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Abstract

We use a workhorse model of bank competition and risk-taking to show that increased competition from market integration affects banks' risk-taking in more ways than by simply increasing the number of competitor banks. Previous research has shown that increased competition in the form of an increase in the number of competitor banks can reduce risk-taking—the *bank-competitor effect*. Market integration increases not only the number of banks, but also the number of potential customers (depositors and borrowers) available to each bank. Increases in the customer base induces banks to behave more like price takers in both deposit and loan markets. We show that increased competition, in the form of convergence towards banks' price-taking behavior, can either increase or decrease bank risk-taking—the *bank-customer effect*. The effect of market integration on bank risk-taking comprises the bank-competitor and bank-customer effects. When these effects oppose each other, market integration can increase bank risk-taking. Even in the absence of the bank-customer effect, we show that market integration facilitates bank mergers and incentivizes bank risk-taking by reducing the number of competitor banks.

JEL codes: D82, G21, L13.

Keywords: Bank competition; market integration; risk-taking.

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1 Introduction

The Financial Crisis of 2008-2009 renewed attention to the linkages between bank competition and financial stability. Recent studies have re-examined these linkages, albeit with different conclusions.¹ Understanding how the evolution of competition influences bank risk-taking remains critical to achieving financial stability goals.

Bank competition has evolved in two distinct phases since the Great Depression. Prior to the 1970s, U.S. states suppressed competition by restricting banking activity both within and across state borders.² Since the early 1970s, U.S. banks have been permitted to expand beyond a single local market into new areas, initially within state boundaries and then across multiple states (Kroszner and Strahan, 1999). As financial deregulation over the years removed constraints on bank competition, banking markets became increasingly “integrated.”³ By some accounts, this process of deregulation and increased competition from *market integration* has also led to greater instability (Vives, 2011).⁴ In light of the evolution of competition through the deregulation of entry barriers, it is important to account for the geographic expansion of banking markets in any analysis of risk-taking.

The purpose of this paper is to study how market integration affects bank risk-taking. Market integration in the form of branching deregulation and removal of restrictions on geographical expansion has been a key driver of increased competition in the banking industry. Using a model that has become the workhorse in the theory of bank competition and risk-taking (Allen and Gale, 2000, 2004; Boyd and De Nicolò, 2005; Martinez-Miera and Repullo, 2010), we show that increased competition from market integration affects risk-taking in ways beyond a simple increase in the number of rival banks. Prior research has shown that increased competition in the form of an increase in the number of competitor banks can reduce risk-taking—the *bank-competitor effect* (Boyd and De Nicolò, 2005). However, market integration not only increases the number of banks, but also the number of potential customers (depositors and borrowers) available

¹For example, the OECD (2011, p. 10) report on bank competition and financial stability finds that “[T]he pre-crisis regulatory landscape has set in motion changes in business models and activities in response to competition that proved not to be conducive to financial stability.” More recently, Corbae and Levine (2018) has re-emphasized this tradeoff between bank competition and stability. On the other hand, Beck, Coyle, Dewatripont, Freixas, and Seabright (2010) and Vives (2019) argue that competition is important for financial stability.

²Although the primary motivation here is the evolution of the banking industry in the United States (Berger, Kashyap, and Scalise, 1995; Jones and Critchfield, 2008; DeYoung, 2008; Kroszner and Strahan, 2014), the European experience has followed a similar trajectory (Gaspar, Hartmann, and Sleijpen, 2003; Carletti and Vives, 2009).

³In particular, state-by-state banking deregulation in the U.S. occurred through regional or national reciprocal arrangements (Amel, 1993). Not only could banks from neighboring states enter the home state, local banks could also buy banks in any other state in the arrangement. In this way, deregulation allowed for the potential geographic expansion of bank operations and enabled bank competition to span multiple local markets (Radecki, 1998).

⁴The term ‘market integration’ is used as a shorthand to refer to the removal of entry barriers and other geographic restrictions that prevailed around the early 1970s. The process involved branching deregulation, initially across counties within a state (for example, in the case of unit banking that existed in 17 states), and subsequently across states on a reciprocal basis, culminating in the Riegle-Neal Interstate Banking and Branch Deregulation Efficiency Act of 1994.

to each bank—thereby expanding deposit supply and loan demand. Accordingly, increases in the customer base also increases competition and induces banks to behave more like price takers in both deposit and loan markets. We show that increased competition, in the form of convergence towards banks’ price-taking behavior, can either increase or decrease bank risk-taking—the *bank-customer effect*. The overall effect of market integration on bank risk-taking comprises the bank-competitor and bank-customer effects. When these effects oppose each other, market integration can increase, rather than decrease, bank risk-taking.

We also show how market integration affects risk-taking by facilitating bank mergers. Prior to the dismantling of regulatory barriers, restrictions protected incumbent banks from competition, arguably reducing efficiency. Lack of competitive pressures can create inefficiencies and regulatory barriers can generate heterogeneity so that banks across different markets operate at different efficiencies.⁵ We model this heterogeneity in terms of differences in bank-specific operating costs (non-interest expenses) across different markets. We find that market integration among banks with heterogeneous costs creates incentives for bank mergers. The ensuing consolidation yields efficiency gains as described in numerous empirical studies (see [Berger et al., 1999](#), and references therein). However, by reducing the number of competitor banks, bank mergers can increase bank risk-taking due to the aforementioned bank-competitor effect. Importantly, we obtain this result even if the bank-customer effect is null. Therefore, our analysis reveals an additional channel through which market integration can increase risk-taking by banks—namely, by facilitating bank mergers.

Our model presents a risk-incentive mechanism, the bank-customer effect, that has not been modeled in studies that measure increased competition only as an increase in the number of competitor banks. An important attribute of our workhorse model is that risk-taking increases with the loan rate ([Stiglitz and Weiss, 1981](#)). Accordingly, the bank-customer effect, which stems from a convergence towards banks’ price-taking behavior in both deposit and loan markets, is best described in terms of its effect on the loan rate. *Ceteris paribus*, an increase in the number of potential depositors flattens the deposit supply schedule, increasing the loanable funds available to banks. This tends to lower loan rates and disincentivize risk-taking by borrowers. In contrast, an increase in the number of potential borrowers tends to raise loan rates by flattening the loan demand schedule and this incentivizes risk-taking. Depending on the relative magnitudes of changes in the deposit supply and loan demand schedules, the bank-customer effect can increase or decrease risk-taking by banks. The overall impact of market integration depends on the relative strength of both the bank-competitor and the bank-customer effects. A negative bank-customer effect reinforces the bank-competitor effect and the aggregate effect of market integration on bank risk-taking is unambiguously negative. In contrast, when the bank-customer effect is positive and

⁵For example, [Kroszner \(2001, p. 38\)](#) argues that, “. . . branching restrictions tend to reduce the efficiency and consumer convenience of the banking system, and small banks tend to be particularly inefficient in states where branching restrictions offer them the most protection.”

sufficiently large, it dominates the bank-competitor effect, increasing risk-taking by banks. In sum, the bank-customer effect extends the ways in which market integration affects risk-taking beyond a simple increase in competitor banks.

Market integration presents us with seemingly different meanings of “increased competition”. The first is an increase in the number of banks, and the second is a convergence towards banks’ price-taking behavior in deposit and loan markets. The notion that increased competition goes beyond a simple increase in the number of banks (firms) has its roots in [Novshek \(1980\)](#). [Hermalin \(1994\)](#) summarizes the argument as follows:

“[t]his requires defining the phrase ‘more competitive’. As [Novshek \(1980\)](#) points out, this is not a straightforward task, because more competitive has at least two meanings. It suggests (1) more firms and (2) a closer approximation to perfect competition. This second meaning is not fully captured by the first—simply adding firms does not yield a closer approximation of perfect competition because the firms do not become price takers in the limit. Following Novshek, a definition that is consistent with this second meaning is one in which the slope of the inverse demand curve tends to zero with the increase in the number of firms in such a way that, in the limit, each firm produces zero, earns zero profits, and faces a flat demand curve.”

To reconcile the two meanings of increased competition with existing studies, we refer to the notion of market replication. [Allen and Gale \(2004, p. 463\)](#) describe market replication in their study of deposit market competition:

“This exercise is enlightening but somewhat artificial since it assumes that we are dealing with a market of fixed size and increasing the number of banks without bound in order to achieve competition. Normally, one thinks of perfect competition as arising in the limit as the number of banks and consumers grows without bound. One way to do this is to *replicate* the market by shifting the supply-of-funds function as we increase the number of banks.”

Market integration is akin to market replication if the integrated markets are homogenous. We show that when markets are homogenous in that they have identical loan demand and deposit supply schedules, the aforementioned bank-customer effect is null. This holds true for most studies that define increased competition simply in terms of an increase in the number of banks. However, with increased competition from the integration of heterogenous banking markets, the non-null bank-customer effect can influence bank risk-taking in a significant way.

The remainder of the paper is organized as follows. Section 2 reviews the literature on competition and risk-taking in banking. Section 3 presents the baseline (linear) model of bank competition, market integration, and risk-taking. Section 4 presents a generalized version of the model described in Section 3. Section 4 extends the model to allow for bank mergers and analyzes the effect of mergers on risk-taking in this framework. Section 5 concludes.

2 Related literature

A large body of research has contributed to our understanding of how bank competition affects bank risk-taking and its implications for financial stability (see [Vives, 2016](#), and references therein). Numerous studies have examined how increased competition, through the various episodes of deregulation and the consequent market integration, affected bank risk-taking.⁶ Meanwhile, theory has focused on how the competitive mechanism operates in the presence of important market failures such as asymmetric information, switching costs, and network externalities ([Carletti, 2008](#)). Most of these theoretical studies define increased competition by an increase in the number of competitor banks.

