Welfare Effects of Financial Integration

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Abstract: This paper compares four forms of inter-regional financial risk sharing: (i) segmentation, (ii) integration trough the secured interbank market, (ii) integration trough the unsecured interbank market, (iv) integration of retail markets. The secured interbank market is an optimal risk-sharing device when banks report liquidity needs truthfully. It allows diversification without the risk of cross-regional financial contagion. However, free-riding on the liquidity provision in this market restrains the achievable risk-sharing as the number of integrated regions increases. In too large an area this moral hazard problem becomes so severe that either unsecured interbank lending or, ultimately, the penetration of retail markets is preferable. Even though this deeper financial integration entails the risk of contagion it may be beneficial for large economic areas, because it can implement an efficient sharing of idiosyncratic regional shocks. Therefore, the enlargement of a monetary union, for example, extending the common interbank market might increase the benefits of also integrating retail banking markets through cross-border transactions or bank mergers. We discuss these results in the context of the ongoing debate on European financial integration and the removal of bank branching restrictions in the United States happening primarily during the 1980s and early 1990s, and we derive implications for the relationship between financial integration and financial stability. Last we illustrate the scope for cross-regional risk sharing with data on non-performing loans for the European Union, Switzerland and the United States.

Keywords: Financial integration, interbank market, cross border lending, financial contagion.

1 Introduction

In recent years financial integration has risen to the top of policy agendas and become a major topic for research. In the United States the removal of bank branching restrictions within and across states during the 1990s has led to a movement towards a number of very large banks with increasingly country-wide presence. Highly integrated securities markets are now combined with a banking system whose fragmentation along state boundaries is disappearing.[1] In Europe Economic and Monetary Union (EMU) has given a major spur to financial integration with the introduction of the euro in 1999. More than seven years later, however, financial integration is by far not complete. While interbank money markets integrated very fast and also bond markets tend to be fairly well integrated by now, progress in banking and retail financial services is still quite limited. For example, cross border corporate lending remains only a small fraction of total bank lending and cross border bank mergers are still the exception rather than the rule in Europe.[2] International financial integration or financial globalization is also widely debated. Some argue that many countries are not able to take advantage of it and others hold it even responsible for global imbalances.[3] Around the globe, cross-border banking increases (including in Europe) and poses regulatory and supervisory challenges.[4]

The present paper discusses different forms of financial integration across countries or regions and their implications for stability and welfare. Our focus is on banks and how they contribute to international or interregional risk sharing. By shedding light on the costs and benefits of different forms of banking integration we strive to derive optimal market structures for financial risk sharing. In particular we focus on the extent of risk sharing that can be achieved under

1. national or regional segmentation,

2. integration through the secured interbank market,

[1]See for example Jayaratne and Strahan (1997) for an overview of US branching deregulation.

[2]See, for instance, Baele, Ferrando, Hördahl, Krylova, and Monnet (2004) or Freixas, Hartmann, and Mayer (2004) for broad overviews of the state of European financial integration and Barros, Berglöf, Fulghieri, Gual, Mayer, and Vives (2005) for a discussion of European banking integration.

[3]See Stulz (2005) and Bernanke (2005), respectively.

[4]See for example Caprio, Evanoff, and Kaufman (2006).

3. integration through the unsecured interbank market,

4. the cross-border penetration of retail markets.

To this end we develop a model that is based on a mechanism design interpretation of the interbank market. On an interbank money market each bank signs one or more bilateral contracts. Since banks hold private information about their liquidity situation such a game is a Bayesian game in which banks condition their actions on their private information about the returns from their projects. From the revelation principle we know that any such game can be replaced by the corresponding revelation mechanism. Therefore, in this paper we do not model a complex interbank market game (as we have for example done in Fecht and Grüner (2006)). We instead directly consider two direct revelation mechanisms. The first direct mechanism is supposed to capture the key features of a system that relies on secured interbank lending. It does not entail any sort of financial contagion, because a bank that offers a credit line to another bank that turns out to be distressed may always make use of the security pledged as collateral and will therefore itself not get into financial difficulties. The second mechanism reflects a key feature of a market with unsecured interbank lending. When there is enough aggregate liquidity, banks with a lot of liquidity lend to those with too little liquidity. In case of aggregate liquidity shortages, however, this mechanism leads to the breakdown of other participating banks. This is meant to represent cases of contagion and we assume that it affects all banks.[5]

We find that in large integrated financial systems the interbank market fails to provide a constraint efficient risk sharing whereas the cross-border penetration of retail banking markets can achieve the constraint efficient solution. In contrast, for a sufficiently small integrated financial area a secured interbank market may be preferable. A financial area of intermediate size benefits most from an unsecured lending mechanism.

[5]The possibility of aggregate liquidity shortages emerging from bank asset shocks is similar to Carletti, Hartmann, and Spagnolo (2007), who relate their likelihood and extent to the degree of competition in a differentiated loan market. Contrary to these authors we assume that late repayment of loans can lead to default and is not solved through the provision of liquidity by a central bank. The role of a central bank as lender of last resort could be addressed in future research.

In contrast to unsecured cross-regional interbank lending and cross-border penetration of retail markets a secured interbank market prevents cross-regional contagion. However, it can lead to moral hazard behavior with respect to banks' liquidity holdings. Banks have an incentive to free-ride on the liquidity provision of others through the interbank market and may thus fail to hold sufficient reserves. This free-rider problem becomes the more severe the bigger the integrated financial system is. Eventually it prohibits any cross-regional risk-sharing.

An internalization of these negative externalities can be achieved partially by an unsecured interbank market. In an unsecured interbank market the fear to trigger contagion that eventually hurts oneself limits banks' incentives to free-ride on the liquidity provision of the interbank market. The full internalization of the negative externalities can only be achieved by the cross-border penetration of retail markets, which might however be a risk-sharing mechanism that involves more real costs. Thus, for sufficiently small financial systems the optimal means of integration may be an interbank market with secured lending. At an intermediate level an unsecured interbank market may provide the efficient outcome and beyond a certain size of the financial system the cross-border penetration of retail markets is preferable.

