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Switching costs and financial stability

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SWITCHING COSTS AND FINANCIAL STABILITY*

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We establish that the effect of intensified deposit market competition, measured by reduced switching costs, on the probability of bank failures depends critically on whether we focus on competition with established customer relationships or competition for the formation of such relationships. With inherited customer relationships, intensified competition (i.e., lower switching costs) destabilizes the banking market, whereas it stabilizes the banking market if we shift our focus to competition for the formation of customer relationships. These findings imply that the proportion between new and locked-in depositors is decisively important when determining whether intensified competition destabilizes the banking market or not.

KEYWORDS: *Deposit market competition, financial stability, bank failures, switching cost, competition versus stability tradeoff*

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1. Introduction

Since the 1990´s a spectrum of influential studies, comprising theoretical, policy-oriented as well as empirical ones, has focused on the fundamental question of whether there is a tradeoff between competition and stability in banking (see Carletti and Hartmann (2003) for a literature survey and Allen and Gale (2004) for a synthesis of various theories). In this study we will re-address this issue by applying a two-period switching cost model designed to characterize the effects of intensified competition in the deposit market on the probability of bank failures. Such a switching cost approach to assess the relationship between competition and financial stability in banking is justified in light of convincing empirical evidence according to which switching costs are a significant source of market power in banking (for example, Shy (2002), Stango (2002), and Kim et al (2003)).

In the present study we demonstrate that the effect of intensified deposit market competition on the probability of bank failures depends critically on whether we focus on competition with established customer relationships or competition for the formation of such relationships. With inherited customer relationships, intensified competition in the deposit market destabilizes the banking market, whereas it stabilizes the banking market if we shift our focus to the stage at which banks compete for the formation of customer relationships. Thus, the proportion of new, unattached depositors relative to the locked-in depositors is a decisively important factor when determining whether intensified competition tends to destabilize the banking market or not.

In his influential study, Keeley (1990) formalizes the idea that increased market power[1] will reduce the risk-taking incentives of banks. Through this mechanism there will be a tradeoff between competition and stability in the sense that intensified competition will promote fragility of the banking market. Boyd and De Nicolo (2005) highlight the role of banks as intermediaries, lending to entrepreneurs with incentives of their own, implying that the return distributions of the banks are endogenous. By incorporating such a modification Boyd

[1] Keeley (1990) refers to market power as the charter or franchise value of banks.

and De Nicolo (2005) find that intensified lending market competition induces more stable banking markets[2]. Martinez-Miera and Repullo (2010) extend the approach developed by Boyd and De Nicolo (2005) by taking into account that a lower lending rate does not only increase the probability that a borrower can meet the debt obligation, but it also reduces the bank´s returns from performing loans. Taking that effect into account, Martinez-Miera and Repullo (2010) show that there will be a non-monotonic, U-shaped relationship between competition and the risk of bank failures.

To the best of our knowledge there are no previous studies that would have explored the theoretical mechanisms underlying the relationship between switching costs and banking market stability. Brown et al. (2014) document how increased switching costs slowed down withdrawals from two large distressed banks in Switzerland in the financial crisis of 2008-2009. Such a result appears to provide support for Basel III liquidity regulations that allow banks with stickier deposits to hold less liquidity. However, one key contribution of our study is to show that switching costs also have stability implications from an ex ante perspective when banks compete for deposits. Therefore Basel lll liquidity regulations emphasizing tighter depositor relationships as a stability-promoting feature of bank funding may be partially misleading: While stickier deposits certainly constitute a more stable source of funding for banks, they may not necessarily be conducive for bank stability from an ex ante perspective. Furthermore, our results suggest that policy proposals such as bank account number portability (see, e.g, FCA (2015)) with the aim of promoting competition in the banking industry by lowering depositor switching costs should be assessed from the point of view of stability.

Policy discussions regarding financial stability are closely linked to views regarding the relationship between competition and financial fragility. For example, the adoption and design of capital requirements build on the idea that such requirements discipline the risk-taking incentives of banks. But, as Repullo (2004) emphasizes, to the extent that capital regulation reduces franchising values of banks, it may also promote risk-taking in line with

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[2] Koskela and Stenbacka (2000) reach a similar result - the absence of a tradeoff between lending market competition and financial stability - in their analysis with endogenous lending volumes.

Keeley´s hypothesis, thereby discouraging banking stability. Thus, the design of an optimal policy with respect to capital requirements depends fundamentally on the relationship between competition and stability, in particular with banking markets characterized by imperfect competition.

The banking industry typically operates within the framework of an institutional and legal environment such that stability concerns are addressed by financial supervisory authorities, often linked to the central banks, whereas competition concerns are dealt with by the competition authorities. These authorities typically operate very independently from each other. However, the existence of a potential systematic relationship between competition and stability leads Vickers (2010) to ask whether it is optimal that stability policies are conducted independently of competition policy as far as the banking industry is concerned[3]. As Vickers (2010) points out, for example during the financial crisis stability concerns induced the European Commission to support the banking industry in ways which were hardly consistent with established European competition policy regarding state aid.

Our study proceeds as follows. In Section 2 we describe the two-period model of deposit market competition with switching costs. Section 3 characterizes the period-2 deposit rate equilibrium and explores its properties as far as the implications for banking stability are concerned. Section 4 conducts a similar analysis at the stage when banking relationships are formed. Section 5 offers discussions regarding important modelling features. In Section 6 we present concluding comments. Formal mathematical proofs can be found in the Appendix.