The starting point of our theoretical analysis is the model, first developed by [Allen and Gale \(2000\)](#), that has become the workhorse in theoretical analyses of bank competition and risk-taking. Similar to related work analyzing deposit market competition such as [Keeley \(1990\)](#), [Hellmann et al. \(2000\)](#), and [Repullo \(2004\)](#), Allen and Gale show that risk-taking increases as competition in deposit markets reduces the rents banks can earn. To this setting, [Boyd and De Nicolò \(2005\)](#) introduce loan market competition in a moral hazard framework, showing that less competition yields more rents not only in the deposit market but also the loan market. However, moral hazard of the part of borrowers facing higher loan rates optimally leads to more risk-taking—the bank-competitor effect. In a world where borrower returns are perfectly correlated, more risk-taking by borrowers yields riskier banks. However, if loan defaults are imperfectly correlated, lower revenues from performing loans can increase risk at banks ([Martinez-Miera and Repullo, 2010](#)). Throughout this paper, we retain the assumption of perfectly correlated returns and so that the bank-competitor effect always holds. This helps us show how increased competition from market integration can affect risk-taking in ways beyond that captured by the bank-competitor effect.

Our first contribution is illustrated in terms of the bank-customer effect—the mechanism by which increased competition, in the form of convergence towards banks’ price-taking behavior, can either increase or decrease bank risk-taking. As the market expands due to integration, it increases deposit supply available at a given rate, thereby raising the supply of loanable funds and putting downward pressure on the loan rate. At the same time, market expansion from integration tends to increase loan demand which puts an upward pressure on the loan rate. Accordingly, increased competition in the form of convergence to banks’ price-taking behavior

⁶Research on bank competition and risk-taking has often been framed as a debate between the ‘competition-fragility’ and the ‘competition-stability’ views ([Berger, Klapper, and Turk-Ariss, 2009](#); [Beck, De Jonghe, and Schepens, 2013](#); [Akins, Li, Ng, and Rusticus, 2016](#); [Corbae and Levine, 2018](#)). The competition-fragility view argues that an increase in competition increases risk-taking incentives by reducing bank profit margins and lowering franchise values ([Keeley, 1990](#); [Hellmann, Murdock, and Stiglitz, 2000](#); [Matutes and Vives, 2000](#); [Repullo, 2004](#)). In contrast, the ‘competition-stability’ argues that competition is critical to financial stability and increased concentration has been shown to increase bank risk-taking using different empirical measures ([Jayaratne and Strahan, 1998](#); [Barth, Lin, Lin, and Song, 2009](#); [Houston, Lin, Lin, and Ma, 2010](#); [Akins, Li, Ng, and Rusticus, 2016](#)).

in the deposit and loan markets yields opposite effects on the loan rate, and thereby, on bank risk-taking. Despite a large volume of empirical studies on the effects of bank competition on loan and deposit rates (see [Degryse and Ongena, 2008](#), for a survey), there are no direct tests of the impact of market integration on these rates. Still, as [Park and Pennacchi \(2008\)](#) observe in the case of U.S. deregulation, “a greater presence of large multi-market banks tends to promote competition in retail loan markets but also tends to harm competition in retail deposit markets”.⁷ In terms of our theoretical model, these conditions are necessary but not sufficient for increased risk-taking by banks.⁸

A second contribution relates to the role of mergers on bank risk-taking in any post-integration equilibrium. While our model is intended to examine risk-taking effects of increased competition from market integration, it also captures some of the broad patterns of merger activity in U.S. banking. In particular, we model how efficient banks can target relatively inefficient, less profitable banks that operate within the same integrated market ([Berger et al., 1999](#), p. 150):

“The prior geographic restrictions on competition may have allowed some inefficient banks to survive. The removal of these constraints allowed some previously prohibited M&As to occur, which may have forced inefficient banks to become more efficient by acquiring other institutions, by being acquired, or by improving management practices internally.”

A large literature documents how deregulation in the U.S. led to unambiguous efficiency gains from bank mergers ([DeYoung, Evanoff, and Molyneux, 2009](#)). We capture these efficiencies in terms of bank-specific differences in operating costs. In any pre-integration equilibrium, banks’ operating costs vary by market but they are identical within each market. We show that market integration not only facilitates competition between heterogeneous banks, but also increases bank risk-taking by facilitating mergers. The increased risk-taking follows from the bank-competitor effect working in the opposite direction. Studies have shown that banks have used their increased market power from mergers and acquisitions by shifting to higher risk portfolios, income streams, and banking practices ([Demsetz and Strahan, 1997](#); [Group of Ten, 2001](#)).

Regulatory review of bank merger applications in the U.S. have prevented consolidation in which excessive increases in risks were expected. This established practice has finally been formalized: the Dodd-Frank Act of 2010 authorized “the addition of a financial stability factor to the review conducted by the Federal Reserve Board of proposed mergers and acquisitions involving banks and bank holding companies. This . . . contrasts with an antitrust pre-merger review,

⁷In related work, some accounts trace the increased risk-taking in residential real estate lending at banks prior to the financial crisis to the competitive pressures induced by bank deregulation—a strong loan supply effect. For example, [Favara and Imbs \(2015\)](#) showed that deregulation affected the supply of mortgage loans, and via its effect on credit, the price of housing.

⁸Needless to say, these results have strong implications for the role of banking deregulation and subsequent episodes of financial turmoil ([Mian and Sufi, 2018](#)). [Mian, Sufi, and Verner \(2020\)](#) trace the credit expansion in early deregulation states to a boost in household loan demand.

in which the focus is solely on whether the transaction would substantially lessen competition” (Tarullo, 2012). When evaluating a proposed bank acquisition or merger, the Federal Reserve Board is now required to consider “the extent to which [the] proposed acquisition, merger, or consolidation would result in greater or more concentrated risks to the stability of the United States banking or financial system”.⁹

3 Competition versus risk-taking

We follow the static Cournot model that has become the workhorse in the literature on bank competition and risk-taking (Allen and Gale, 2000, 2004; Boyd and De Nicolò, 2005; Martinez-Miera and Repullo, 2010).¹⁰ There are $M \geq 2$ distinct and segmented banking markets.¹¹ We begin by characterizing banks’ equilibrium *risk-shifting* behavior under autarky in each of the M segmented markets.¹² Next, we analyze how risk-shifting changes when $m \in [2, M]$ of these individual markets are integrated into a single banking market. Market integration not only increases the number of banks, but also increases competition so that banks behave more like price takers as described below.

3.1 Bank competition and risk-taking under autarky

For the purposes of exposition, we present a simple model of bank competition with linear deposit supply and linear loan demand schedules. A more general version of the model is presented in the Section 4.

Deposit supply and loan demand Consider the M segmented banking markets indexed by $j = 1, \dots, M$. Each market j consists of three classes of risk neutral agents—depositors, entrepreneurs (borrowers), and n_j banks, where $n_j \geq 1$. We refer to depositors and borrowers collectively as *customers* of banks. Under autarky, each bank operates in one and only one market, and customers do not transact with banks outside their market. Market conditions for each bank in market j are characterized by an inverse supply of deposits and an inverse demand for loans. Let D_{ij} denote the deposits of bank i in market j . The inverse deposit supply function

⁹The ‘financial stability’ factor is included in Section 604(d) of the Dodd-Frank Wall Street Reform and Consumer Protection Act. This section amended Section 3(c) of the Bank Holding Company Act of 1956.

¹⁰See Grochulski and Kareken (2004) for a discussion on alternative formulations.

¹¹We use the terms markets, regions, and economies interchangeably. This framework focuses on market segmentation due to institutional, non-economic barriers such as geography, legislation, or regulation.

¹²We use the terms risk-taking and risk-shifting interchangeably. In debt-financed firms, owners and managers have incentives to take excessive risks because they benefit from the upside potential while debt-holders bear the downside risks. This well-known risk-shifting problem is particularly acute in banks where a significant proportion of liabilities are insured deposits.

for market j is given as

$$R_j(Z_j) = a_j Z_j \quad \text{where } Z_j = \sum_{i=1}^{n_j} D_{ij} \quad \text{and } a_j \geq 1 \text{ for all } j. \quad (1)$$

Likewise, let L_{ij} denote bank i 's loans in market j . The inverse loan demand function for market j is given as¹³

$$r_j(L_j) = \lambda - b_j L_j \quad \text{where } L_j = \sum_{i=1}^{n_j} L_{ij} \quad \text{and } b_j \geq 1 \text{ for all } j. \quad (2)$$

For a given interest rate, slope parameters a_j and b_j determine market j 's deposit supply and loan demand respectively. In particular, for a given deposit rate, R , and loan rate, r , deposit supply and loan demand are given by R/a_j and $(\lambda - r)/b_j$, respectively.