Our analysis points towards a simple explanation for the slow pace with which the integration of retail banking advances, in Europe and other regions in the world. Sizable gains from expanding retail business across borders only arise under two conditions. First, the interbank market must be sufficiently large to have significant disadvantages from free-riding behavior on liquidity. Second, the cross-border integration of retail markets needs to be sufficiently widespread in terms of the number of regions penetrated in order to reap enough benefits from diversification. As these hurdles are quite high, cross-regional retail business does not tend to expand fast. The first steps may yield low additional profits and are therefore unlikely to be undertaken. For example, "big bang" mergers or even merger waves have not really been observed in Europe in the recent past.[6][7]

[6]Even the merger between UniCredito and HypoVereinsbank was not that enormous in size and geographical scope.

[7]One important argument raised in the debate is that informational asymmetries in the borrower-lender-relation require close proximity of banks to borrowers (see for example Degryse and Ongena (2004)). However, this does not explain why cross-border mergers and lending through foreign branches are so disappointing. Moreover, as pointed out by Barros, Berglöf, Fulghieri, Gual,

In the empirical part we illustrate the room for international risk sharing among European countries and the United States for the period 1997 to 2004. In line with the theoretical model we take the variability of non-performing loans as our measure of bank risk. We first compare the uncertainty about loan repayments between the countries covered. We then consider a large number of ways how the risk of late loan repayments can be shared among the sample countries. We show how risk is reduced through the addition of more countries and which groups of countries are particularly attractive for diversification and which not.

Our theoretical analysis is closely related to Allen and Gale (2000). Similar to their approach financial integration in our model is a measure to share the risk of regional specific and unverifiable liquidity shocks. However, in contrast to their model in which regional liquidity shocks result from stochastic intertemporal consumption preferences we follow Diamond and Rajan (2005) and assume that the timing of loan repayments in the respective regions is uncertain.[8] Furthermore, Allen and Gale (2000) only analyze the implications of integration with unsecured interbank deposits, assuming that these are the only means to integrate across borders. We consider different ways of financial integration and compare the performance of those different ways for different sizes of an integrated financial system.

In doing so we follow Bhattacharya and Gale (1987) and Bhattacharya and Fulghieri (1994) who both argue that the interbank market might fail in implementing optimal risk sharing because of banks' incentive to free ride on the liquidity provision of other banks in the interbank market. Banks might have an incentive to gamble on the liquidity provision in the interbank market instead of holding sufficient reserves. As shown by Fecht and Grüner (2006), however, unsecured interbank deposits, in contrast to secured interbank deposits, help contain this problem. An unsecured interbank market creates an incentive for banks to provide excess liquidity to illiquid banks, because of the threat of contagion. The risk of contagion induced by unsecured interbank deposits serves as a disciplining device implementing the constraint efficient risk sharing against regional liquidity shocks. However, this disciplinary ef-

Mayer, and Vives (2005) since equity finance is more sensitive to information problems than debt finance this argument contradicts the observation that cross-border private equity flows exceed cross-border loans.

[8]See also Freixas, Parigi, and Rochet (2000) for a model in which interbank credit lines serve as a means to share the liquidity risk from depositors' withdrawal decisions.

fect is weakened the more regional banks participate in a common interbank market. Thus the more regional banks participate in the interbank market, i.e. the bigger the integrated financial system, the more likely it is that this moral hazard prevents any risk sharing through the interbank market. Thus for very large integrated financial systems only a cross-regional penetration of retail markets might be able to implement an efficient insurance against regional liquidity shocks.

An additional major difference with respect to both, Bhattacharya and Gale (1987) and Bhattacharya and Fulghieri (1994), is that these papers entail no aggregate uncertainty and hence no risk of financial contagion. The present paper analyzes various mechanisms for risk sharing when the number of regions is finite. In such cases aggregate risk obtains and a single bank's behavior may make a difference for systemic stability.

With respect to the disciplinary role of contagion risk our paper is also related to Leitner (2005). He argues that banks choose incomplete interbank network structures that increase the system's fragility to commit to bail each other out in the event of a default. Also in Rochet and Tirole (1996) the risk of financial contagion has a beneficial incentive effect in that it increases banks' incentives to engage in peer monitoring. Similarly, Freixas and Holthausen (2004) stress that secured interbank claims cannot ensure peer monitoring while unsecured can. Interestingly, they show that since peer monitoring is less efficient across borders, because of larger informational asymmetries, cross border risk sharing can only be achieved via secured interbank claims. This is different in our model. Here the larger the informational asymmetries the larger are banks' incentives to free-ride on other banks' liquidity provision in the interbank market and thus the more beneficial is an unsecured interbank market that reduces these distorting incentives.

2 The regional economy

2.1 Assumptions

The regional economy is inhabited by a continuum of investors of measure one each endowed with one unit of a consumption good. The model has three periods, $t = 0, 1, 2$. Investors only care about consumption in period $t = 2$. There are two direct investments publicly available: 1) a storage technology that returns one unit of the consumption good in $t+1$ for each unit invested in t and 2) investments into firms. There is also a continuum of firms available in the economy. Each firm has a production technology that generates a return R for each unit invested. However, the particular timing of the returns is uncertain. With probability 1/2 the return is generated already in $t=1$, with probability 1/2 it is only realized in $t=2$.

In addition to these public investment alternatives, a fraction $q>1/2$ of depositors receives in $t=1$ a private direct investment opportunity that yields a return $X>R$ in period $t=2$. This investment opportunity can only be run by the respective investor himself and the availability of this technology is unverifiable. A fraction $1-q>0$ of depositors has no such opportunity. Note that one may also think of the former consumers as "early" consumers who need liquidity to purchase goods in $t=1$ and who would be willing to borrow against future income at a rate of $X>R$.