2. Deposit Market Competition with Switching Costs: The Framework

We consider a risk-neutral economy with two banks, A and B, a continuum of depositors, and three dates *t*=0, 1, 2. The banks apply the discount factor $\delta \in [0,1]$ per period.

Each depositor has one unit of capital at *t*=0, and access to an outside investment opportunity with a rate of return normalized to zero. The banks compete for deposits at *t*=0 and *t*=1 by offering standard one-period deposit contracts that amount to a promise to pay a fixed interest

[3] Similar issues have been raised by, for example, Beck (2008) and Beck et al (2010).

rate at t+1 on the depositor's unit of capital. For simplicity, we assume that deposits are fully insured.[4] As a result, the volume of deposits offered to a bank depends only on the banks' deposit rates. Retail deposits also constitute the only source of funds for the banks in our model.

The banks have exclusive access to a one-period stochastic investment technology, meaning that the banks' investment projects materialize each period. More precisely, we assume that the investment activities of bank i (i=A, B) at date t yields a gross return of ρ_{t+1}^{i} at date t+1. For reasons of tractability, we assume that $\rho_{t+1}^{i} \sim U[0, \bar{\rho}]$, *i.i.d*. In words, the returns are uniformly distributed on the interval $[0, \bar{\rho}]$ and they are identically and independently distributed over time and across the competing banks.

Whereas we take the banks' investments as exogenous, the banks influence their risks, and, in particular, the probabilities of bank failures via their choices of deposit interest rates. Stochastic returns associated with the investment activities may render the value of a bank's assets smaller than the value of its deposit liabilities both at t=1 and t=2. In such a case the bank becomes insolvent. A bank that is insolvent at t=1 is not allowed to accumulate deposits and participate in the competition for date-2 profits. If the bank survives, it meets the contractual obligation to its depositors. Further, for simplicity, we assume that at t=1, a surviving bank distributes all the profits to its owners, and depositors consume the interest rate earned from date-0 deposits. As a result, the deposit markets are subject to identical capital endowments of banks and depositors at t=0 and t=1.

At t=0 banks compete for depositors who are ex ante identical, and competition is intense at this stage as there are no established competition barriers. Deposit market competition at t=1 is constrained by the presence of switching costs for the depositors. Such switching costs serve as a source of market power for banks. The presence of switching costs is often considered to be a typical feature of banking markets. For example, the evidence presented in Shy (2002), Stango

[4] As we focus on competition for retail deposits, our assumption of complete deposit insurance seems to be a sufficiently good representation of the banking industry. Currently, deposit insurance coverage is limited to €100 000 in the European Union and to $250 000 in the United States. However, in most countries no limits are placed on the number of protected accounts held with different banks. Shy et al (2015) explore the effects of limited deposit insurance coverage on the intensity of deposit market competition, on consumer welfare and on total welfare.

(2002) and Kim et al (2003) suggests that banking markets are characterized by significant switching costs, and that these costs are differentiated across customers. Further, Brown et al (2014) present evidence for how switching costs may limit retail deposit withdrawal even when banks face distress.

Formally, the switching costs of a depositor indexed by *s* are captured by $c(s) = \sigma s$, where s is uniformly distributed on the unit interval $[0,1]$. We can attach two different interpretations to the parameter σ. One interpretation is that the parameter σ captures the expected magnitude of the switching costs facing all depositors. Alternatively, we could view σ as a measure of the heterogeneity of the switching costs across all depositors. In the present analysis we will not separate between the expected magnitude and the dispersion of the switching costs. We will simply refer to σ as a measure of the magnitude of the switching costs.[5]

In sum, in the deposit market banks compete at *t*=0 for unattached depositors by promising to pay a gross interest rate r_1^i (i=A, B) for each unit of capital deposited at *t*=1. Contingent on the customer relationships formed at *t*=0, the banks compete again at *t*=1 by offering deposit rates r_2^i. We assume that the banks compete in uniform deposit rates, which are the same for all depositors irrespective of their customer histories.[6] Nonetheless, we repeat that deposit rate

[5] It would be possible to separate the effects associated with the expected switching costs from those associated with the dispersion by assuming that the switching costs are distributed on an interval $[\theta - \omega, \theta + \omega]$ such that θ measures the mean and ω measures the dispersion. However, such an extension would take place at the expense of transparency of the presentation as it would increase the number of model parameters.

[6] The analysis could be conducted by focusing on history-based deposit rates such that each bank separates the deposit rates offered to their existing customers from the poaching rates offered to their rival´s customers. That would increase the number of relevant deposit rates offered at *t*=1 from two to four. Gehrig and Stenbacka (2007) analyze that type of history-based pricing in their study of information exchange in the lending market. However, history-based pricing seems to play a bigger role in the lending market than in the deposit market, because factors such as asymmetric information regarding borrowers characteristics and the ability of banks to learn about the creditworthiness of their own customers provide a strong reason the application of history-based lending rates.

competition at t=1 is subject to bank market power generated by the switching costs as well as to the switching option on behalf of the depositors.

We analyze the model by proceeding backwards. We first determine the deposit market equilibrium at t=1, conditional on the customer relationships inherited from t=0. The equilibrium deposit rates determine the probability that a bank fails at t=2. Subsequently, we characterize the date-0 deposit market competition, which determine the failure probabilities as well as the market shares of banks at t=1.

3. Deposit Rate Competition at t=1

At t=1, depositors choose whether they continue the banking relationship established at t=0, i.e., keep their unit of capital in the same bank as they chose at t=0, or whether they transfer their unit of capital to the rival bank. We let μ ($0 \leq \mu \leq 1$) denote the market share inherited by bank A from t=0, meaning that bank B enters into date-1 competition with a market share of $1-\mu$.