Entrepreneurs and risk-shifting Entrepreneurs have access to risky projects of fixed size, normalized to 1. Projects are financed with loans from banks. The risk-shifting choice of each entrepreneur, S , determines the probability of success, $p(S)$. Therefore, if $y > 0$ dollars are invested in a project, it yields a stochastic cash flow

$$\tilde{y} = \begin{cases} Sy \end{cases}$$

where

$$p(S) = 1 - \frac{S}{\lambda} \quad \text{for } S \in [0, \lambda].$$

Given the loan rate $r_j(L_j)$ and limited liability, entrepreneurs choose the riskiness of the project in order to maximize their expected payoff, so that

$$S(L_j) = \operatorname{argmax}_{S \in [0, \lambda]} \{p(S)(S - r_j(L_j))\} = \lambda - \frac{b_j L_j}{2}. \quad (3)$$

Entrepreneurs' optimal choice of risk in market j is simply a function of the loan amount, L_j , with $S'(L_j) < 0$. Importantly, risk-shifting increases with the loan rate—raising the loan rate decreases the return on successful projects, prompting borrowers to seek projects less likely to succeed but with higher returns when successful ([Stiglitz and Weiss, 1981](#)).

Competition and risk-taking under autarky In solving the optimization problem for each bank, we make two simplifying assumptions. First, we assume that banks have no equity and it follows from the balance sheet identity that aggregate loan demand equals aggregate deposit

¹³The downward-sloping loan demand function can be obtained by maximizing borrower utility using, for example, a quadratic utility function (see [Martinez-Miera and Repullo, 2010](#), for details).

supply in market j , $L_j = Z_j$. Second, we assume that all deposits are insured for which each bank pays a flat premium that is normalized to zero.

Importantly, entrepreneur's choice of risk in (3) is not verifiable and cannot be contracted upon. Although banks' loan contracts cannot specify borrowers' choice of risk, each bank has to account for the entrepreneurs' risk incentives when setting the loan rate.

Accordingly, bank i in market j chooses the volume of deposits, D_{ij} , to maximize profits, taking into account choices made by its competitors and the entrepreneurs' choice of S as determined by (3). Therefore, each bank solves the following maximization problem under autarky:

$$\max_{D_{ij}} p(S(Z_j))(r_j(Z_j) - R_j(Z_j))D_{ij},$$

subject to *incentive compatibility constraint* (3). In a symmetric Cournot equilibrium, $D_{ij} = Z_j/n_j$. So, the first-order condition of the maximization problem yields equilibrium risk-shifting in market j as

$$S(n_j; a_j, b_j) = \lambda \left\{ 1 - \frac{b_j(n_j + 1)}{2(a_j + b_j)(n_j + 2)} \right\}. \quad (4)$$

It follows that an increase in competition, measured by an increase in the number of banks, n_j , decreases risk-taking, S .¹⁴ This is the bank-competitor effect.

3.2 Bank competition and risk-taking with market integration

Deposit supply and loan demand in the integrated market Suppose that m (≥ 2) out of the M segmented markets are now integrated. Integration of one or more banking markets not only increases the number of banks operating in each market but also allows local banks to transact with customers (borrowers and depositors) outside the local market.¹⁵

To simplify, we abstract from transaction and other non-pecuniary costs faced by customers switching banks. We also assume that there is no entry or exit of banks due to market integration. Consequently, the total number of banks across the m markets is the same before and after market integration and is given by

$$n(m) = \sum_{j=1}^m n_j.$$

Without loss of generality, we further assume that $n_1 \leq \dots \leq n_m$, $a_1 \geq \dots \geq a_m$, and $b_1 \geq$

¹⁴We assume that entrepreneurs' returns are perfectly correlated as in [Boyd and De Nicolò \(2005\)](#). This is equivalent to the assumption of bank portfolios being composed of perfectly correlated risks ([Allen and Gale, 2004](#)). The risk associated with each project can in general be decomposed into a systemic and idiosyncratic component. With a large number of projects, the idiosyncratic component can be perfectly diversified away. This assumption helps focus the analysis on the common component representing systematic risks. [Martinez-Miera and Repullo \(2010\)](#) present a model with imperfectly correlated project returns, whereas [Acemoglu, Ozdaglar, and Tahbaz-Salehi \(2015\)](#) consider a model of risk choice of banks with both idiosyncratic and systemic risks.

¹⁵On the other hand, a policy measure granting more banking charters would increase the number of local banks without a concomitant increase in the total number of customers available to banks.

$\dots \geq b_m$. Accordingly, the markets are heterogenous, with individual market's deposit supply and loan demand increasing in the index m .¹⁶ Therefore, when the m markets are integrated, the aggregate deposit supply and loan demand in the integrated market are given by

$$R(Z, m) = \frac{Z}{a(m)} \quad \text{where } Z = \sum_{j=1}^m Z_j \quad \text{and } a(m) = \sum_{j=1}^m \frac{1}{a_j} \quad \text{and} \quad (5)$$

$$r(L, m) = \lambda - \frac{L}{b(m)} \quad \text{where } L = \sum_{j=1}^m L_j \quad \text{and } b(m) = \sum_{j=1}^m \frac{1}{b_j}, \text{ respectively.} \quad (6)$$

The inverse deposit supply of the integrated market is the horizontal sum of the m individual inverse deposit supply schedules, and therefore, the inverse deposit supply function $R(Z, m)$ is flatter than $R_j(Z_j)$ for any $j = 1, \dots, m$. Similarly, the inverse loan demand function, $r(L, m)$, is flatter than $r_j(L_j)$ for any $j = 1, \dots, m$.

By construction, $n(m)$, $a(m)$, and $b(m)$ are all increasing in the number of integrated markets, m . For a given deposit rate, R , deposit supply in the integrated market, $a(m)R$, increases with m . Likewise, for a given loan rate, r , loan demand in the integrated market, $b(m)(\lambda - r)$, also increases with m . Competition can also be said to increase with m because of the resultant increases in deposit supply and loan demand (Raith, 2003). As more and more markets integrate, the size parameters $a(m)$ and $b(m)$ also increase, and banks face flatter deposit supply and loan demand schedules. In the limit, banks become price takers in both deposit and loan markets as described in Novshek (1980) and Allen and Gale (2004).¹⁷ Therefore, competition increases as m increases, not only because of the increase in the number of banks, $n(m)$, but also the increase in size parameters $a(m)$ and $b(m)$ so that banks behave more like price takers. Put differently, an increase in $a(m)$ and $b(m)$ denotes increased competition in the form of convergence to banks' price taking behavior in the integrated deposit and loan markets, respectively.

The bank-competitor and the bank-customer effects We solve for the symmetric Cournot equilibrium of the integrated market with $L = Z$. Accordingly, equilibrium risk-shifting is derived as a function of the number of integrated markets as

$$S(m) \equiv S(n(m), a(m), b(m)) = \lambda \left\{ 1 - \frac{1}{2} \cdot \frac{n(m) + 1}{n(m) + 2} \cdot \frac{a(m)}{a(m) + b(m)} \right\}. \quad (7)$$

Market integration affects bank risk-taking through increases in $n(m)$, $a(m)$, and $b(m)$. A simple comparative statics exercise isolates the effects of these these channels of increased competition

¹⁶Consider, for example, two markets, 1 and 2. If $b_1 > b_2$, then at any given loan rate r , the loan demand in market 2 is greater than that in 1, i.e., $\frac{\lambda-r}{b_1} < \frac{\lambda-r}{b_2}$.

¹⁷With an infinite number of markets ($M = \infty$), the analysis can be extended, so that m , n , a , and b are continuous variables and that $\lim_{m \rightarrow \infty} a(m) = \infty$ and $\lim_{m \rightarrow \infty} b(m) = \infty$.

on bank risk-taking. More formally,

$$S'(m) = \underbrace{\frac{\partial S}{\partial n} \cdot n'(m)}_{\text{bank-competitor effect}} + \underbrace{\frac{\partial S}{\partial a} \cdot a'(m) + \frac{\partial S}{\partial b} \cdot b'(m)}_{\text{bank-customer effect}} \quad (8)$$

With $n(m)$, $a(m)$, and $b(m)$ all increasing in m , the sign of each term on the right-hand side of (8) is determined by the sign on the partial derivative in each term. The signs on the partial derivatives for each of the three terms are derived in the appendix. The first term on the right-hand side of (8) is the bank-competitor effect involving the number of banks, $n(m)$. We obtain $\frac{\partial S}{\partial n} < 0$, that is, the bank-competitor effect is negative (Boyd and De Nicolò, 2005). In addition to the bank-competitor effect, market integration yields the *bank-customer effect* which is comprised of the second and third terms on the right-hand side of (8). We find that the second term is negative (because $\frac{\partial S}{\partial a} < 0$) while the third term is positive (because $\frac{\partial S}{\partial b} > 0$). In sum, the first two terms on the right-hand side of (8) are negative, while the third term is positive.

Under our moral hazard framework with limited liability, equilibrium risk-shifting increases with the loan rate as obtained in (3). Therefore, to understand the intuition behind the sign on the partial derivatives in (8), it helps to consider the effect of an increase in m on the equilibrium loan rate. First, an increase in $n(m)$, all else equal, lowers the market power of each bank. As this tends to lower the loan rate and reduce risk-taking by borrowers, the bank-competitor effect is negative. Second, an increase in $a(m)$ is an expansion in deposit supply in the integrated market and, in turn, the loanable funds available to banks at any given deposit rate. This tends to lower loan rates and reduce risk-taking by borrowers. Lastly, an increase in $b(m)$ is an expansion in loan demand in the integrated market, flattening the loan demand schedule. This tends to raise loan rates and thereby increase risk-taking by borrowers.

The bank-customer effect is comprised of two terms: a negative effect associated with deposit supply and a positive effect associated with loan demand. Because the loan demand and deposit supply effects move in opposite directions, the overall bank-customer effect depends on the relative magnitudes of the two effects. If $\varepsilon_a(m)$ and $\varepsilon_b(m)$ are the market integration elasticities of deposit supply and loan demand, the bank-customer effect can be stated in terms of the following lemma (proofs of all results are given in the appendix).

