec 1996	0.163	0.186	0.195	0.043	0.066
Jun 1997	0.170	0.176	0.192	0.040	0.086
Dec 1997	0.157	0.176	0.200	0.051	0.071
Jun 1998	0.130	0.130	0.198	0.061	0.063
Dec 1998	0.134	0.150	0.195	0.058	0.043

Source: BCRA.
For each loan type, the table shows the standard deviation of the share of each type of loan in total loans across the largest (by loans at each period) 20 banks.

these firms, they would have been the first to exit.[23] Thus, the stricter regulation could have eliminated high-risk institutions with higher than average returns, which, in turn, could have generated a decrease in average spreads. However, the data presented in Fig. 2 show the evolution of average spreads for the 20 largest banks as of 1999. Given that the decrease in spreads holds for a fixed group of banks, this reduction in spreads cannot be explained by the hypothesis of elimination of high-risk players.

A related hypothesis is that the decrease in spreads arises from a reduction in banks' risk-taking induced by the implementation of capital requirement regulations which incentive the holding of a more conservative portfolio.[24] This more cautious approach to risk-taking can be reflected in a change in the composition of loan portfolios in favor of safer assets. However, the reduction in spreads has taken place within each loan segment. For example, Fig. 5 shows a decrease in spreads even in the mortgage market, which has the lowest risk level.

In addition to the effect of changes in prudential regulation, during this period Argentina's financial sector also experienced other structural transformations which may explain our stylized facts. One hypothesis is that the liberalization of capital markets allowed foreign banks to participate in the domestic financial sector, even without opening a local branch. Thus, the total number of banks operating in the market could have increased, had we considered international intermediaries. In short, our measures of concentration could be misleading. However, the reduction in spreads has also taken place in segments with no international participation such as the mortgage market, as shown in Fig. 5.[25]

Finally, the process of globalization and privatization may have improved the efficiency of the financial sector, reducing spreads through a reduction in banks' costs.[26] For example, Dick (1996) shows that the system has experienced substantial cost reduction and improvements in X-efficiency.[27] However, cost reductions should be associated with an increase in the number of firms under free entry, which is at odds with the evidence.

[23] This could be exacerbated due to the fact that capital requirement regulations penalize risk-taking.

[24] Brock and Rojas Suarez (1998) develop this view and test the hypothesis for emerging economies.

[25] The literature has studied extensively how increased competition may arise from a reduction in regulatory restrictions that inhibited bank competition. These encompass at least three different interpretations of a fall in entry barriers: despecialization (e.g. competition between commercial banks and non-bank financial institutions), globalization (e.g. cross-border lending or relaxation of limits to foreign participation), and elimination of branching restrictions (e.g. relaxation of limits to the participation of other domestic banks). In the case of Argentina, only cross-border lending regulations exhibited significant changes. See Mishkin (1996) on the issue of branch banking and Cordella and Levy Yeyati (1998) on the issue of financial sector globalization.

[26] Cost reductions in financial intermediation could have also taken place due to the significant reduction in country risk experienced in Argentina during this period.

[27] See also Burdisso et al. (1998) for an evaluation of the impact of privatizations.