Consider a depositor having an inherited customer relationship with bank A. If bank A offers the deposit rate r_2^A and bank B offers r_2^B, a customer with switching costs $\hat{s}^A$ satisfying the condition $\hat{s}^A=(r_2^B-r_2^A)/\sigma$ is indifferent between staying loyal to bank A and switching to bank B. Clearly, customers belonging to bank A´s inherited market segment stay loyal if they have sufficiently high switching costs. Formally, bank A´s customers stay loyal if their switching costs (s^A) satisfy the condition $s^A \geq \hat{s}^A$, whereas they switch to bank A if $s^A < \hat{s}^A$. Analogously, $\hat{s}^B=(r_2^A-r_2^B)/\sigma$ is the switching threshold for bank B's depositors. We proceed under the assumption that the switching thresholds $\left(\hat{s}^A, \hat{s}^B\right)$ belong to the unit interval, and later confirm that the assumption is fulfilled in equilibrium.

Bank A determines its deposit rate in order to solve the following problem

$$\max_{r_2^A} \pi_2^A(r_2^A, r_2^B) \quad = \quad \frac{\mu}{\bar{\rho}} \int_{r_2^A}^{\bar{\rho}} (1-\hat{s}^A)(\rho_2^A - r_2^A)\, d\rho_2^A + \frac{1-\mu}{\bar{\rho}} \int_{r_2^A}^{\bar{\rho}} \hat{s}^B (\rho_2^A - r_2^A)\, d\rho_2^A \quad . \qquad \text{(1a)}$$

In the right-hand side of (1a) the first term captures the incumbency profits that bank *A* makes on its loyal customers, whereas the second term measures the poaching profits associated with depositors who switch from bank B. Further, the deposit rate r_2^A is the breakeven state of return at which the profit from the investment activities matches the bank's costs of funds, i.e., the deposit rate. If the realized return from the bank's investment portfolio ρ_2^A falls short of the threshold r_2^A, the bank becomes insolvent. In that case the bank's depositors get the realized return (ρ_2^A) and will be reimbursed by the deposit insurance for the remaining part $\left(r_2^A - \rho_2^A\right)$. By limited liability the bank's shareholders get zero.[7]

Analogously to (1a), bank B sets its deposit rate to solve

$$\max_{r_2^B} \pi_2^B(r_2^B, r_2^B) \quad = \quad \frac{1-\mu}{\bar{\rho}} \int_{r_2^B}^{\bar{\rho}} (1-\hat{s}_2^B)(\rho_2^B - r_2^B)\, d\rho_2^B + \frac{\mu}{\bar{\rho}} \int_{r_2^B}^{\bar{\rho}} \hat{s}_2^A (\rho_2^B - r_2^B)\, d\rho_2^B . \qquad \text{(1b)}$$

By solving the optimization problems (1a) and (1b) we are able to report the following proposition, which is formulated conditional on the assumption that banks A and B have inherited the market shares μ and $1-\mu$, respectively.

Proposition 1

(a) *With inherited customer relationships the equilibrium deposit rates are given by*

$$r_2^A = \bar{\rho} - \frac{2\sigma}{5}(\mu+2), \quad r_2^B = \bar{\rho} - \frac{2\sigma}{5}(3-\mu) . \qquad \text{(2)}$$

(b) *The period-2 equilibrium profits are given by*

$$\pi_2^A = \frac{2\sigma^2}{\bar{\rho}}\left(\frac{\mu+2}{5}\right)^3, \quad \pi_2^B = \frac{2\sigma^2}{\bar{\rho}}\left(\frac{3-\mu}{5}\right)^3 . \qquad \text{(3)}$$

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[7] By adjusting the profit functions of the banks our model could be extended to incorporate equity. Forcing the bank to hold equity as a capital buffer would shift the insolvency threshold downwards, but it would not qualitatively affect the results insofar as the threshold would be an increasing function of the period-2 deposit rates.

For the proof of Proposition 1 we refer to the Appendix.

The switching cost parameter can be viewed as a measure of the intensity of deposit market competition, as a higher value of σ endows the banks with stronger market power. With this interpretation the equilibrium deposit rates (2) formalize the intuitive view that intensified competition, meaning a lower value of σ , induces banks to offer higher deposit rates. Furthermore, Proposition 1(a) demonstrates that the period-2 deposit rates would be asymmetric if the banks inherited different market shares from the previous period. Nevertheless, identical market shares ($\mu = \frac{1}{2}$) in period 1 would imply a symmetric deposit rate equilibrium in period 2.

From Proposition 1 we can also conclude that an increase in the parameter $\overline{\rho}$ intensifies deposit rate competition, thereby raising the period-2 deposit rates. Consistent with this property, an increase in the parameter $\overline{\rho}$ reduces the equilibrium profits in period 2, as formally shown by (3).

As the deposit rates define the costs of funds for the banks, our model has immediate implications for financial stability. Since the probability that a bank fails in period 2 is given by $r_2^i / \overline{\rho}$, the equilibrium deposit rates (2) immediately yield the following conclusion regarding financial stability in period 2.

Proposition 2

With inherited customer relationships, intensified competition in the deposit market destabilizes the banking market by increasing the probability of bank failures.

In light of Proposition 2, with inherited customer relationships there is a tradeoff between competition and stability. The qualitative features of this result resemble the classic result obtained by Keeley (1990).

We will next shift our attention to deposit market competition at the stage when the customer relationships are formed. In particular, we explore the effects of intensified competition at that stage on the stability of the banking sector.