Lemma 1 *The bank-customer effect of market integration is positive, zero, or negative, according as $\varepsilon_b(m) \gtrless \varepsilon_a(m)$.*

Equilibrium risk-shifting in the integrated market The overall effect of market integration on bank risk-taking is comprised of the bank-competitor effect and the bank-customer effect as determined by (8). The bank-competitor effect in this setup is unambiguously negative. Therefore, a negative bank-customer effect that tends to lower the equilibrium rate also reinforces the bank-competitor effect. In this case, market integration reduces bank risk-taking

and a negative bank customer effect is a sufficient condition for a negative association between competition and risk-shifting. In contrast, a positive bank-customer effect tends to increase the equilibrium loan rate. If the positive bank-customer effect is sufficiently strong, it can more than offset the negative bank-competitor effect, resulting in an increase in bank risk-taking. Therefore, a positive bank-customer effect is a necessary condition for a positive association between competition and risk-shifting. Taken together, the overall effect of market integration on risk-taking can be indeterminate, as summarized by the following Proposition.

Proposition 1 *Equilibrium risk-shifting, $S(m)$, is strictly decreasing in $n(m)$ and $a(m)$, but strictly increasing in $b(m)$. Therefore, the overall effect of an increase in the number of integrated markets, m , on $S(m)$ is indeterminate.*

As mentioned above, the equilibrium risk-shifting result in [Boyd and De Nicolò \(2005\)](#) emerges as a special case in our formulation, namely, the case of *market replication*. In their model of deposit market competition, [Allen and Gale \(2004, p. 463\)](#) describe market replication whereby “as the number of banks is increased, the number of depositors is increased proportionately, so that the supply of funds in relation to a particular bank is unchanged.” Consider the integration of m markets where $n_j = \bar{n}$, $a_j = \bar{a}$, and $b_j = \bar{b}$ for all $j = 1, \dots, m$. In this special case, the integration of m markets is equivalent to replicating any of the (identical) individual markets m times over. Under market replication, it follows from [Lemma 1](#) that $\varepsilon_a(m) = \varepsilon_b(m)$, so that the bank customer effect is zero. Therefore, the effect of market replication on risk-shifting is composed entirely of the (negative) bank-competitor effect.

3.3 Relationship between risk-shifting and competition: an example

To conclude this section, we present an example of the preceding analysis using specific functional forms. This example illustrates how risk-shifting can change with market integration. We assume $n_j = j$ so that

$$n(m) = \sum_{j=1}^m j = \frac{m(m+1)}{2}.$$

Additionally, for expressions in [\(5\)](#) and [\(6\)](#), we take

$$a(m) = m^\alpha \quad \text{and} \quad b(m) = m^\beta \quad \text{with} \quad \alpha, \beta \in [0, 1].$$

When $a_j = b_j = m$ for all j , it follows that $\alpha = \beta = 0$. Also, when $a_j = b_j = 1$ for all j , $\alpha = \beta = 1$. For any other distribution of $\{a_j\}_{j=1}^m$ and $\{b_j\}_{j=1}^m$, we have $\alpha, \beta \in (0, 1)$ and $a(m), b(m) \in (1, m)$. Using [\(7\)](#), we derive the expression for the equilibrium risk-shifting as

$$S(m; \alpha, \beta) = \lambda \left\{ 1 - \frac{1}{2} \cdot \frac{m(m+1) + 2}{m(m+1) + 4} \cdot \frac{1}{1 + m^{\beta-\alpha}} \right\}. \quad (9)$$

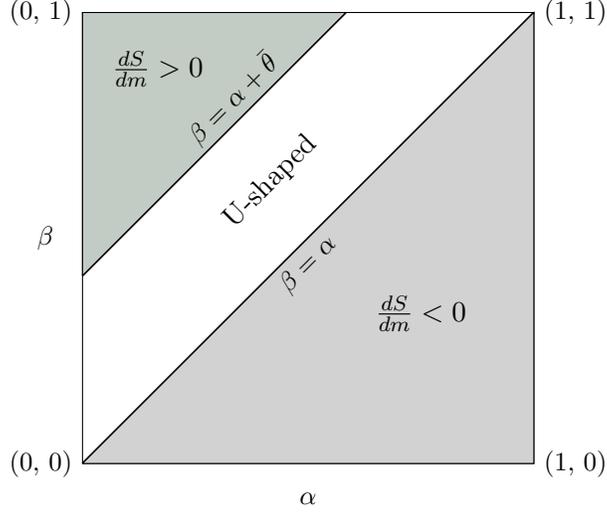


Figure 1: *Equilibrium association between risk-shifting and the number of integrated markets when $n(m) = m(m + 1)/2$, $a(m) = m^\alpha$ and $b(m) = m^\beta$.*

Figure 1, depicts different risk-shifting equilibria in (α, β) space. The details and proof are provided in the appendix. From Lemma 1, it follows that whenever $\beta \leq \alpha$, the bank-customer effect is negative. As a result, equilibrium risk-shifting is declining in the number of integrated markets and the negative bank-customer effect is a sufficient condition for this negative association.

However, when $\beta > \alpha$, the bank-customer effect is strictly positive and leans against the negative bank-competitor effect. In the appendix, we show that when the difference $(\beta - \alpha)$ is sufficiently large so that $\beta \geq \alpha + \bar{\theta}$, where $\bar{\theta} \approx 0.435$, the positive bank-customer effect dominates the negative bank-competitor effect for all values of m , and hence, the equilibrium association between risk-shifting and competition is positive.

Finally, if $\beta \in (\alpha, \alpha + \bar{\theta})$, the positive bank-customer effect is not strong enough to outweigh the negative bank-competitor effect for all m . If fewer markets are integrated, (i.e., m is small), the bank-competitor effect dominates the bank-customer effect, and consequently, the equilibrium risk-shifting is decreasing in m . In contrast, when a large number of markets are integrated, (i.e., m is sufficiently large), the bank-customer effect dominates the bank-competitor effect, and the equilibrium risk-shifting is increasing in m . Put differently, bank risk-shifting first decreases and then increases with the number of integrated markets generating a non-monotonic (*U-shaped*) relationship between risk-shifting and market integration.

4 A general model of bank competition and risk-taking

This section presents a generalized version of the model in the previous section. All agents are risk neutral. The analysis focuses on how risk-taking by banks changes as m segmented markets are integrated. The analysis above shows how equilibrium interest rates for deposits and loans depend on the number of integrated markets. The inverse deposit supply function in the integrated market is given by $R = R(Z, m)$ where $Z = \sum_{i=1}^{n(m)} D_i$ and D_i denotes the total deposits of the bank i in the integrated market. On the other hand, the inverse loan demand function is given by $r = r(L, m)$ where $L = \sum_{i=1}^{n(m)} L_i$ and L_i denotes the total loans of the bank i in the integrated market. We assume

$$(1) \quad R(0, m) \geq 0 \text{ for all } m; \partial R/\partial Z > 0, \partial R/\partial m \leq 0 \text{ and } \partial^2 R/\partial m \partial Z \leq 0 \text{ for all } (Z, m);$$

$$(2) \quad r(0, m) \geq R(0, m) \text{ for all } m; \partial r/\partial L < 0, \partial r/\partial m \geq 0 \text{ and } \partial^2 r/\partial m \partial L \geq 0 \text{ for all } (L, m).$$

These assumptions indicate how deposit and loan rates change with market integration. While the expansion deposit supply tends to decrease deposit rates, the expansion in loan demand tends to increase the loan rate. Moreover, as more and more markets integrate, deposit supply and loan demand expand, both schedules becomes flatter, and each bank behaves more like a price taker.

For entrepreneurs, the probability of success for the project is given by $p(S)$, which is defined on $[0, S_{max}]$, with $p(0) = 1$, $p(S_{max}) = 0$, $p'(S) < 0$, $p''(S) \leq 0$ and $Sp(S)$ strictly concave. Given a loan rate, r , entrepreneurs choose S according as

$$S = \underset{\tilde{S} \in [0, S_{max}]}{\operatorname{argmax}} \quad p(\tilde{S})(\tilde{S} - r). \quad (10)$$

The objective function in (10) is strictly concave in S and the interior solution to (10) is given by the first-order condition

$$h(S) \equiv S + \frac{p(S)}{p'(S)} = r(L, m). \quad (11)$$

Equation (11) shows how entrepreneurs' choice of risk-shifting, S , varies with the loan rate r . From our assumptions that $p(S)$ is decreasing and concave in S , we obtain $h'(S) > 0$. It follows that the entrepreneur's choice of S increases with the loan rate, $r(L, m)$. We state this formally in terms of the following lemma.