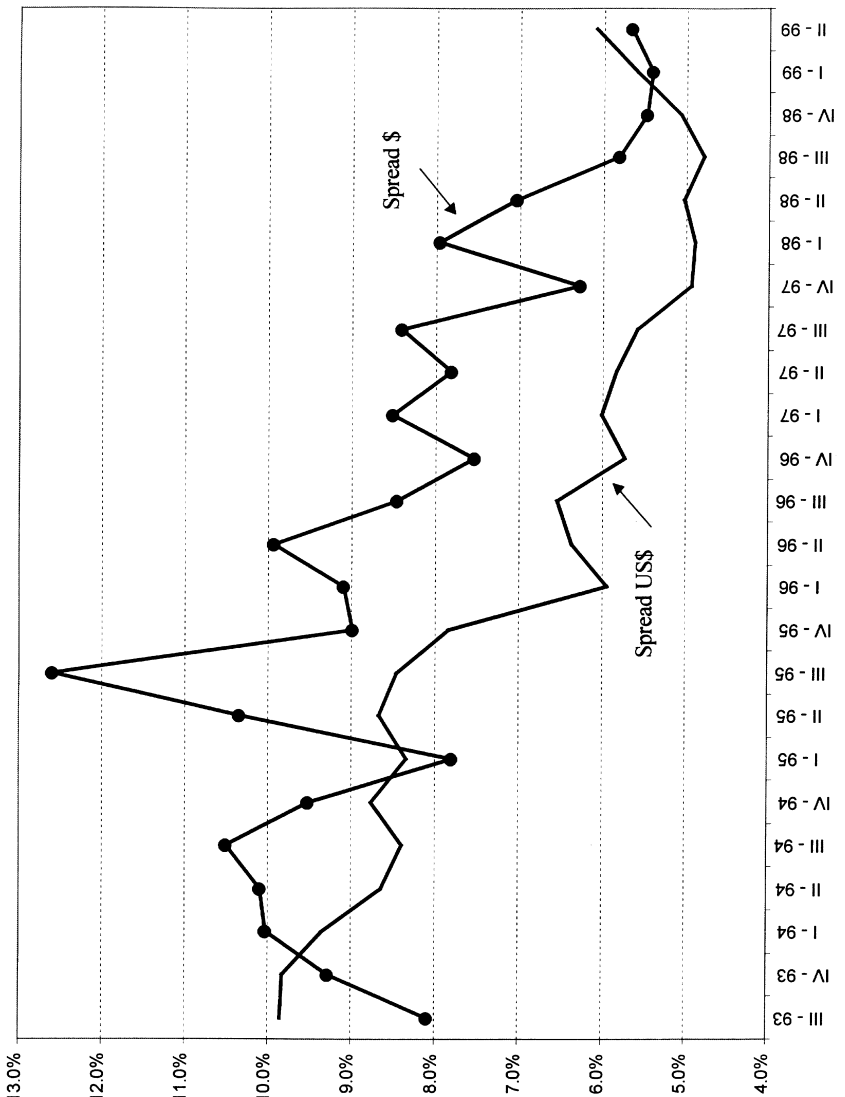

Fig. 5. Mortgage market spreads. Source: BCRA.

In short, while we do not rule out that reductions in costs and risk-taking might be part of the story, we think that tougher competition induced by a reduction in product differentiation, both in the geographical and sectorial dimensions, has played an essential role in explaining the recent developments in the Argentine financial sector.

4. Conclusions

The traditional view predicts a trade-off between solvency and competition in banking regulation. Our model shows that, once product differentiation is endogenized, this trade-off does not necessarily exist. A tightening in prudential regulation that leads to increased concentration may also induce banks to compete more strongly by offering less differentiated products.

If this is the case, capital requirements may not necessarily be costly, as they may lead simultaneously to a more solvent and a more competitive financial sector. Obviously, one should be cautious when going from the model to reality. First of all, our model has an ambiguous policy implication: spreads could go up or down with prudential regulation. However, even when spreads decrease, our results should not be interpreted as suggesting that capital requirements should be increased to infinity. The results are only valid for oligopolistic competition (as they have been derived assuming at least two banks). As capital requirements increase, the market could become monopolized. Moreover, increased capital requirements may become eventually redundant, rendering no effect from that point on. In fact, this can happen even with a relatively large number of banks.

The specification can be extended in several ways. Although in the model product differentiation is horizontal, i.e. banks compete offering different qualities, banks can also compete under vertical product differentiation, with high-quality banks specialized in financing safe projects and low-quality banks specialized in riskier projects (Apt and Schargrodsky, 1996). In this case, the tightening of capital requirements could also result in more competition by narrowing the product spectrum. Moreover, while we have considered the effect of capital requirements, the analysis applies to other forms of regulation with an impact on market participation. Thus, the model can be applied to a broader set of issues that go beyond the adoption of BIS standards. Finally, we believe the explanation has the potential of being applied to other sectors of economic activity which have also experienced simultaneous changes in concentration and product differentiation.

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Appendix A. First and second order conditions

Assuming symmetry, the first order conditions for the *small-capital requirement* economy are obtained from maximizing Eq. (2) with respect to θ_i and a_i:

$$\frac{\partial E(\pi_i)}{\partial a_i} = -\frac{(a_i + Kn - p)(a_i n - np - \theta_i)}{n^2 \theta_i \bar{S}} = 0, \tag{A.1}$$

$$\frac{\partial E(\pi_i)}{\partial \theta_i} = \frac{(a_i - p)(a_i + Kn - p)(-1 + 2nV'(\theta_i))}{2n^2 \theta_i \bar{S}} = 0. \tag{A.2}$$

Eq. (A.1) has two solutions. However, one implies a credit rate lower than the deposit rate. Thus, the correct solution is the one shown in Eq. (3). Eq. (A.2), using the appropriate solution to Eq. (A.1), gives the solution shown in Eq. (4).