4. Deposit Rate Competition at *t*=0

The banks decide on the date-0 deposit rates in order to maximize the discounted sum of the profits accumulating over the two-period horizon.

At *t*=0, the banks compete for unattached depositors, and we denote the market share acquired by bank A as μ, whereas the market share of bank B is ($1-\mu$). Clearly, the market shares μ and $1-\mu$ are determined by the period-1 deposit rates. Regarding the mode of period-1 competition, we assume that $\partial\mu\left(r_1^A, r_1^B\right)/\partial r_1^A = g$, with g>0, and $\partial\mu\left(r_1^A, r_1^B\right)/\partial r_1^B = -g$. These properties capture the idea that the demand for deposits of a bank is increasing its own deposit interest rate and decreasing in the rival's rate. Thus, the parameter g measures the sensitivity of a bank's market share in period 1 to an increase in its deposit rate at date *t*=0.

For the moment, we consider g to be exogenous. However, if depositors were fully forward-looking, it would be plausible to think that changes in σ would affect g. We will explore this particular feature in greater detail in Section 5.1, where we also present an explicit example of period-1 competition, allowing g to depend on the parameters of the model.

Bank *A* determines its deposit rate at *t*=0 in order to maximize the discounted value of the two-period profits according to

$$\max_{r_1^A} \Pi^A(r_1^A, r_1^B) \quad = \quad \frac{\mu(r_1^A, r_1^B)}{\bar{\rho}} \int_{r_1^A}^{\bar{\rho}} (\rho_1^A - r_1^A) d\rho_1^A + \delta \frac{\left(\bar{\rho} - r_1^A\right)}{\bar{\rho}} \pi_2^A, \tag{4}$$

where π_2^A is bank A´s equilibrium profit in period 2 as characterized in (3). As (3) shows, π_2^A depends on μ and thereby on r_1^A. The first term in (4) denotes the profit of bank *A* at *t*=1 under circumstances where the realization of the bank´s investment portfolio is sufficiently successful so that it can meet its debt obligations to its depositors. The second term captures the expected discounted value of the period-2 profit when also taking into account that the deposit rate chosen by bank A at t=0 affects its insolvency risk at t=1. Formally, the factor $(\bar{\rho}-r_1^A)/\bar{\rho}$ denotes the probability that bank A survives so that it can compete for period-2 profits. Bank B determines its period-0 deposit rate in an analogous way.

The last term of the objective function (4) formalizes the feature that a failed bank is replaced by a new bank so that the structure of the banking market remains stable. This could capture, for example, a configuration where the operation of a failing bank is taken over by a foreign bank, for which this takeover facilitates market entry. A similar formalization has been adopted in, for example, Hellmann et al. (2000), Hyytinen and Takalo (2002), and Repullo (2004). We discuss the implications of this simplifying assumption together with alternative formalizations in Section 5.2.

In the Appendix we prove the following result:

Proposition 3

At the stage where banks compete for the formation of customer relationships the equilibrium deposit rates are given by

$$r_1^i = \bar{\rho} - \left(\frac{H}{2} + \sqrt{\frac{H^2}{4} + G} \right) , \quad (i=A,B) \quad , \tag{5}$$

where $H = \frac{1}{g} - \delta \frac{3\sigma^2}{5\bar{\rho}}$ and $G = \delta \frac{\sigma^2}{2g\bar{\rho}}$.

The equilibrium deposit rates given by equation (5) imply that the probability of a bank failure at t=1 is given by

$$\frac{r_1^i}{\bar{\rho}} = 1 - \frac{1}{\bar{\rho}} \left(\frac{H}{2} + \sqrt{\frac{H^2}{4} + G} \right). \tag{6}$$

We next use (6) in order to explore the effects of competition (as measured by σ) and the discount factor (δ) on financial stability. We can formulate the following findings:

Proposition 4

At the stage when banks compete for the formation of customer relationships

(a) *intensified competition in the deposit market decreases the probability of a bank failure,*

(b) *a higher discount factor increases the probability of a bank failure.*

For the proof of Proposition 4 we refer to the Appendix.

According to Proposition 4 (a), at the stage when customer relationships are formed intensified competition, measured as a reduction in the switching cost parameter of depositors, stabilizes the banking markets. The reason is that a lower switching cost parameter reduces the value of a customer relationship, thereby reducing the incentives for banks to offer high deposit rates in order to acquire customers. This mechanism lowers the investment return threshold above which banks stay solvent, meaning that the probability of a bank failure is reduced.

In light of Propositions 2 and 4(a) we can conclude that the effect of intensified competition on banking market stability depend critically on whether we focus on competition with established banking relationships or competition for the formation of such relationships. In the presence of new, unattached depositors as well as locked-in depositors the relative proportions of these different customer categories would determine whether competition with established customer relationships or competition for the formation of such relationships is the dominant mode of competition, thereby determining whether intensified competition tends to destabilize the banking market or not. For example, our model predicts that intensified competition promotes financial stability in an emerging economy with a growing depositor base, whereas the effect of competition on stability would be reverse in developed countries with mature banking markets.

Keeley's (1990) well-established argument regarding the detrimental effect of competition on stability arises because stronger market power implies higher bank charter values, which induces banks to reduce their risk taking. In line with Keeley, Proposition 4 (a) suggests that intensified competition, measured as a decrease in the switching cost parameter, dilutes the charter value. In our model, however, the result is relaxed competition at the stage when customer relationships are formed and, thereby, a more stable banking market. This insight is confirmed by Result 4 (b), which shows the effect of the discount factor on bank stability.