Lemma 2 *Optimal risk-shifting, $S(L, m)$ is decreasing in aggregate loan volume, L , but non-decreasing in the number of integrated markets, m .*

As in the previous section, we make two simplifying assumptions: (1) bank deposits are insured at a flat rate per-dollar which is normalized to zero and (2) banks have no equity so that the balance sheet identity yields $L = Z = \sum_{i=1}^n D_i$. In a Cournot-Nash equilibrium, each bank

i chooses the amount of deposits, D_i to maximize its expected profits. Therefore, bank i solves the following maximization problem:

$$\max_{D_i} p(S(Z, m))\mu(Z, m)D_i, \quad (12)$$

subject to the incentive compatibility constraint (11), where $Z = \sum_{i=1}^{n(m)} D_i$ is the aggregate deposits of the integrated market, $S(Z, m) \in [0, S_{max}]$ is the risk-shifting function, and $\mu(Z, m) \equiv r(Z, m) - R(Z, m)$ is the *intermediation margin* of each bank under the market-clearing condition $L = Z$. The first-order condition of the above maximization problem is given by

$$\mu(Z, m)(p'(S(Z, m))S_1(Z, m)D_i + p(S(Z, m))) = -p(S(Z, m))\mu_1(Z, m)D_i.$$

In a symmetric interior equilibrium, we have $D_i = Z/n(m)$ for all $i = 1, \dots, n(m)$, and therefore, the above first-order condition reduces to

$$\mu(Z, m) = F(Z, m), \quad (13)$$

where

$$F(Z, m) \equiv - \frac{(\partial\mu/\partial Z)p(S(Z, m))Z}{p'(S(Z, m))(\partial S/\partial Z)Z + n(m)p(S(Z, m))}.$$

The second-order (necessary) condition for the interior solution associated with (12) is given by

$$\eta(Z, m) \equiv \frac{\partial\mu}{\partial Z}(Z, m) - \frac{\partial F}{\partial Z}(Z, m) < 0. \quad (14)$$

The intermediation margin, $F(Z, m)$ of each bank is strictly positive because $\partial\mu/\partial Z < 0$, $p'(S) < 0$ and $\partial S/\partial Z < 0$. Totally differentiating (13) we obtain

$$\frac{dZ}{dm} = - \frac{\partial\mu/\partial m - \partial F/\partial m}{\eta(Z, m)}.$$

Given that in equilibrium $S = S(Z, m)$, from the above it follows that

$$\frac{dS}{dm} = \frac{\partial S}{\partial Z} \cdot \frac{dZ}{dm} + \frac{\partial S}{\partial m} = \underbrace{\left(-\frac{\partial S}{\partial Z} \cdot \frac{1}{\eta(Z, m)} \right)}_{<0} \left(\frac{\partial\mu}{\partial m}(Z, m) - \frac{\partial F}{\partial m}(Z, m) \right) + \underbrace{\frac{\partial S}{\partial m}}_{\geq 0}. \quad (15)$$

Note that $\partial\mu/\partial m \geq 0$ because $\partial r/\partial m \geq 0$ and $\partial R/\partial m \leq 0$. However, the sign of $\partial F/\partial m$ is indeterminate. As a result, the expression $(\partial\mu/\partial m - \partial F/\partial m)$ can be either positive or negative. Therefore, in a symmetric interior equilibrium, the effect of market integration on the equilibrium level of risk-shifting is in general indeterminate.

5 Market integration, bank mergers and risk-shifting

In this section, we extend our analysis of how market integration affects bank risk-taking by including the possibility of bank mergers. In doing so, we relax our assumption of no entry or exit of banks due to market integration. Our aim here is to provide a parsimonious model that reflects how market integration affects risk-taking by facilitating mergers. Empirical work has highlighted the efficiency-enhancing role of mergers (Berger et al., 1999; DeYoung et al., 2009). We assume heterogeneity in operating costs (non-interest expenses) to capture differences in efficiencies, with more efficient banks having lower operating costs. Moreover, the source of differences in efficiency has been attributed to the lack of competition due to restrictions on geographic expansion that provided banks with local monopoly power (Kroszner, 2001). Accordingly, we assume that prior to integration, operating costs vary by market but they are identical within each market.

To simplify the analysis, we assume that, aside from differences in bank operating costs, the banking markets are homogenous. The assumption of homogenous markets implies that the aforementioned bank-customer effect is zero. In this setting, we show that, under certain regularity conditions, market integration not only facilitates competition between heterogenous banks (i.e., both efficient and inefficient banks make non-negative profits as they compete in the integrated market) but also incentivizes mergers between them (i.e., mergers between efficient and inefficient banks increases profits).

In the absence of the bank customer effect, the implications for bank-risk taking are straightforward. With an increase in the number of banks in the post-integration equilibrium, bank risk-taking is lower than that in the autarky equilibrium because of the bank-competitor effect. However, mergers increase market concentration and risk-taking in the post-merger equilibrium is higher than that in the post-integration equilibrium. With the bank-customer effect set to zero, our analysis reveals an additional channel by which market integration can lead to an increase in bank risk-taking, namely by facilitating bank mergers.

5.1 Pre-integration equilibrium

We focus our analysis on two banking markets that are initially segmented, which we denote as market 1 and market 2. Both markets have the same number $n (\geq 1)$ of banks, and the deposit supply and loan demand schedules in each market are given by (1) and (2), respectively. The model setup closely follows Section 3, with one exception. We assume, without loss of generality, that $a_1 = a_2 = 1$ and $b_1 = b_2 = 1$. With this assumption, it follows from lemma 1 that the bank-customer effect is zero. Nullifying the bank-customer effect allows us to focus on yet another channel by which market integration can adversely affect bank risk-shifting.

We assume that bank i 's operating costs in market j is given by

$$C_{ij}(D_{ij}) = c_j D_{ij}.$$

While banks' operating cost of funds, c_j , differ across markets, they are identical within each market. We use the shorthand type- j bank to mean a bank with cost of operations, c_j .¹⁸ The differences in operating costs can be viewed as reflecting differences in efficiencies, with more efficient banks having lower operating costs. Without loss of generality, we assume that $0 = c_1 < c_2 = c < \lambda$, that is, banks in market 1 are more efficient.

Using (4), the expressions for equilibrium risk-shifting in markets 1 and 2 are derived as

$$S_1^0(n, c) = \lambda - \frac{\lambda(n+1)}{4(n+2)}, \quad \text{and} \quad S_2^0(n, c) = \lambda - \frac{(\lambda-c)(n+1)}{4(n+2)}$$

respectively. The expressions confirm the bank-competitor effect in the pre-integration (autarkic) equilibrium—bank risk-shifting within each market is strictly decreasing in the number of banks, n . With $c > 0$, it follows that $S_2^0(n, c) > S_1^0(n, c)$. Bank risk-shifting is lower in the market where banks have lower operating costs. Put differently, equilibrium risk-taking is higher if banks are less efficient.

5.2 Post-integration equilibrium

When markets 1 and 2 integrate, each bank faces the following deposit supply and loan demand schedules

$$R(Z) = \frac{Z}{2} \quad \text{where} \quad Z = Z_1 + Z_2, \quad (16)$$

$$r(L) = \lambda - \frac{L}{2} \quad \text{where} \quad L = L_1 + L_2, \quad (17)$$

with Z_j and L_j ($j = 1, 2$) denoting the aggregate deposits and loans of the type- j banks in the integrated market. Just as in Section 3, we assume that, initially, there is no entry or exit of banks due to integration. Therefore, the integrated market has $2n$ banks out of which n are low-cost and n are high-cost banks.

From the incentive compatibility constraint (3), entrepreneurs' choice of risk-shifting is given as

$$S(L) = \lambda - \frac{L}{4}. \quad (18)$$

Again, entrepreneurs' risk-shifting is decreasing in the aggregate loan volume, L . Using (18) and the fact that $L = Z$, the expected profit of each type- j bank becomes

$$\pi_j = p(S(Z)) (r(Z) - R(Z) - c_j) D_j = \frac{Z}{4\lambda} (\lambda - c_j - Z) D_j \quad j = 1, 2.$$

In a symmetric equilibrium, each type- j chooses the same amount of deposits, $D_j = Z_j/n$, to

¹⁸The cost function described here is similar to the Monti-Klein model of bank competition (e.g. Klein, 1971) where costs are typically a function of both deposits and loans. However, given that banks in our model do not hold equity, it is fairly innocuous to assume that the cost function depends only on the volume of deposits.

maximize its expected profit. In the integrated market, total deposits for individual bank types, Z_1 and Z_2 , are solutions to the following first order conditions

$$(Z_1 + Z_2) [\lambda - (Z_1 + Z_2)] + \frac{Z_1}{n} [\lambda - 2(Z_1 + Z_2)] = 0 \quad (19)$$

$$\text{and } (Z_1 + Z_2) [(\lambda - c) - (Z_1 + Z_2)] + \frac{Z_2}{n} [(\lambda - c) - 2(Z_1 + Z_2)] = 0, \quad (20)$$

respectively. The result can be summarized in the following lemma.

Lemma 3 *Let $Z_j^* \equiv Z_j^*(n, \lambda, c)$ be the equilibrium deposits of the type- j banks in the integrated market. If $c < \bar{c} \equiv \frac{\lambda}{n+2}$, all banks make loans so that $Z_1^* > 0$, $Z_2^* > 0$, and aggregate deposits, $Z^* = Z_1^* + Z_2^*$, is given by*

$$Z^*(n, c) = \frac{(2\lambda - c)(3n + 2) + \sqrt{c^2(3n + 2)^2 + 4\lambda(\lambda - c)n^2}}{8(n + 1)}.$$

However, if $c \geq \bar{c}$, the difference in costs between the two bank types is sufficiently large so that high-cost banks do not lend in the integrated market and $Z_2^* = 0$.¹⁹ As a result, the integrated market comprises of only low-cost banks from market 1 and, $Z^* = Z_1^*$. Lemma 3 shows that when the cost differential is sufficiently small (i.e., $c < \bar{c}$), both bank types compete in the integrated market (i.e. their loan amounts are strictly positive). Using this result, equilibrium risk-shifting in the integrated market can be characterized by the following proposition.