Consumers in principle would like to invest in the external technology but they would also like to insure against the need for early liquidity. They do this through financial intermediaries called banks. Banks offer a deposit contract $D=(d_1;d_2)$ that promises a repayment d_1 if deposits are withdrawn in $t=1$ and d_2 on deposits held until $t=2$. There is only one regional bank. However, the regional banking market is contestable and the regional bank is therefore forced to offer investors the utility maximizing deposit contract. In order to do so, the bank invest the funds it raises by issuing deposits in storage technology and a diversified portfolio of firms.

Besides the fully diversifiable idiosyncratic cash flow risk of individual firms there is also a aggregate regional liquidity risk. Only with probability $(1-a-b)$ half of the firms in the regions actually generate their returns in $t=1$ and half in $t=2$. With probability $\frac{a}{2}$ all projects realize their cash flow R already in $t=1$ and with probability $\frac{a}{2}$ they are all delayed until $t=2$. With a very small probability $b\geq 0$ all projects relaize no return whatsoever.

A bank's *liquidity* in $t=1$ is defined as the sum of returns derived from projects that realize early and the amount of initial liquidity that has previously been invested in the storage technology. The latter amount will also be called the bank's *liquidity provision.*

If a bank is unable to honor all withdrawals in $t=1$ it is liquidated. This early liquidation of a bank is assumed to be costly. For simplicity we assume that the liquidation value of a bankrupt bank in $t = 1$ is zero.

Table 1: timing and technology

Date	0	1	2
	Financial contracts	Regional shock observable to bank	
Normal liquidity $1 - a - b$	-1	$R/2$	$R/2$
Early liquidity $a/2$	-1	R	0
Late liquidity $a/2$	-1	0	R
Default (probability $b \geq 0$)	-1	0	0

2.2 Equilibrium in autarky

Initially banks choose liquidity holdings l, investment in firms $k = 1 - l$, and a deposit contract D which they offer to local depositors. Since the most productive technology is the private investment technology that investors randomly receive, the bank maximizes investors expected utility by ensuring that those depositors disposing in $t = 1$ of such a project receive maximum funds in $t = 1$. However, since the availability of the private technology is publicly unobservable also other investors could claim to have such a technology in order to receive a repayment in $t = 1$ and store it until $t = 2$. Thus in order to ensure that only depositors with the private productive investment withdraw the contract has to satisfy the incentive compatibility constraint $d_1 \leq d_2$.

When a is sufficiently small[9] the bank will not preserve sufficient liquidity to avoid liquidation in case of an aggregate liquidity shortage. In this case the optimal deposit contract implies $d_1 > l$. However, the bank will hold sufficient reserves to

[9]We assume b to be small enough so that we can disregard it in all the calculations that follow. The small probability of default will only become important when we discuss the incentive compatibility constraints in section 4.

sustain *normal* cases without any aggregate liquidity shock. This yields the following period 1 budget constraint:

$$qd_1 = l + \frac{1}{2}Rk. \tag{1}$$

Consequently, in case of no aggregate liquidity shortage and of a positive aggregate liquidity shock the bank is able to serve exactly, the deposit contract D.[10] Thus the optimal deposit contract solves

$$\max(1 - \frac{a}{2})\left[qd_1X + (1-q)\,d_2\right] \tag{2}$$

$$s.t. \quad qd_1 = l + \frac{1}{2}(1-l)\,R, \tag{BC1}$$

$$(1-q)\,d_2 = \frac{1}{2}(1-l)\,R, \tag{BC2}$$

$$d_2 \geq d_1. \tag{IC}$$

The optimal deposit contract must solve IC with equality. Thus it follows from BC1 and the second period budget constraint BC2 that

$$q\,(1-l)\,R = 2\,(1-q)\,l + (1-q)\,(1-l)\,R. \tag{3}$$

The optimal level of liquidity holdings is given by

$$l^* = \frac{(2q-1)\,R}{2\,(1-q) + (2q-1)\,R}. \tag{4}$$

Reinserting in BC1 shows that the optimal deposit contract is

$$d^* = d_1^* = d_2^* = \frac{R}{(2q-1)\,R + 2\,(1-q)}. \tag{5}$$

This deposit contracts provides investors with an expected utility of

$$U^* = (1 - \frac{a}{2})\frac{\left[qX + (1-q)\right]R}{(2q-1)\,R + 2\,(1-q)}. \tag{6}$$

In order to prevent liquidation also in case of a liquidity shortage the bank could offer a deposit contract that solves

$$\max\left[qd_1X + (1-q)\,d_2\right]$$

$$s.t. \quad qd_1 = l, \tag{BC1'}$$

$$(1-q)\,d_2 = (1-l)\,R, \tag{BC2'}$$

$$d_2 \geq d_1. \tag{IC}$$

[10] Note that in case of a positive aggregate liquidity shock the bank will simply store $(1-q)d_2 = \frac{1}{2}Rk$ from $t = 1$ to $t = 2$.

In this case the optimal deposit contract is

$$d' = d'_1 = d'_2 = \frac{R}{(1-q)+qR}. \tag{7}$$

and generates an expected utility of

$$U' = \frac{[qX + (1-q)]\,R}{(1-q)+qR}. \tag{8}$$

From $U' \leq U^*$ it follows that the bank will choose to run the risk of being liquidated in case of an aggregate liquidity shortage if $a < \hat{a}$ with

$$\hat{a} = \frac{2(1-q)(R-1)}{(1-q)+qR}. \tag{9}$$

In what follows we shall assume that this is the case. Graphically the optimal deposit contract can be derived as described in figure 1. Point A characterizes the allocation when the bank does not keep any liquidity in $t = 0$. Here late consumption exceeds early consumption because early consumers are a majority. Keeping more liquidity initially enables the bank to increase early withdrawals without violating the incentive compatibility constraint of late consumers. The optimum is characterized by point B, where the incentive compatibility constraint becomes binding.