In general, a higher discount factor enhances the weight of future profits in banks' decision making. In our model, this feature generates two opposing effects. There is the standard charter value effect, which increases the banks' willingness to avoid insolvency at *t*=1, thereby making competition for depositors at *t*=0 less aggressive. However, in our model, a higher discount factor also induces banks to invest more in order to acquire locked-in customers, who can be exploited in the second period. A high deposit rate at *t*=0 is the mechanism for the acquisition of such customers. Proposition 4 (b) suggests that the latter effect dominates over the former effect. As a result, a higher discount factor increases the initial deposit rates, destabilizing the banking market at the intermediate stage. In particular, we can immediately observe from (6) that when $\delta = 0$ the probability of a bank failure at *t*=1 is $r_1^i / \overline{\rho} = 1 - 1/(2\overline{\rho}g)$, and positive discount factors raise this failure probability monotonically.

5. Extensions

With the intention to highlight the effects of switching costs on bank stability in a transparent way, a number of important features are outside of our model. In this section we will comment on and briefly analyse some selected issues of robustness. Future research should address these issues in greater detail.

5.1 Forward-looking Depositors

So far we have assumed that the effect of a bank's deposit interest rate on the bank's market share at *t*=0 is given by the positive constant g. This assumption, common in the literature, captures the simplified view according to which depositors are myopic in the sense that their reaction to a bank's interest rate change is invariant to a change in the switching costs or in the depositors' discount factor. With fully forward-looking depositors one would expect that $\partial^2 \mu / \partial r_1^A \partial \sigma < 0$. This formalizes the plausible feature that higher switching costs render a bank's market share less sensitive to its own deposit rate at t=0, because depositors realize that the bank will have higher market power in setting its deposit rate at t=1. Similarly, we would expect that $\partial^2 \mu / \partial r_1^B \partial \sigma > 0$, i.e., that higher switching costs render a bank's market share less sensitive to the rival's deposit rate at t=0. It would therefore be a plausible hypothesis that g would be a decreasing function of σ. An analogous argument applies to the relationship between g and δ. More precisely, if depositors become more patient, they will place a higher weight on the bank's market power at t=1 when they select a bank at t=0. Formally, we would expect that the parameter g to depend on σ as well as on δ, $g(\delta,\sigma)$, in such a way that $\partial g / \partial \delta < 0$ and $\partial g / \partial \sigma < 0$.

Allowing g to be a (decreasing) function of δ and σ would leave the qualitative properties of our basic analysis and Propositions 1-3 intact, but with this generalization the equilibrium deposit rate (5) in period 1 is given in implicit form. This means that the analysis of the effects of switching costs and the discount factor on bank stability at t=1 is more complex, since δ and σ have an additional effect on the equilibrium failure probability $r_1^i / \overline{\rho}$ via $g(\delta,\sigma)$. In particular, if g is a decreasing function of δ and σ, banks have weaker incentives to raise interest rates t=0 to acquire locked-in customers. Hence, increases in δ and σ are less detrimental to bank stability at t=1 than in the case analysed in Section 4, where g is independent of δ and σ.

For brevity, our formal analysis here focuses on σ, as the analysis concerning δ would be qualitatively identical. Let us denote the elasticity of $g(\sigma)$ by $\varepsilon(\sigma)$, i.e., $\varepsilon(\sigma) \equiv g'(\sigma)\sigma / g(\sigma)$. In the Appendix we prove the following result:

Proposition 5

If the elasticity with respect to the switching cost parameter of the bank´s sensitivity to the period-1 deposit rates is sufficiently small, i.e., if $\varepsilon(\sigma)$ is sufficiently small, intensified competition at the stage where customer relationships are formed decreases the probability of a bank failure.

Proposition 5 generalizes Proposition 4(a) to the case where depositors are fully forward-looking. We can conclude that the generalization is valid whenever the elasticity with respect to the switching cost parameter of depositors' reaction to the period-1 deposit rates is limited. Condition (A6) in the Appendix characterizes mathematically the threshold for the elasticity. As long as the elasticity is below this threshold intensified competition for new depositors will stabilize the banking sector. Furthermore, the Appendix verifies that Proposition 4(a) always holds true if it were the case that an increased switching cost parameter would make depositors more sensitive to the period-1 deposit rates (i.e., $\partial g / \partial \sigma > 0$). Proposition 4(b) can be extended based on analogous arguments.

5.1.1 Example

In order to illustrate the effects of allowing dependence g to depend on δ and σ, we consider the well-known Hotelling model of competition between the two horizontally differentiated banks. Following the standard Hotelling model, we assume that depositors are uniformly distributed on the unit interval and that the banks are located at the opposite ends of this interval. Assuming that the parameter $\tau > 0$ captures the depositor's travel costs (i.e., the depositor's disutility of using services of an existing bank rather than the depositor´s ideal combination of services), we show in the Appendix that with Hotelling competition g is given by

$$g(\delta,\sigma) = \frac{5}{2(5\tau + 2\delta\sigma)} \quad . \qquad (7)$$

From (7) we can conclude that $\partial g / \partial \delta = -5\sigma(5\tau + 2\delta\sigma)^{-2} < 0$ and $\partial g / \partial \sigma = -5\delta(5\tau + 2\delta\sigma)^{-2} < 0$, meaning that g is a decreasing function of δ and σ, thereby verifying our conjectures above about the plausible relationship between g and δ and σ. The equilibrium deposit rates as well as the associated implications for financial stability can now be characterized by substituting (7) into (2), (5) and (6), keeping in mind that with a symmetric equilibrium $\mu = 1/2$.