Proposition 2 *In an equilibrium where both bank types compete in the integrated market, risk-shifting is given by*

$$S^*(n, c) = \lambda - \frac{(2\lambda - c)(3n + 2) + \sqrt{c^2(3n + 2)^2 + 4\lambda(\lambda - c)n^2}}{32(n + 1)}.$$

Both high-cost and low-cost banks take less risk in the integrated market so that $S^(n, c) < S_j^0(n, c)$ for $j = 1, 2$.*

With the bank-customer effect set to zero by design, market integration increases the number of competitor banks and yields an equilibrium loan rate that is lower than the pre-integration equilibrium loan rates in markets 1 and 2. As a result, equilibrium bank risk-shifting in the integrated market is lower than risk-shifting in markets 1 and 2 under autarky.

5.3 Bank mergers in the integrated market and risk-taking

When the cost difference between high- and low-cost banks is sufficiently small, that is $c < \bar{c}$, both bank types make positive profits in the integrated market. We now show that, under the

¹⁹The precise conditions under which $Z_2^* \leq 0$ are $\lambda \leq 3c$ and $n \geq 1$.

same regularity conditions (i.e., $c < \bar{c}$), any merger between a low-cost and a high-cost bank is profitable.

We solve the model for one such equilibrium wherein each low-cost bank acquires exactly one high-cost bank and the merged entity takes the (zero) operating cost of the low-cost bank. In doing so, we are assuming that the merged entity captures the entire efficiency gains from the merger. As result, the post-merger integrated market is comprised of n low-cost banks.

Proposition 3 *In an equilibrium where $c < \bar{c} \equiv \frac{\lambda}{n+2}$, each low-cost bank acquires exactly one high-cost bank, and the merged entity has the (zero) operating cost of the low-cost bank, the following results hold:*

- (a) *mergers are profitable, that is, the profits of the merged entity is greater than the sum of the profits of the individual banks prior to the merger;*
- (b) *post-merger levels of bank risk-shifting in the integrated market, S_M , is greater than pre-merger levels of bank risk-shifting, S^* , but also equals the risk-shifting of banks in the low-cost market, S_1^0 , prior to market integration, that is,*

$$S^*(n, c) < S_M(n) = S_1^0(n, c);$$

- (c) *for each n , there is a unique $c^* \in (0, \bar{c})$ such that the expected social welfare of the integrated market in the post-merger equilibrium is greater than that in the pre-merger equilibrium, if and only if $c > c^*$.*

Each low-cost bank acquires exactly one high-cost bank so that there are only n low-cost banks in this post merger equilibrium. The supply of deposits and demand for loans are given by (16) and (17), respectively. With only n type-1 banks in the integrated market, each bank chooses deposits D_i to maximize

$$\pi_i = p(S(Z)) (r(Z) - R(Z)) D_i = \frac{Z}{4\lambda} (\lambda - 2Z) D_i.$$

Solving the maximization problem, we denote the expected profits for each merged entity as $\pi_M(n, \lambda)$. We obtain that mergers are profitable, that is,

$$\pi_M(n) > \pi_1^*(n, c) + \pi_2^*(n, c),$$

where π_1^* and π_2^* denote the expected pre-merger profits in the integrated market of the type-1 and type-2 banks, respectively. Importantly, mergers are profitable under the same regularity conditions as those required for the interior equilibrium (cf. Lemma 3).

The symmetric equilibrium risk-shifting, which follows immediately from (4), is given by

$$S_M(n) = \lambda - \frac{\lambda(n+1)}{4(n+2)} = S_1^0(n, c).$$

In the absence of any bank-customer effect, the effect on risk-taking is comprised entirely of the bank-competitor effect. Mergers reduce the number of banks in the integrated market, thereby raising loan rates and risk-taking by entrepreneurs. Equilibrium risk-taking in the post-merger equilibrium is the same as that of the equilibrium in market 1, prior to market integration because both equilibria consist of the same n low-cost banks.

Finally, from the standpoint of social welfare, the results from the merger analysis offers an important insight. Social welfare is defined as the sum of the surplus obtained by depositors, borrowers, and banks. In the post-merger equilibrium described above, profitable mergers capture efficiency gains and unambiguously increase bank surplus. However, mergers also have countervailing effects on bank-customers (borrowers and depositors). The increase in market power from bank mergers tends to increase the loan rate, thereby lowering borrower surplus. Increased market power also tends to decrease the deposit rate, reducing depositor surplus. Relative to the pre-merger equilibrium, the post-merger equilibrium yields a larger surplus for banks but a smaller surplus for bank-customers (depositors and borrowers). In the appendix, we show that when merger efficiency gains are sufficiently small ($c \leq c^*$), the decrease in customer surplus exceeds the increase in bank surplus, reducing social welfare in the post-merger equilibrium. For the expected social welfare to be higher in the post-merger equilibrium, efficiency gains have to be sufficiently high ($c > c^*$). In other words, despite efficiency gains for banks, mergers are not always and everywhere welfare enhancing.

5.4 Some general implications of bank mergers for risk-taking

The stylized model above makes simplifying assumptions including (1) the number of low- and high-cost banks in the integrated market are the same, so that $n_1 = n_2$, and (2) each low-cost bank acquires exactly one high-cost bank. This simplified baseline case can be extended to different situations, wherein $n_1 \neq n_2$ and multiple dissimilar (high-cost and low-cost) banks merge. For example, relaxing condition (1), so that $n_1 \geq n_2$, does not materially change Proposition 3 in that equilibrium bank risk-taking in market 1 under autarky and in the integrated market post-merger are equivalent, that is, $S_M = S_1^0$. Alternatively, $n_2 > n_1$, yields $S_M \in (S^*, S_1^0)$; bank risk-taking increases from the post-integration pre-merger equilibrium, but remains below the market-1 levels obtained under autarky. In this setup, the change in equilibrium bank risk-taking is determined by the change in the number of banks due to the mergers. Since mergers between banks with similar costs are not profitable, the number of low-cost banks creates a lower bound to the number of banks in the post-merger equilibrium. In sum, risk-taking increases with bank mergers in the integrated market, but this increase is bounded above by bank risk-taking

in market 1 under autarky.

In alternative formulations, bank risk-taking in a post-merger integrated market can increase beyond levels obtained in the autarkic equilibrium. These formulations can be described as follows. First, bank risk-shifting in a post-merger equilibrium can be greater than autarkic levels if the bank-customer effect is positive. In terms of the formulation above, with (1) and (2) denoting market j 's deposit supply and loan demand schedules, respectively, we can relax our earlier assumption so that $a_1 \neq a_2$ and $b_1 \neq b_2$. Under these conditions, the bank-customer effect is positive if and only if

$$\frac{b_1}{b_2} > \frac{a_1}{a_2}. \quad (21)$$

We obtain $S_M > S_1^0$ if and only if the bank-customer effect is positive (see Appendix for a formal proof). Bank risk-shifting in the post-merger integrated market can exceed autarkic levels because both bank-competitor and bank-customer effects increase bank risk taking.

Second, post-merger bank risk-taking can increase beyond their autarkic levels, if banks can sustain collusive behavior. In terms of our framework, the takeover of all the high-cost banks yields a symmetric banking market comprised of only low-cost banks in the post-merger equilibrium. Previous research has shown that collusive outcomes are easier to sustain when markets are symmetric.²⁰ This *pro-collusive effect* of mergers tends to raise loan rates and increase risk-taking beyond that obtained at the autarkic level.

Third, a richer setup that yields synergies with mergers between similar banks can also lead to increased risk-taking. Our setup allows for efficiency gains only from mergers between dissimilar banks, such as the merger between a high-cost and low-cost bank. As a result, the post-merger equilibrium comprises of low-cost banks only. Any scenario which could sustain subsequent mergers among these surviving low-cost banks would increase risk-taking beyond autarkic levels. [Boyd and Graham \(1998\)](#) present an account of mergers between similar and relatively larger (cost-efficient) banks throughout the 1980s and 1990s.

6 Conclusion

The existing theoretical literature examining the linkages of competition and financial stability has often defined an increase in competition simply as an increase in the number of competitor banks. Theory has shown that when banks compete in both deposit and loan markets where the bank sets the loan rate and the borrower determines project risk, strategic interaction between the bank and the borrower will lower the borrowers' choice of optimal risk as the number of competitor banks increase.

²⁰[Bernheim and Whinston \(1990\)](#) show that tacit collusion is easier when firms are symmetric with respect to production costs and market shares. See [Motta \(2004, Chapter 4\)](#) for a detailed analysis of how symmetry among firms facilitates collusive agreements.

Meanwhile, the source of increased competition since the early 1970s can be traced to branching deregulation and removal of restrictions on geographical expansion both within and across state borders. In studying the impact of increased competition from market integration on bank risk-taking, we find that its influence extends beyond that explained by a simple increase in the number of banks. Market integration not only increases the number of rivals each bank faces in a given market, but also increases each bank's potential customer base (depositors and borrowers). The expansion in customer base yields increased competition in the form of convergence to banks' price-taking behavior in both the loan and deposit market. As the market expands due to integration, it increases deposit supply available at a given rate, thereby raising the supply of loanable funds and putting downward pressure on the loan rate. This dampens borrowers' incentives for risk-taking and reinforces the negative association between competition and risk-taking due to an increase in the number of banks. However, market integration also tends to increase loan demand which puts an upward pressure on the loan rate, thereby increasing borrowers' incentives for risk-taking. The overall impact of increased competition from market integration clearly extends beyond a simple increase in the number of banks and with a sufficiently strong expansion in loan demand, can even increase the borrowers' choice of optimal risk. In addition, we show that market integration can also affect risk-taking by facilitating efficiency-enhancing bank mergers in any post-integration equilibrium. Bank mergers increase market concentration, thereby raising the borrowers' choice of optimal risk.