3 The multiregional economy

3.1 Assumptions

We now turn to a multiregional economy in which banks may insure themselves against regional liquidity risk. Consider an economy that consists of n identical region as characterized in the previous section. For simplicity, we assume that the fraction of early project s_j in regions $j = 1..n$ is *iid* with $\Pr\left[s_j = \frac{1}{2}\right] = 1 - a$ and $\Pr[s_j = 0] = \Pr[s_j = 1] = \frac{a}{2}$. We define $(1 - A(n)) = \Pr\left[\sum_{j=1}^{n} s_j/n = \frac{1}{2}\right]$ as the probability that n regions have normal liquidity on average at $t = 1$. A joint probability distribution of liquidity from the point of view of a single bank is given in table 2. In this table s_j gives the fraction of projects being early in region j.

Figure 1: The optimal deposit contract

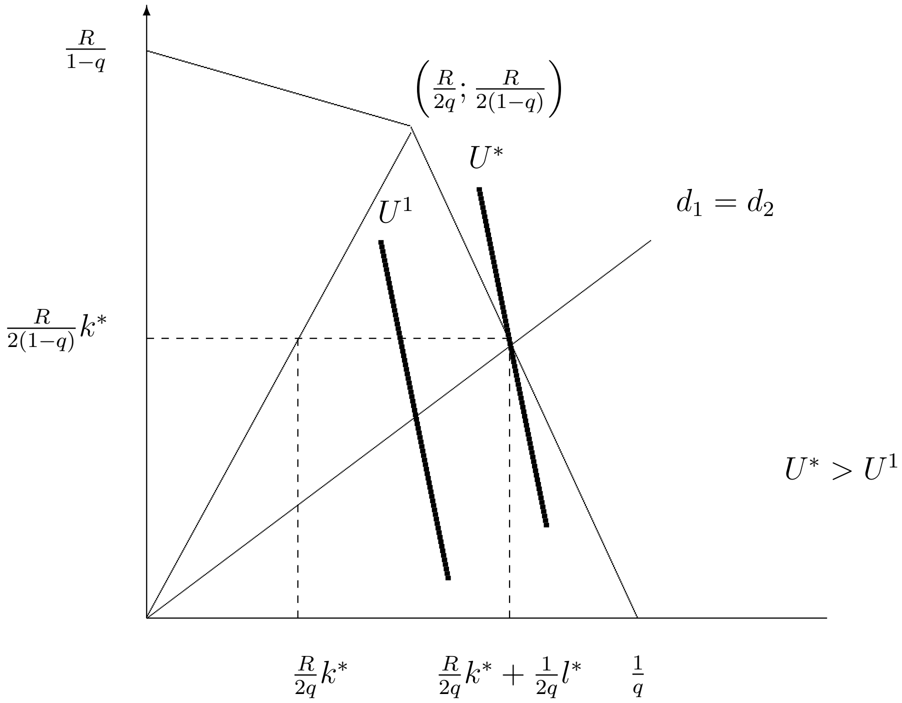

Table 2

	$\sum_{-j} \frac{s_{-j}}{n-1} < \frac{1}{2}$	$\sum_{-j} \frac{s_{-j}}{n-1} = \frac{1}{2}$	$\sum_{-j} \frac{s_{-j}}{n-1} > \frac{1}{2}$
$s_j = 0$	$\frac{a}{2}\frac{A(n-1)}{2}$	$\frac{a}{2}\left(1 - A\left(n-1\right)\right)$	$\frac{a}{2}\frac{A(n-1)}{2}$
$s_j = \frac{1}{2}$	$\left(1-a\right)\frac{A(n-1)}{2}$	$\left(1-a\right)\left(1 - A\left(n-1\right)\right)$	$\left(1-a\right)\frac{A(n-1)}{2}$
$s_j = 1$	$\frac{a}{2}\frac{A(n-1)}{2}$	$\frac{a}{2}\left(1 - A\left(n-1\right)\right)$	$\frac{a}{2}\frac{A(n-1)}{2}$

It is important to note that

$$A\left(n-1\right) < A\left(n\right), \tag{10}$$

and

$$\lim_{n \longrightarrow \infty} A\left(n\right) = 1. \tag{11}$$

This means that with an increasing number of regions the probability that there is neither any aggregate liquidity shortage nor any aggregate liquidity overhang goes to zero.

3.2 Market mechanisms and cross border activity

On an interbank money market each bank signs one or more bilateral contracts. The regulation of this market determines the game which is played among the banks. Since banks hold private information about their liquidity situation such a game is a Bayesian game - played at $t = 1$. Banks choose Bayesian strategies, i.e. they condition their actions on their private information about the return from their projects. From the revelation principle we know that any such game can be replaced by the corresponding revelation mechanism. This mechanism asks all banks to report their financial situation in $t = 1$ and assigns a decision (an allocation) to the vector of all banks' reports. Therefore, in this paper we do not model a complex interbank market game (as we have done in Fecht and Grüner (2006)). We instead directly consider two direct revelation mechanisms.

The first direct mechanism is supposed to capture the key features of a system that relies on secured interbank lending. It does not entail financial contagion because a bank that offers a credit line to another bank that is distressed may always make use of the corresponding security and will therefore itself not get into financial difficulties. The second mechanism reflects a key feature of a market with unsecuritized interbank lending. When there is enough aggregate liquidity, banks with high liquidity lend to those with too little liquidity. However, aggregate liquidity shortages lead to the breakdown of all participating banks.

3.3 The secured interbank market mechanism

The secured interbank clearing mechanism can be viewed as a naive way of dealing with banks' privately observable liquidity needs at $t = 1$. This mechanism asks all participating banks for a liquidity statement in $t = 1$. It provides all banks that are in need of liquidity with an amount $(1 - l^*) R/2$ if and only if at least as many banks state excess liquidity as banks state too little liquidity. The latter repay $(1 - l^*) R/2$ in period two to their respective creditors. If instead n banks have too little liquidity and $m < n$ banks hold excess liquidity then $n - m$ banks of the n banks that signaled too little liquidity are liquidated. Those banks are selected at random.