5.2. Bank Failures and Market Structure

As we mentioned when commenting on (4) our model does not incorporate any strategic incentives associated with the potential effects of a bank failure on market structure. Actually, our model shares this feature with many influential models focusing on the effects of capital regulation on risk taking, for example Hellman et al (2000) and Repullo (2004).

An alternative modelling approach, taking the strategic incentives associated with market structure effects into account, would be to modify (4) in the following way. The discounted value of bank A´s survival profits in (4) could be decomposed into two terms: a component with duopoly profit realized with the probability that both banks survive ($(\overline{\rho}-r_1^A)(\overline{\rho}-r_1^B)/\overline{\rho}^2$) and a component with monopoly profit realized with the probability that bank A is the only surviving bank ($(\overline{\rho}-r_1^A)r_1^B/\overline{\rho}^2$). Such an approach would capture a configuration where the assets of a failed bank are sold or transformed to the surviving rival. Perotti and Suarez (2002) analyse the effects for risk-taking behavior associated with the market structure effect, i.e. the feature that the number of banks decrease in response to a market failure.[8] Further, Acharya and Yorulmazer (2007, 2008) explore how the option for surviving banks to take over failing banks may affect potential time-consistency problems associated with bank closure policies.

6. Concluding Comments

This study has analytically established that the effect of intensified deposit market competition, measured by reduced switching costs, on the probability of bank failures depends critically on whether we focus on competition with established customer relationships or competition for the formation of such relationships. With inherited customer relationships, intensified deposit market competition destabilizes the banking market, whereas it stabilizes the banking market if we shift our focus to the stage at which banks compete for the formation of customer relationships. These findings imply that the proportion of new,

[8] Also, Allen et al (2015) explore this market structure effect within the framework of a two-period duopoly model of stakeholder governance.

unattached depositors relative to the locked-in depositors is a decisively important factor when determining whether intensified competition tends to destabilize the banking market or not.

In its attempt to highlight the mechanism created by switching costs as a generator of a relationship between the intensity of competition and financial stability in banking markets, our model has abstracted from a number of important factors that should be incorporated in a future analysis. For example, we have characterized the return distributions associated the banks´ investments (lending activities) as an exogenous feature of our model. However, it is likely that changes in switching costs affect the banks' lending and investment decisions in ways reminding of the effects of changes in various regulatory policies (see, e.g., Hellman et al. (2000) and Repullo (2004)) for the effects of capital requirements and Moreno and Takalo (2015) for the effects of transparency regulation on banks' asset risk taking). Likewise, Matutes and Vives (2000) show how imperfect competition in the deposit market together with limited liability and deposit insurance affects the banks' asset risk-taking incentives.

Our model could be modified to analyse the effects of (foreign) entry in configurations where all depositors belong to the inherited market segment of the incumbent bank. Earlier studies (see, e.g., Sengupta (2007)) have highlighted the benefits of foreign entry in banking markets. However, if the domestic bank's depositors face switching costs, increased competition via foreign entry would not only lead to higher deposit rates, but potentially also to less stable banking market, in line with the casual evidence from, for example, the effects of cross-border entry of Icelandic banks in various markets in the early years of the 2000s.

Furthermore, as emphasized by Basel III liquidity regulations and the findings in Brown et al. (2014), tighter depositor relationships consistent with higher switching cost barriers are likely to make depositors, ceteris paribus, less likely to run on a bank in a crisis. To make a comprehensive evaluation of the stability implications of switching costs one should build a bank run model with multiple banks where depositors can switch deposits from one bank to another (see, e.g., Chen and Hasan (2006) for a contribution in this direction).

Appendix

Proof of Proposition 1:

By substitution of $\hat{s}_2^A$ and $\hat{s}_2^B$ into (1a) and (1b) we see the objective functions can be rewritten according to

$$\max_{r_2^A} \pi_2^A(r_2^A, r_2^B) = \frac{1}{\bar{\rho}}\int_{r_2^A}^{\bar{\rho}} (\mu + \frac{1}{\sigma}(r_2^A - r_2^B)(\rho_2^A - r_2^A))d\rho_2^A = \frac{1}{2\bar{\rho}}\left(\mu + \frac{r_2^A - r_2^B}{\sigma}\right)(\bar{\rho} - r_2^A)^2,$$

(A1a)

$$\max_{r_2^B} \pi_2^B(r_2^B, r_2^A) = \frac{1}{\bar{\rho}}\int_{r_2^B}^{\bar{\rho}} (1 - \mu + \frac{1}{\sigma}(r_2^B - r_2^A)(\rho_2^B - r_2^B))d\rho_2^B = \frac{1}{2\bar{\rho}}\left(\mu + \frac{r_2^B - r_2^A}{\sigma}\right)(\bar{\rho} - r_2^B)^2. \quad \text{(A1b)}$$

The objective functions (1a) and (1b) imply the reaction functions

$$\frac{\partial \pi_2^A}{\partial r_2^A} = \frac{1}{\bar{\rho}}\int_{r_2^A}^{\bar{\rho}} (\frac{1}{\sigma}(\rho_2^A - r_2^A) - \mu - \frac{1}{\sigma}(r_2^A - r_2^B))\, d\rho_2^A = 0 \quad \text{(A2a)}$$

$$\frac{\partial \pi_2^B}{\partial r_2^B} = \frac{1}{\bar{\rho}}\int_{r_2^B}^{\bar{\rho}} (\frac{1}{\sigma}(\rho_2^B - r_2^B) - (1-\mu) - \frac{1}{\sigma}(r_2^B - r_2^A))\, d\rho_2^B = 0\,. \quad \text{(A2b)}$$

Solving the system of equations defined by (A2a) and (A2b) yields the equilibrium deposit rates

$r_2^A = \bar{\rho} - \frac{2\sigma}{5}(\mu+2)$, $r_2^B = \bar{\rho} - \frac{3\sigma}{5}(2-\mu)$ as given by (2).