To obtain the second order conditions we differentiate the expected profit function twice with respect to θ_i and a_i. Under symmetry and in the optimum, this gives:

$$\left.\frac{\partial^2 E(\pi_i)}{\partial \theta_i^2}\right|_{a^*,\theta^*,n^*} = \frac{[2Kn^{*2} + 3\theta^* - 4(Kn^{*3} + 2n^*\theta^*)V'(\theta^*) + 4n^{*2}\theta^*(V'(\theta^*))^2 + 4n^*\theta^*(Kn^{*2} + \theta^*)V''(\theta^*)]}{4n^{*4}\bar{S}\theta^*} < 0,$$

$$\left.\frac{\partial^2 E(\pi_i)}{\partial a_i^2}\right|_{a^*,\theta^*,n^*} = -\frac{2(Kn^{*2} + \theta)}{n^{*2}\bar{S}\theta^*} < 0.$$

The Hessian can be shown to equal:

$$H = \left.\left[\frac{\partial^2 E(\pi_i)}{\partial a_i^2}\frac{\partial^2 E(\pi_i)}{\partial \theta_i^2} - \left[\frac{\partial^2 E(\pi_i)}{\partial \theta_i \partial a_i}\right]\right]\right|_{a^*,\theta^*,n^*}$$

$$= -\frac{(Kn^{*2} + \theta^*)[2Kn^{*2} + 3\theta^* - 4(Kn^{*3} + 2n^*\theta^*)V'(\theta^*) + 2(Kn^{*4} + 3n^{*2}\theta^*)(V'(\theta^*))^2 + 4n^*\theta^*(Kn^{*2} + \theta^*)V''(\theta^*)]}{2n^{*6}\bar{S}^2\theta^{*2}},$$

where $\varepsilon = (V''(\theta^*)\theta^*)/(V'(\theta^*)) < -1/2$ is a sufficient condition for $H > 0$.

Appendix B. The small-capital requirement economy

Bankruptcy can arise whenever $(a_i - p)D_i(.) + K(1+p) < \bar{S}$. Using Eqs. (3)–(5), in the symmetric Nash equilibrium this condition reduces to:

$$\bar{S} > \frac{\theta^*}{n^{*2}} + K(1+p) = \frac{2\bar{S} - K(1+p)}{1 + \sqrt{\dfrac{2\bar{S}}{K(1+p)}}} + K(1+p) \Leftrightarrow \frac{\bar{S}}{2} > K(1+p).$$

Thus, the probability of bankruptcy is positive when the capital requirements are small relative to the shocks in the economy.

Appendix C. The large-capital requirement economy

The first order conditions for the *large-capital requirement* economy are obtained from maximizing Eq. (2′) with respect to θ_i and a_i. In the symmetric Nash equilibrium, a^* and θ^* are again defined by Eqs. (3) and (4). Substituting them into Eq. (2′), equilibrium profits are now equal to:

$$E(\pi^*) = \frac{\theta^*}{n^2} - \frac{\bar{S}}{2},$$

which gives, under free entry, an equilibrium number of banks:

$$n^* = \frac{\sqrt{2\theta^*}}{\sqrt{\bar{S}}}. \tag{5′}$$

In the *large-capital requirement* economy, capital requirements are so high that they do not have any effect on the equilibrium number of firms and, therefore, on the equilibrium of the system. We will be in this case when the probability of bankruptcy is zero, i.e. whenever $(a_i - p)D_i(.) + K(1+p) \geq \bar{S}$. Using Eqs. (3), (4) and (5′), in the symmetric Nash equilibrium, this condition reduces to:

$$\bar{S} \leq \frac{\theta^*}{n^{*2}} + K(1+p) = \frac{\bar{S}}{2} + K(1+p) \Leftrightarrow \frac{\bar{S}}{2} \leq K(1+p).$$

Appendix D. Bankruptcy probability

Bank i's probability of bankruptcy in the *small-capital requirement* economy is given by:

$$P(\text{bankruptcy}) = P\big(s_i > D_i(.)(a_i - p) + (1+p)K\big),$$

which, in equilibrium, and given the uniform distribution of the shocks, reduces to:

$$P\left(s > \frac{\theta^*}{n^{*2}} + K(1+p)\right) = 1 - \left[\frac{2 + \sqrt{\frac{2K(1+p)}{\bar{S}}}}{1 + \sqrt{\frac{2\bar{S}}{K(1+p)}}}\right],$$

which is clearly decreasing in K. Thus, as expected, the capital requirements have a positive effect on banks' solvency.

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