To the best of our knowledge, this paper is the first to examine the effect of market integration on risk-taking. While future modeling efforts can include richer settings that improve our understanding about the linkages between competition and stability in banking, we have opted for a simpler and more tractable approach. Even in this parsimonious setting, the effect of competition on bank risk-taking extends beyond a mere increase in the number of local banks. Still, existing research and policy analysis focus on local retail competition studying changes in the number of competitor banks within a limited geographic area. Our analysis would suggest that a re-examination of the idea that bank competition is confined to local markets may be overdue.

Appendix

Proof of Lemma 1

The bank-customer effect is given by

$$\frac{\partial S}{\partial a} a'(m) + \frac{\partial S}{\partial b} b'(m) = \frac{\lambda(n(m) + 1)[a(m)b'(m) - b(m)a'(m)]}{2(a(m) + b(m))^2(n(m) + 2)}.$$

The above term is positive if and only if

$$a(m)b'(m) - b(m)a'(m) > 0 \iff \underbrace{\frac{mb'(m)}{b(m)}}_{\varepsilon_b(m)} > \underbrace{\frac{ma'(m)}{a(m)}}_{\varepsilon_a(m)}.$$

This completes the proof of the lemma. \square

Proof of Proposition 1

The incentive compatibility constraint of the entrepreneurs is given by:

$$S(L, m) = \operatorname{argmax}_{S \in [0, \lambda]} \left(1 - \frac{S}{\lambda}\right) \left\{S - \left(\lambda - \frac{L}{b(m)}\right)\right\} = \lambda - \frac{L}{2b(m)}. \quad (22)$$

From the above it follows that the probability of success is given by

$$p(L, m) \equiv p(S(L, m)) = \frac{L}{2\lambda b(m)}.$$

Using the equilibrium condition $Z = \sum_{i=1}^{n(m)} D_i = L$, each bank's intermediation margin is given by

$$\mu(Z, m) \equiv r(Z, m) - R(Z, m) = \lambda - Z \left(\frac{1}{b(m)} + \frac{1}{a(m)}\right).$$

Each bank i chooses D_i , subject to $S(L, m) \in [0, \lambda]$, to solve

$$\max_{D_i} \left\{ p(Z, m) \mu(Z, m) D_i = \frac{L}{2\lambda b(m)} \left[\lambda - Z \left(\frac{1}{b(m)} + \frac{1}{a(m)} \right) \right] D_i \right\}.$$

The first-order condition of the above maximization problem is given by

$$\mu(Z, m)(p_1(Z, m)D_i + p(Z, m)) = -p(Z, m)\mu_1(Z, m)D_i \quad (23)$$

In a symmetric equilibrium, $D_i = Z/n(m)$ for all $i = 1, \dots, n(m)$, and hence, (23) reduces to:

$$\begin{aligned} & \left\{ \lambda - Z \left(\frac{1}{a(m)} + \frac{1}{b(m)} \right) \right\} \left\{ \frac{Z}{2\lambda a(m)b(m)n(m)} + \frac{Z}{2\lambda a(m)b(m)} \right\} \\ &= \frac{Z}{2\lambda a(m)b(m)} \left\{ \frac{1}{a(m)} + \frac{1}{b(m)} \right\} \frac{Z}{n(m)}. \end{aligned}$$

The above yields the equilibrium aggregate deposits which is given by

$$Z(m) \equiv Z(n(m), a(m), b(m)) = \frac{\lambda a(m)b(m)(n(m) + 1)}{(a(m) + b(m))(n(m) + 2)}. \quad (24)$$

Therefore, it follows from (22) that

$$S(m) = S(Z(m), m) = \lambda - \frac{Z(m)}{2b(m)} = \lambda \left\{ 1 - \frac{1}{2} \cdot \frac{n(m) + 1}{n(m) + 2} \cdot \frac{a(m)}{a(m) + b(m)} \right\}. \quad (25)$$

Partially differentiating the above expression with respect to n , a and b , respectively we obtain

$$\begin{aligned} \frac{\partial S}{\partial n} &= -\frac{\lambda a}{2(a+b)(n+2)^2} < 0; \\ \frac{\partial S}{\partial a} &= -\frac{\lambda b(n+1)}{2(a+b)^2(n+2)} < 0; \\ \frac{\partial S}{\partial b} &= \frac{\lambda a(n+1)}{2(a+b)^2(n+2)} > 0. \end{aligned}$$

The above three inequalities establish the proposition. \square

Analysis of Section 3.3

Let $a(m) = m^\alpha$, $b(m) = m^\beta$ and $n(m) = m(m+1)/2$. The equilibrium risk-shifting in this case is given by (9). We state the following lemma which has been depicted in Figure 1.

Lemma 4 *Let $S(m)$ be the equilibrium risk-shifting given in (9). Then,*

- (i) *if $\beta \leq \alpha$, then equilibrium risk-shifting is monotonically decreasing in m ;*
- (ii) *If $\beta \in (\alpha, \alpha + \bar{\theta})$ where $\bar{\theta} \approx 0.435$, then equilibrium risk-shifting is U-shaped with respect to the number of integrated markets, i.e., there is a unique $\hat{m}(\theta) > 2$ with $\hat{m}'(\theta) < 0$ such that equilibrium risk-shifting is monotonically decreasing (increasing) in m for all $m < (>) \hat{m}(\theta)$;*
- (iii) *If $\beta \geq \alpha + \bar{\theta}$, then equilibrium risk-shifting is monotonically increasing in m .*

Proof Let $\theta \equiv \beta - \alpha$. Because $0 \leq \alpha, \beta \leq 1$, we have $-1 \leq \theta \leq 1$. Differentiating the expression in (9) with respect to m we obtain

$$\frac{dS}{dm} = \frac{\lambda m^{\theta-1}(2+m+m^2)}{2(1+m^\theta)^2(4+m+m^2)} \underbrace{\left(\theta - \frac{2m(1+2m)(1+m^{-\theta})}{(2+m+m^2)(4+m+m^2)} \right)}_{H(m; \theta)}. \quad (26)$$

Therefore, $\text{sign}[dS/dm] = \text{sign}[H(m; \theta)]$. Note first that $\theta \leq 0$, i.e., $\beta \leq \alpha$ implies that $H(m; \theta) < 0$ for all $m \geq 2$, and hence, $dS/dm < 0$. Next, consider $\theta \in (0, 1]$. In this case, the bank-customer effect is positive. Note that

$$H_2(m; \theta) = 1 + \frac{2m^{1-\theta}(1+2m)(\log m)}{(2+m+m^2)(4+m+m^2)} > 0 \quad \text{for all } m \geq 2,$$

i.e., $H(m; \theta)$ is strictly increasing in θ for all $m \geq 2$. Write $H(m; \theta) = \theta - h(m)g(m; \theta)$, where

$$h(m) \equiv \frac{2m(1+2m)}{(2+m+m^2)(4+m+m^2)} \quad \text{and} \quad g(m; \theta) \equiv 1 + m^{-\theta}.$$

Note that $h(m) > 0$ and $g(m; \theta) > 0$ for all $m \geq 2$ and $\theta > 0$. Clearly, $h(m)$ is strictly decreasing in m , i.e., $h'(m) < 0$ for all $m \geq 2$, and $g(m; \theta)$ is strictly decreasing in m for all $\theta > 0$ as $g_1(m; \theta) = -\theta m^{-(1+\theta)} < 0$. Therefore, $H_1(m; \theta) = -(h'(m)g(m; \theta) + h(m)g_1(m; \theta)) > 0$. It can also be shown that $H(m; \theta)$ is strictly concave in m . Next, note that

$$\lim_{m \rightarrow \infty} H(m; \theta) = \theta.$$

The above expression is equal to 0 for $\theta = 0$, i.e., $\beta = \alpha$, and is strictly positive for any $\theta > 0$, i.e., $\beta > \alpha$. Finally,

$$H(2; \theta) = \theta - \frac{1}{4} \left(1 + 2^{-\theta}\right).$$

Because $H(2; \theta)$ is strictly increasing in θ , $H(2; 0) = -0.5$ and $H(2; 0.5) \approx 0.073$, by the Intermediate Value theorem, there is a unique $\bar{\theta} \in (0, 0.5)$ such that $H(2; \bar{\theta}) = 0$. It turns out that $\bar{\theta} \approx 0.435$. Therefore, for any $\theta \in (0, \bar{\theta})$, $H(m; \theta) < 0$ if and only if $m < \hat{m}(\theta)$. Note that, for any $\theta \in (0, \bar{\theta})$, we have $H(2; \theta) < 0$ and $\lim_{m \rightarrow \infty} H(m; \theta) = \theta > 0$, and hence, the Intermediate Value theorem guarantees the existence of $\hat{m}(\theta)$. Because $H(m; \theta)$ is strictly increasing in m for all $\theta > 0$, $\hat{m}(\theta)$ is unique. Finally, $\hat{m}'(\theta) < 0$ as $H(m; \theta)$ is strictly increasing in θ . Finally, for any $\theta > \bar{\theta}$, we have $H(m; \theta) > 0$ for all $m \geq 2$. Figure 2 summarizes the above discussion. \square

One can alternatively consider slope functions linear with respect to m , i.e., $a(m) = 1 + \alpha(m - 1)$ and $b(m) = 1 + \beta(m - 1)$ with $\alpha, \beta \in [0, 1]$, in which case we obtain similar results as Lemma 4. The proof is available upon request. \square