Substitution of the equilibrium deposit rates back into the objective functions yields the equilibrium profits $\pi_2^A = \frac{2\sigma^2}{\bar{\rho}}(\frac{\mu+2}{5})^3$, $\pi_2^B = \frac{2\sigma^2}{\bar{\rho}}(\frac{3-\mu}{5})^3$, which are reported in (3). These equilibrium profits can also be written as $\pi_2^A = \frac{1}{4\sigma\bar{\rho}}(\bar{\rho} - r_2^A)^3$, $\pi_2^B = \frac{1}{4\sigma\,\bar{\rho}}(\bar{\rho} - r_2^B)^3$.

QED

Proof of Proposition 3:

By applying Leibniz´s rule when differentiating (4) we find that bank A´s reaction function is given by

$$-\frac{1}{\overline{\rho}}\left(\frac{\mu}{2}(\overline{\rho}-r_1^A)+\delta\,\pi_2^A(\mu)\right)+\frac{\overline{\rho}-r_1^A}{\overline{\rho}}\left(\frac{\overline{\rho}-r_1^A}{2}\frac{\partial\mu}{\partial r_1^A}-\frac{\mu}{2}+\delta\frac{\partial\pi_2^A(\mu)}{\partial r_1^A}\right) = 0\,. \quad \text{(A3)}$$

Substitution of (3) for the second-period profits, imposing symmetry ($r_1^A{=}r_1^B, \mu=1/2$) and defining $x_1^A=\overline{\rho}-r_1^A$ the first-order condition (A3) can be simplified according to

$$(x_1^A)^2 \; - \; H\,x_1^A \; - \; G \; = \; 0\,, \qquad \text{(A4)}$$

where we have introduced the notation that $H{=}1/g{-}3\delta\sigma^2/(5\overline{\rho})$ and $G{=}\delta\sigma^2/(2g\overline{\rho})$.

There are two solutions to equation (A4). But, as we can ignore the negative root, the unique equilibrium period-1 deposit rate is given by $x_1^A{=}H/2{+}\sqrt{H^2/4{+}G}$, which is equivalent to the period-1 deposit rate reported in Proposition 3.

This solution to equation (A4) satisfies the sufficient second-order condition, because the second-order derivate of bank *A*´s profit function is $-g\,x_1^A+g\,H<0$ when evaluated in a neighborhood of the solution to (A4).

QED

Proof of Proposition 4:

(a) By differentiation of (6) with respect to σ we find that

$$\frac{\partial}{\partial\sigma}\left(\frac{r_1^i}{\overline{\rho}}\right) = -\frac{1}{2\overline{\rho}\sqrt{\dfrac{H(\sigma,\delta)^2}{4}+G(\sigma,\delta)}}F(\sigma,\delta)\;,$$

where $H(\sigma,\delta)$ and $G(\sigma,\delta)$ are defined in Proposition 3 and where we have introduced the notation $F(\sigma,\delta){=}H_\sigma(\sigma,\delta)\left(\sqrt{H(\sigma,\delta)^2/4{+}G(\sigma,\delta)}{+}H(\sigma,\delta)/2\right){+}G_\sigma(\sigma,\delta)$. By investigation of $F(\sigma,\delta)$ we find that $F(\sigma,\delta)<0$ if and only if $\sqrt{H(\sigma,\delta)^2/4{+}G(\sigma,\delta)}{>}5/(6g){-}H(\sigma,\delta)/2$.

Straightforward calculations verify that the last inequality holds true for all values of σ. Therefore, we can conclude that

$$\frac{\partial}{\partial\sigma}(\frac{r_1^i}{\overline{\rho}}) = -\frac{1}{2\overline{\rho}\sqrt{\frac{H(\sigma,\delta)^2}{4}+G(\sigma,\delta)}}F(\sigma,\delta) > 0,$$

meaning that relaxed competition increases the probability of a bank failure.

(b) Analogously to part (a), by differentiation of (6) with respect to δ we find that

$$\frac{\partial}{\partial\delta}(\frac{r_1^i}{\overline{\rho}}) = -\frac{1}{2\overline{\rho}\sqrt{\frac{H(\sigma,\delta)^2}{4}+G(\sigma,\delta)}}D(\sigma,\delta),$$

where we have defined $D(\sigma,\delta)$ according to $D(\sigma,\delta) = H_\delta(\sigma,\delta)\left(\sqrt{H(\sigma,\delta)^2/4+G(\sigma,\delta)}+H(\sigma,\delta)/2\right)+G_\delta(\sigma,\delta)$. We find that $D(\sigma,\delta)<0$ if and only if $\sqrt{H(\sigma,\delta)^2/4+G(\sigma,\delta)}>5/(6g)-H(\sigma,\delta)/2$, which holds true for all values of δ. Consequently, we reach the conclusion that

$$\frac{\partial}{\partial\delta}(\frac{r_1^i}{\overline{\rho}}) = -\frac{1}{2\overline{\rho}\sqrt{\frac{H(\sigma,\delta)^2}{4}+G(\sigma,\delta)}}D(\sigma,\delta) > 0,$$

meaning that a higher discount factor increases the probability of bank bankruptcy.