The secured interbank market mechanism involves no financial contagion. An institution can not be forced to provide others with liquidity if it does not want to do so. Note that the mechanism can also be interpreted as an interbank market with secured interbank deposits. Such an interbank market also requires the bilateral consent for any transfer in $t = 1$ from one bank to another (c.f. Fecht and Grüner (2006)).

3.4 The interbank market mechanism with contagion

An alternative mechanism punishes banks for falsely stating a low liquidity by introducing a risk of financial contagion (see Fecht and Grüner (2006) for details about how to install such a mechanism in a case with two regions). The market mechanism with contagion asks all participants for a liquidity statement in $t = 1$. It provides banks in need of liquidity with $(1 - l^*)\, R/2$ if and only if at least as many banks state excess liquidity as banks state too little liquidity. The latter repay $(1 - l^*)\, R/2$ in period two to their respective creditors – if possible. If aggregate liquidity is less than $n \cdot d_1^*$ all participating banks (even those not claiming any liquidity needs) are liquidated and all payoffs are zero.

This mechanism is an extreme version of any market mechanism that involves some risk of contagion in case of an aggregate liquidity shortage. Contagion is extreme because (i) it occurs as soon as aggregate liquidity is slightly negative, and (ii) contagion affects all bank that participate in the market. We concentrate on this extreme mechanism because it provides the best incentives for banks not to understate liquidity or to keep too little initial liquidity holdings. If this mechanism is not incentive compatible then there is no other mechanism involving contagion that is.

Under this mechanism each region could benefit from an offsetting liquidity shocks in the other regions with probability $\left(\frac{a}{2}\right) \frac{A(n-1)}{2}$ (see Table 1). The probability that due to a negative liquidity shock in the other regions there is a liquidity shortage in the entire economy is given by $(1 - a)\, \frac{A(n-1)}{2}$. Thus the probability for diversification benefits is higher than the probability of aggregate liquidity shocks originated in only one region if

$$a \geq \underline{a} = \frac{2}{3}. \tag{12}$$

This is a necessary condition for a bank's participation in the unsecured interbank market. Throughout the paper we assume that a is large enough to satisfy this constraint and at the same time small enough to satisfy the previous condition that ensures liquidity provision for normal states, $a < \hat{a}$. It is easy to see that appropriate values of q and R ensure that the corresponding interval for a, $[\underline{a}, \hat{a}]$ is nonempty.[11] Also note that the probability that one region can benefit from an excess liquidity in another region goes from $\frac{a}{2} > \frac{1}{3}$ for $n = 2$ to $\frac{A(\infty)}{2} = \frac{1}{2}$ for $n \longrightarrow \infty$.

3.5 Cross border market penetration

The third option for integration that we study is cross border market penetration. We assume that a bank that operates in many regions invests identical amounts in all these regions. If all banks invest in all regions, then there is no need for an interbank market. Banks self insure against regional liquidity shocks. If at date 1 such an international bank holds too little liquidity to satisfy its payment obligations it goes bankrupt. This means that we exclude the possibility that the international bank has some branches that go bankrupt while others remain intact.

4 Bayesian Equilibrium

The next step of our analysis is to identify the Bayesian equilibria of the various mechanisms described above. We first need to characterize banks' strategy sets. Each bank chooses initial liquidity holdings in $t = 0$. Liquidity holdings remain private information. In $t = 1$ banks privately observe their respective liquidity shock and choose a corresponding announcement for the interbank market mechanism.

When the number of regions is small, the moral hazard problem on a market with contagion is mitigated because it is unlikely that there is enough surplus liquidity to insure a liquidity-free rider. With a small probability of abnormal liquidity (i.e. low values of a), a zero probability of complete failure ($b = 0$), and a low number of market participants even the secured interbank market mechanism can implement a desirable outcome.

[11]Note that, alternatively, one could assume a richer stochastic structure that permits a stronger negative correlation of liquidity holdings across regions. This would make it possible that a functioning interbank market increases welfare for arbitrarily low values of a.

Lemma 1 *Let $b = 0$. For all n there is an upper bound $\bar{a} > 0$ on a such that for all $a \in [\underline{a}, \min\{\hat{a}, \bar{a}\}]$ the following is an equilibrium of the secured interbank market mechanism: (i) All banks keep liquidity l^* in period 0 and offer contract d^* to their depositors. (ii) All banks correctly announce their excess liquidity.*

Proof First suppose that all banks hold l^*. In this case, there is an equilibrium of the Bayesian game at date $t = 1$ in which all banks correctly state excess liquidity because they do not benefit from carrying the excess liquidity themselves. This equilibrium exists for all values of a. This is so because banks obtain the same payoff by lending the excess liquidity to another bank that repays with certainty. They also have no incentive to misreport in the other two states.

Next consider a single bank at date 0. Suppose that all other banks plan to make correct announcements about their liquidity at date $t = 1$ and that all other banks hold l^*. The single bank does not have an incentive to keep too little liquidity for a given contract d because the probability to fail as a consequence of this is too high if a is sufficiently small.

The probability to fail goes to 1 as a goes to zero. This holds for all possible announcement strategies of this bank. Given that the bank holds the correct amount of liquidity it offers d^*. To determine the upper boundary on a, $\bar{a}$ we have to consider the following (best) deviation. One bank offers contract (R, R) to its depositors and keeps liquidity zero. It withdraws liquidity $(1 - l^*) R/2$ from the system if it has normal liquidity in period 1, and it does not withdraw liquidity otherwise. This yields an expected gain of

$$\left(1 - a + \frac{a}{2}\right) \frac{A(n-1)}{2} (R - d^*) \left(\frac{1 - q + qX}{2}\right) \tag{13}$$

where $\frac{A(n-1)}{2}$ denotes the probability that the rest of the system holds excess liquidity in the aggregate. The gain obtains only if the bank has normal or excess liquidity. The expected loss is

$$\left(1 - a + \frac{a}{2}\right) (1 - A(n-1)) d^* \left(\frac{1 - q + qX}{2}\right). \tag{14}$$