Proof of Lemma 2

Note that

$$h'(S) = 2 - \frac{p(S)p''(S)}{(p'(S))^2} \geq 2$$

because $p''(S) \leq 0$ by assumption. Differentiating (11) with respect to L we obtain

$$h'(S(L, m)) \frac{\partial S}{\partial L}(L, m) = \frac{\partial r}{\partial L}(L, m).$$

Because $\partial r / \partial L < 0$, we have $\partial S / \partial L < 0$. Similarly, differentiating (11) with respect to m we obtain

$$h'(S(L, m)) \frac{\partial S}{\partial m}(L, m) = \frac{\partial r}{\partial m}(L, m).$$

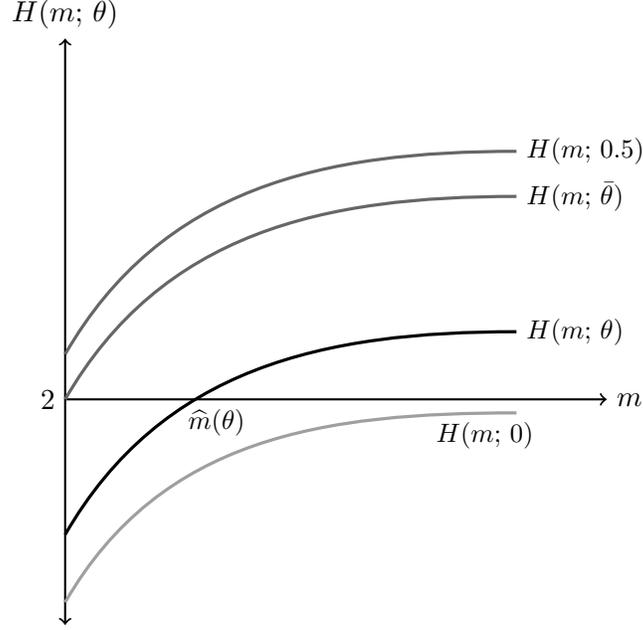


Figure 2: For $\theta = 0$, $H(m; \theta) < 0$, and hence, $dS/dm < 0$. For any $\theta \in (0, \bar{\theta})$, $H(m; \theta)$ intersects the horizontal axis at a unique point $\hat{m}(\theta)$, i.e., $H(m; \theta) < (>) 0$ if $m < (>) \hat{m}(\theta)$, and hence, $S(m)$ is U-shaped with respect to m . For any $\theta \in (\bar{\theta}, 1]$, $H(m; \theta) > 0$, and hence, $dS/dm > 0$.

Because $\partial r/\partial m \geq 0$, we have $\partial S/\partial m \geq 0$. □

Proof of Lemma 3

There are three sets of solutions (Z_1, Z_2) to the simultaneous equation system (19) and (20). The first set is discarded because it has $Z_1 = Z_2 = 0$. The final expressions for Z_1 and Z_2 in the other two sets of solutions are very cumbersome, so we omit them. One set of Z_1 and Z_2 yields

$$Z = Z_1 + Z_2 = \frac{(2\lambda - c)(3n + 2) - \sqrt{c^2(3n + 2)^2 + 4\lambda(\lambda - c)n^2}}{8(n + 1)}.$$

Note that, at $c = 0$, the above expression becomes $\lambda/2$ which is independent of n . This is not consistent with the expression for risk-shifting in (7), and hence, is discarded. The last set of solutions (Z_1, Z_2) yields

$$Z^*(n, c) = \frac{(2\lambda - c)(3n + 2) + \sqrt{c^2(3n + 2)^2 + 4\lambda(\lambda - c)n^2}}{8(n + 1)}.$$

It turns out that $Z_2^* > 0$ if $c < \max\{\lambda/3, \lambda/(n + 2)\} = \lambda/(n + 2)$ because $n \geq 1$.²¹ □

²¹We used *Mathematica* to carry out the analysis of Section 5. The codes are available upon request to the authors.

Proof of Proposition 2

Given the loan demand function (17), the incentive compatibility constraint of the entrepreneurs imply

$$S(Z) = \lambda - \frac{Z}{4}$$

which in turn implies the expression of the equilibrium risk-shifting in Proposition 2. It is immediate to show that $S^*(n, \lambda, c) < S_1^0(n, \lambda, c)$ if Lemma 3 holds. \square

Proof of Proposition 3

Let $\pi_j^*(n, \lambda, c)$ be the expected profit of a type j bank in the post-integration (pre-merger) equilibrium, which is given by

$$\pi_j^*(n, c) = p(S(Z^*)) (r(Z^*) - R(Z^*) - c_j) \frac{Z_j^*}{n} = \frac{Z^*}{4\lambda} (\lambda - c_j - Z^*) \frac{Z_j^*}{n}.$$

On the other hand, the expected profit of each merged entity in the post-merger equilibrium is given by

$$\pi_M(n) = p(S(Z_M)) (r(Z_M) - R(Z_M)) \frac{Z_M}{n} = \frac{Z_M}{4\lambda} (\lambda - Z_M) \frac{Z_M}{n}.$$

It is easy to show that $\pi_M > \pi_1^* + \pi_2^*$ if the parameter restrictions of Lemma 3 hold.

Part (b) follows from Proposition 2. To show part (c), let DS and BS denote respectively the surpluses of the depositors and the borrowers. If the deposit supply function is aZ , then the depositor surplus is given by $aZ^2/4$. On the other hand, if the loan demand function is $\lambda - bL$, then the borrower surplus is given by $bZ^2/4$. Given that $p(S(L)) = bL/4\lambda$, $L = Z$ and $a = b = 1$, the expected customer surplus is given by

$$\mathbb{E}[CS] = \mathbb{E}[DS] + \mathbb{E}[BS] = \frac{Z}{4\lambda} \left(\frac{Z^2}{4} + \frac{Z^2}{4} \right) = \frac{Z^3}{8\lambda}.$$

Therefore, the expected social welfare of the integrated market in the pre- and post-merger equilibria is given by

$$W^*(n, c) = \frac{(Z^*)^3}{8\lambda} + \pi_1^*(n, c) + \pi_2^*(n, c), \quad \text{and} \quad W_M(n) = \frac{Z_M^3}{8\lambda} + \pi_M(n).$$

Determining the sign of $W^*(n, c) - W_M(n)$ is not easy as this expression is non-monotonic on $[0, \bar{c}]$. It can be shown that $W^*(n, 0) - W_M(n) \geq 0$ and $W^*(n, \bar{c}) - W_M(n) \leq 0$ for all $n \geq 1$ and $\lambda > 0$. Therefore, by the intermediate value theorem, there is a $c^* \in (0, \bar{c})$ such that $W^*(n, c^*) = W_M(n)$. It is also the case that $W^*(n, c) - W_M(n)$ is strictly convex in c , and achieves a minimum at $c^{**} > c^*$ with $W^*(n, c^{**}) - W_M(n) < 0$. Because (a) $W^*(n, c) - W_M(n)$ is strictly increasing on $[c^{**}, \bar{c}]$ and $W^*(n, \bar{c}) - W_M(n) \leq 0$, and (b) $W^*(n, c) - W_M(n)$ is strictly

decreasing on $[0, c^{**}]$ with $W^*(n, 0) - W_M(n) \geq 0$ and $W^*(n, c^{**}) - W_M(n) < 0$, c^* is unique. Therefore, $W^*(n, c) > W_M(n)$ if and only if $c < c^*$. \square

Positive bank-customer effect and risk-taking in the post merger equilibrium

Let

$$R_j(Z_j) = a_j Z_j \quad \text{and} \quad r_j(L_j) = \lambda - b_j Z_j$$

respectively be the deposit supply and loan demand functions in market j prior to integration, and suppose $a_1 \neq a_2$ and $b_1 \neq b_2$. Recall that $c_1 = 0$ and $c_2 = c$. Therefore, the autarkic equilibrium level of risk-shifting in market j is given by

$$S_j^0(n, c) = \lambda - \frac{b_j(\lambda - c_j)(n+1)}{2(a_j + b_j)(n+2)}.$$

The deposit supply and loan demand functions in the integrated market are given by

$$R(\underbrace{Z_1 + Z_2}_Z) = \frac{Z}{a_{12}}, \quad \text{where } a_{12} \equiv \frac{1}{a_1} + \frac{1}{a_2}, \quad (\text{DS}')$$

$$r(\underbrace{L_1 + L_2}_L) = \lambda - \frac{L}{b_{12}}, \quad \text{where } b_{12} \equiv \frac{1}{b_1} + \frac{1}{b_2}. \quad (\text{LD}')$$

The post-merger risk-shifting in the integrated market is given by

$$S_M(n) = \lambda - \frac{a_{12}\lambda(n+1)}{2(a_{12} + b_{12})(n+2)}.$$

Note that

$$S_M(n) > S_1^0(n, c) \iff \frac{b_1}{b_2} > \frac{a_1}{a_2}.$$

Proposition 4 *The risk-shifting in the post-merger equilibrium is higher than that under autarky, i.e., $S_M(n) > S_1^0(n, c)$ if and only if the bank-customer effect is positive, i.e., condition (21) holds.*

Let $S^*(n, c)$ the equilibrium risk-shifting in the integrated market before any merger takes place. Because the bank-customer effect is positive, it is not clear that $S^*(n, c) < S_1^0(n, c)$. This follows from Proposition 1. However, our concern is whether the risk-taking in the post-merger equilibrium of the integrated market has increased relative to the autarkic equilibrium, which we have shown. \square

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