QED

Proof of Proposition 5:

Assume that g is a function of σ. From the proof of Proposition 4 we have that the sign of $\partial(r_1^i/\overline{\rho})/\partial\sigma$ is given by the sign of $-F(\sigma,\delta)$, where

$$F(\sigma,\delta) = H_\sigma(\sigma,\delta)\left(\sqrt{\frac{H(\sigma,\delta)^2}{4}+G(\sigma,\delta)}+\frac{H(\sigma,\delta)}{2}\right) + G_\sigma(\sigma,\delta)$$

as before. We want to characterize the circumstances when $F(\sigma,\delta)\leq 0$.

Let us suppress the argument δ for brevity in what follows. Compared with the proof of Proposition 4, the difference is that now

$$\frac{\partial H}{\partial \sigma} = -\frac{1}{g(\sigma)\sigma}\left(\varepsilon(\sigma)+\frac{6}{5}g(\sigma)R(\sigma)\right)$$

and

$$\frac{\partial G}{\partial \sigma} = \frac{R(\sigma)}{g(\sigma)\sigma}\left(1-\frac{\varepsilon(\sigma)}{2}\right),$$

where we have defined $R(\sigma)\equiv\delta\sigma^2/\overline{\rho}$.

After substitution of these formulas for H_σ and G_σ in $F(\sigma)$ and some algebra, we get that the sign of $-F(\sigma)$ is given by the sign of

$$A(\sigma)+\varepsilon(\sigma)\left(\sqrt{\frac{H(\sigma)^2}{4}+G(\sigma)}+\frac{H(\sigma)+R(\sigma)}{2}\right) \tag{A5}$$

where

$$A(\sigma)\equiv R(\sigma)\left[\frac{6g(\sigma)}{5}\left(\sqrt{\frac{H(\sigma)^2}{4}+G(\sigma)}+\frac{H(\sigma)}{2}\right)-1\right]>0\,.$$

(That $A(\sigma)>0$ is the essence of the proof of Proposition 4). Since also

$$\frac{H(\sigma)+R(\sigma)}{2}=\frac{1}{2g(\sigma)}+\frac{R(\sigma)}{5}>0$$

it is immediate from (A5) that $F(\sigma,\delta)\leq 0$ if

$$-\varepsilon(\sigma)\leq\frac{A(\sigma)}{\sqrt{\frac{H(\sigma)^2}{4}+G(\sigma)}+\frac{H(\sigma)+R(\sigma)}{2}}. \tag{A6}$$

Clearly, this condition holds as a strict inequality if $\varepsilon(\sigma) \geq 0$. By continuity, it also holds if $\varepsilon(\sigma) < 0$ but small.

QED

The Details associated with Example of Section 5.1.1:

Let us consider the well-known model of competition between the two horizontally differentiated banks. Assume that depositors are uniformly distributed on the unit interval and that the two banks, A and B, are located at the opposite ends of this interval. Consider a depositor with an address $x \in [0,1]$ on the unit line. If she deposits at bank *A*, located at the 0-end of the unit line, at *t*=0 her payoff is given by

$$u^A(x) = r_1^A - 1 - \tau x + \delta\, {}_2^A(\mu), \tag{A7}$$

where the parameter $\tau > 0$, as mentioned in Section 5.1, denotes the depositor's travel costs, and $u_2^A(\mu)$ is the depositor's utility at *t*=1 when she has an inherited customer relationship with bank A, which has a market share μ. In light of (2) this utility is given by

$$u_2^A(\mu) = r_2^A(\mu) - 1 = \overline{\rho} - \frac{2}{5}\sigma(\mu + 2) - 1. \tag{A8}$$

Note that we assume for simplicity that switching a bank at *t*=1 involves no explicit travel costs. An interpretation is that travel cost parameter τ reflects the intensity of competition ex ante (at *t*=0) and the switching cost parameter σ captures the intensity of competition ex post (at *t*=1). We may also think that potential travel costs at *t*=1 are embodied in the switching costs.

Analogously, if at *t*=0 the depositor located at x chooses bank B, located at the 1-end of the unit line, her utility is given by

$$u^B(x) = r_1^B - 1 - \tau(1 - x) + \delta u_2^B(1 - \mu), \tag{A9}$$

where, after using (2), we have

$$u_2^B(1-\mu) \;=\; r_2^B(1-\mu)-1 \;=\; \bar{\rho} \;-\; \frac{2}{5}\sigma(\mu+2)-1. \qquad \text{(A10)}$$

As usually, we assume that the configuration of parameters is such that the market is fully covered (e.g, τ is sufficiently small). Then the equation $u^A(\tilde{x}) = u^B(\tilde{x})$ defines the location $\tilde{x} \in [0,1]$ of a consumer, who is indifferent between whether to deposit in bank A or bank B at *t*=0. From the well-known nature of the Hotelling model the market shares are directly determined by the location of this indifferent consumer. Making use of (A7)-(A10) we find that the equilibrium market shares are given by

$$\tilde{x} = \mu(r_1^A, r_1^B) = \frac{1}{2} + \frac{5}{2}\left(\frac{r_1^A - r_1^B}{5\tau + 2\delta\sigma}\right).$$

In terms of our model this directly implies that

$$g(\delta,\sigma) \;=\; \frac{\partial\mu(r_1^A, r_1^B)}{\partial r_1^A} \;=\; \frac{5}{2(5\tau + 2\delta\sigma)},$$

which is equation (7) of the main text.

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