where $(1 - A(n-1))$ denotes the probability that the rest of the system holds normal liquidity in the aggregate. Again, the loss obtains only if the bank has normal or excess liquidity. Hence the deviation pays if

$$\left(1-a+\frac{a}{2}\right)\left(R-d^{*}\right)\frac{A\left(n-1\right)}{2} > \left(1-a+\frac{a}{2}\right)\left(1-A\left(n-1\right)\right)d^{*} \tag{15}$$

$$\frac{R}{d^{*}}-1 > 2\frac{1-A\left(n-1\right)}{A\left(n-1\right)}. \tag{16}$$

Inserting the optimal d yields

$$\frac{R}{\frac{R}{\left(2q-1\right)R+2\left(1-q\right)}}-1 > 2\frac{1-A\left(n-1\right)}{A\left(n-1\right)} \tag{17}$$

$$\Leftrightarrow \left(2q-1\right)\left(R-1\right) > 2\frac{1-A\left(n-1\right)}{A\left(n-1\right)}. \tag{18}$$

The right hand side of this inequality is continuous and strictly decreasing in a. At $a=0$ it is 1 at $a=1$ it is zero. For appropriate values of R and q a deviation does not pay if a is sufficiently small. Q.E.D.

For similar reasons, the interbank market with contagion functions well if liquidity shocks are not too frequent.

Lemma 2 *Let $b=0$. For all n there is an upper bound $\bar{a}'>0$ on a such that for all $a\in[\underline{a},\min\{\hat{a},\bar{a}'\}]$ the following is an equilibrium of the interbank market mechanism with contagion: (i) All banks keep l^{*} in period 0 and offer contract d^{*} to their depositors. (ii) All banks correctly announce their excess liquidity. The upper bound satisfies: $\bar{a}'>\bar{a}$.*

PROOF First suppose that all banks hold l^{*}. Banks correctly state excess liquidity because they do not benefit from carrying excess liquidity but they may lose from contagion when they keep too little liquidity. They also have no incentive to misreport in the other two states. Next consider a single bank at date 0. Suppose that all other banks plan to make correct announcements about their liquidity and that all other banks hold l^{*}. The single bank does not have an incentive to keep too little liquidity because the probability to fail as a consequence of this is too high if a is sufficiently small. This holds for all possible announcement strategies of this bank.

To determine the boundary $\bar{a}$ we again have to consider the following deviation. One bank offers contract (R, R) to its depositors and keeps liquidity zero. It withdraws liquidity $(1 - l^*) R/2$ from the system if it has normal liquidity in period 1, and it does not withdraw liquidity otherwise. This yields an expected gain of

$$\left(1 - a + \frac{a}{2}\right) \frac{A(n-1)}{2} (R - d^*) \left(\frac{1 - q + qX}{2}\right) \tag{19}$$

The gain obtains only if the bank has normal or excess liquidity. The expected loss is

$$\left(\left(1 - a + \frac{a}{2}\right)(1 - A(n-1)) d^* + \frac{a}{2}\pi_{-1} d^*\right) \left(\frac{1 - q + qX}{2}\right) \tag{20}$$

where $(1 - A(n-1))$ denotes the probability that the rest of the system holds normal liquidity in the aggregate. The probability that the rest of the system just needs the extra liquidity of this particular bank in order to have normal aggregate liquidity is denoted π_{-1}. Again, the loss obtains only if the bank has normal or excess liquidity. Hence the deviation pays if

$$(1 - a + \frac{a}{2})(R - d^*) \frac{A(n-1)}{2} > \left(1 - a + \frac{a}{2}\right)(1 - A(n-1)) d^* + \frac{a}{2}\pi_{-1} d^* \tag{21}$$

$$\frac{R}{d^*} - 1 > 2\frac{1 - A(n-1)}{A(n-1)} + \frac{\frac{a}{2}}{1 - \frac{a}{2}} \frac{\pi_{-1}}{\frac{A(n-1)}{2}}. \tag{22}$$

Inserting the optimal d yields

$$\frac{R}{\frac{R}{(2q-1)R + 2(1-q)}} - 1 > 2\frac{1 - A(n-1)}{A(n-1)} + \frac{\frac{a}{2}}{1 - \frac{a}{2}} \frac{\pi_{-1}}{\frac{A(n-1)}{2}} \tag{23}$$

$$(2q-1)(R-1) > 2\frac{1 - A(n-1)}{A(n-1)} + 2\frac{\frac{a}{2}}{1 - \frac{a}{2}} \frac{\pi_{-1}}{A(n-1)}. \tag{24}$$

Again the right hand side of this inequality is continuous and strictly decreasing in a. At $a = 0$ it is 1 at $a = 0$ it is zero. Moreover, if (18) holds at $\bar{a}$ with a strict equality then (24) holds with an inequality. Hence, $\bar{a}' > \bar{a}$. Q.E.D.

For all numbers of regions n the upper bound $\bar{a}'$ is larger than the upper bound for the secured market mechanism, i.e. $\bar{a}' > \bar{a}$. Consequently, for $b = 0$ and low values of a the interbank market with contagion is inferior to the market with no contagion because both lead to an appropriate behavior of banks while only the secured market avoids the unnecessary liquidation of viable banks. Contagion is not needed to induce incentive compatibility in those cases and it is counterproductive. The secured interbank market is superior instead when there is enough liquidity risk (i.e. when a assumes a sufficiently large value). This is different when there is an positive probability of failure to repay interbank loans (positive b). In this case the secured interbank market mechanism completely fails to insure agents against liquidity shocks.

Lemma 3 *Let $b > 0$ and $a < \hat{a}$. The secured interbank market mechanism has a unique equilibrium. In this equilibrium all banks keep l^* in period 0 and offer contract d^* to their depositors. All banks with normal liquidity correctly state their liquidity. Banks with excess liquidity understate their liquidity.*

PROOF Offering liquidity to the market entails a loss with a small but positive probability and no gain. This explains both the existence and the uniqueness of this equilibrium. Q.E.D.

For small positive value of b a result similar to Lemma 2 holds for intermediate values of a.

Lemma 4 *For all n and for all $b > 0$ there are bounds $\bar{a}$,$\underline{a}(b)> 0$ with $\lim_{b\to 0} \underline{a}(b) = 0$, such that for all $a \in [\underline{a}, \hat{a}] \cap [\underline{a}(b), \bar{a}]$ the following is an equilibrium of the interbank market clearing mechanism with contagion: (i) All banks keep l^* in period 0 and offer contract d^* to their depositors, (ii) all banks correctly announce their excess liquidity.*

PROOF Follow the steps of the proof of Lemma 2. The only difference is that a bank with excess liquidity has an extra incentive to understate liquidity because the return is uncertain. However, if contagion is likely enough the bank chooses to correctly announce excess liquidity. The lower bound on a, $\underline{a}(b)$ is continuous and zero at $b = 0$. Q.E.D.

The value of a may not be too small because otherwise contagion would not be likely enough to induce banks to correctly announce excess liquidity. Independently of the risk of failure b, an internationally active bank has incentives to keep the correct amount of liquidity.

Lemma 5 *For all n there is an upper bound $\tilde{a} > 0$ on a such that for all $a \in [\underline{a}, \min\{\hat{a}, \tilde{a}\}]$ an internationally active bank keeps liquidity $n \cdot l^*$ in period 0 and offers contract d^* to its depositors.*

Proof Obviously this is strictly optimal for $a = 0$. For positive values of a, the bank can alternatively alter l and d such that it accommodates some negative aggregate liquidity shocks. This requires to reduce d by a positive fixed amount. The corresponding gains and losses are continuous in the probability a. The proposition follows immediately. Q.E.D.

Consequently, an international bank performs as well as the interbank market clearing mechanism with contagion when the underlying liquidity risk is not too large. To summarize, the following equivalence result holds.

Proposition 1 *(i) For all n there is an upper bound $\breve{a} > 0$ on a such that for all $a < \breve{a}$ an international bank provides the same utility to depositors as the interbank market clearing mechanism with contagion. Both provide zero utility in case of aggregate delayed liquidity. Both provide utility $(1 + X)/2 \cdot d^*$ otherwise.*[12]

(ii) Let $b = 0$. For all n there is an upper bound $\bar{a} > 0$ on a such that for all $a < \bar{a}$ the secured interbank market mechanism is superior to a merger.

Proof Follows immediately from Lemmata 1-3 and 5. Q.E.D.

[12] This result differs from Fecht and Grüner (2006) where the merger is always superior to an uncollateralized interbank market. The reason for this is twofold. First in Fecht and Grüner (2006) households are risk avers. Therefore, not only avoiding the inefficient collapse of one bank matters but also the distribution of bank profits and consumption across regions in those states where both banks are liquid. A multiregional bank can implement an equal distribution of consumption also in those states while the interbank markets fails to reallocate bank profits across regions it those cases. Thus a cross-regional merger is superior in Fecht and Grüner (2006). Second in Fecht and Grüner (2006) an unsecured or secured interbank mechanism can generally not ensure ex-post incentive compatibility of the mutual liquidity insurance. Consequently, a secured interbank mechanism allowing for diversification without the costs of contagion is no available in Fecht and Grüner (2006).

5 Optimal financial integration

So far we have seen that - for a given number of regions - secured and unsecured lending mechanisms may yield some risk sharing when the risk of high or low liquidity levels is not too large. When the number of different economic regions increases, the moral hazard problem in interbank lending becomes more severe. Banks can rely on the fact that excess liquidity is quite likely - approaching a probability of 1/2 as n increases. At the same time the event that a single bank's liquidity provision is pivotal - in the sense that this bank decides about whether aggregate liquidity supply is above or below zero - vanishes. Hence, a single bank has an incentive to rely upon the liquidity provided by others and to keep to little initial liquidity holdings in $t = 0$.

Proposition 2 *Let $a > 0$ and $b = 0$. If n is sufficiently large then the following strategy profile is not an equilibrium of the secured interbank market mechanism: (i) all banks keep l^* in period 0 and offer contract d^* to their depositors. (ii) all banks correctly announce their excess liquidity.*

PROOF Suppose such an equilibrium exists. Again consider the same deviation as in the proof of Lemma 1 and note that the right hand side of (18) strictly decreases in n. The result follows. Q.E.D.

A similar result holds for the interbank market with contagion where banks fail to hold enough liquidity when n is too large.

Proposition 3 *Let $a > 0$ and $b \geq 0$. If n is sufficiently large then the following strategy profile is not an equilibrium of the interbank market mechanism with contagion: (i) all banks keep l^* in period 0 and offer contract d^* to their depositors. (ii) all banks correctly announce their excess liquidity.*

PROOF We know from the proof of lemma 2 that such an equilibrium exists if (24) does not hold. The right hand side of (24) strictly decreases in n. Q.E.D.

A consequence of this result is that an increase of the size of the interbank market must lead either to contagion in cases with normal or negative aggregate liquidity demand (excessive contagion) or to too low initial liquidity holdings. We call *excessive contagion* a situation in which the banking system breaks down more often than under the truthful announcement of liquidity. *Suboptimal liquidity provision* is defined as a situation in which banks hold more or less liquidity than $n \cdot l^*$.

Corollary 1 *If n is sufficiently large then the interbank market mechanism with contagion either generates excessive contagion, suboptimal liquidity provision, or both.*

Another consequence of conditions (18) and (24) is that the interbank market with contagion is more robust to an increase of the size of the market.

Corollary 2 *The interbank market with contagion provides better incentives for risk sharing than the secured interbank market in the sense that it has a truthful equilibrium for higher values of n.*

We can now extend our welfare analysis to cases with a larger number of regions. The previous results can be summarized as follows.

Proposition 4 *Let $b = 0$ and take n as given. Consider values of a in $[\underline{a}, \hat{a}]$.*

(i) For $a < \bar{a}$ it maximizes welfare to have financial separation or integration through an integrated secured interbank market.

(ii) For intermediate values of $a, a \in [\bar{a}, \bar{a}']$ the secured interbank market does not have a truth-telling equilibrium while the interbank market with contagion does.

(iii) For $a > \bar{a}'$ the integration through cross border transactions yields a higher welfare than integration through the interbank market with contagion.

PROOF Follows from Lemma 1, Propositions 1, and 2, and from the analysis of section 5. Q.E.D.

Without any risk of complete inability to repay ($b = 0$) the following sequence is related to the growth of an interbank market. Small markets get along well with secured interbank lending. Each participating bank considers it as sufficiently likely that it is pivotal in the market mechanisms and behaves properly. In a larger market incentive compatibility breaks down. In such cases a mechanism involving contagion helps to insure incentive compatibility again. When the market grows further the threat of contagion can no longer help and other arrangements for diversification are needed. Cross border activities or financial mergers can help.

The sequence is slightly different when there is a risk of complete failure ($b > 0$). In such cases the secured interbank market mechanism yields the same result as separation. The interbank market with contagion always yields at least the same welfare as a secured interbank market with voluntary participation. We know that the market with contagion and cross border transactions yield the same welfare level for small n. If n is sufficiently large then integration through cross border transactions yields a higher welfare than integration through the interbank market with contagion. In this case due to the moral hazard problem, the market with contagion involves a suboptimal liquidity provision of banks. A bank that is active across borders appropriately takes this externality into account. Table 3 characterizes the welfare maximizing institutional setup for different numbers of regions.

Table 3: Optimal institutions

	Low n	Intermediate n	High n
$b = 0$	Secured interbank market	Unsecured interbank market Cross-border-transactions	Cross-border-transactions
$b > 0$	Unsecured interbank market	Cross-border-transactions	Cross-border-transactions

6 Empirical illustration of risk sharing

We have shown that there may be welfare gains associated with cross-border activities of financial institutions. These welfare gains emerge if the economy is sufficiently diverse in terms of regional financial risk. Financial integration that is limited to the interbank money market, however, may lead to excessive contagion risk or to limited risk sharing. This is the case when players on this market consider it as very unlikely that their own behavior will have an impact on the stability of the entire financial system. A larger and more diverse economic area should therefore turn to deeper retail financial integration. Accordingly, large monetary unions - which lead by definition to a large and integrated (wholesale) interbank market - can and should be accompanied by significant retail financial integration. In the present model, this integration could be achieved through cross-border lending or the incorporation of several national loan portfolios in one bank through cross-border mergers. The same would hold if retail deposits, instead of corporate or household loans, were the ultimate source of bank risk. Small monetary unions, however, may not need as much retail integration as incentive problems in the interbank market should be more limited.

6.1 Practical relevance and empirical strategy

The theoretical findings seem to be highly relevant in practice. Large economies with common monetary policies typically have a highly integrated interbank market, but often show limited degrees of retail integration. This even applied to the United States before the removal of bank branching restrictions related to the Riegle-Neale Act of 1994. It is particularly visible in the euro area and the European Union. Consequently, the European Union has made the further integration of retail financial services a priority of financial sector policies between 2005 and 2010 (European Commission (2005)). Small monetary unions, such as the one between Belgium and Luxembourg from 1921 until 1999, may not require as much retail integration, as the interbank market incentives should lead to efficient risk sharing.

The empirical part of the paper aims at illustrating how relevant this risk sharing mechanism is. We strive to show how large the liquidity risk and diversification benefits underlying our model can be, taking the important example of loans in the European Union, Switzerland and the United States. We go through three steps. In the first step we show how large the liquidity risk related to non-performing loans is in individual and groups of countries. This corresponds to the notion in the theoretical model that a high a implies high uncertainty about delayed repayments of loans. In the second step, we show how the combination of loan portfolios from different countries can reduce the variability of non-performing loans. Last, we look for groups of countries for which integration is particularly attractive.

6.2 Data

The data we use to assess liquidity risk and diversification benefits are variables that measure the amount of loans whose repayment is delayed. The data source is Bureau van Dijk's Bankscope.[13] We start from 24 European Union countries (excluding only Luxembourg) plus Switzerland and the United States. Since data for the early 1990s

[13]Information from the 1999, 2005 and January 2006 CDs has been pooled.

are only available for a smaller number of countries and at irregular times, we are forced to constrain the sample in terms of countries and time. In the final sample, we can cover 8 euro area countries (Germany, Spain, Finland, France, Greece, Ireland, Italy and Portugal), 3 "old" non-euro area EU countries (Denmark, Sweden and the United Kingdom), 7 "new" EU member states (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Malta and Poland)[14], Switzerland and the United States for the period 1997 to 2004. In 2004 for example the number of banks covered range from 75, 56 and 47 for the United States, Italy and Spain, respectively, to 3, 1 and 1 for Malta, the Czech Republic and Greece, respectively. Since cross-border financial integration is of particular interest, we decided to aggregate the data at the level of countries. For their much better coverage we use consolidated bank data.

We chose the variable "total problem loans" in Bankscope as a measure of asset side liquidity risk. In the database we use this variable is defined as the sum of "overdue loans", "restructured loans" and "other non-performing loans". The first capture loans that are still unpaid after the due date. The second refer to loans that were rescheduled to avoid default, usually by lengthening the maturity. Last, non-performing loans are not meeting their stated principal or interest payments. This usually refers to commercial loans which are overdue by 90 days or more and consumer loans that are overdue by 180 days or more. Following conventional terminology we refer to this aggregate variable as total non-performing loans.[15] As we want to do cross-country comparisons and as the coverage of banks varies across countries, we prefer to use this variable in relative terms, by dividing through total loans.

6.3 Results

The first question is how severe the risk of delayed loan reimbursements or interest payments is in our sample countries. This is shown in table 4, which exhibits the country by country intertemporal variation coefficients of the ratios of non-performing over total loans in increasing order. Countries at the top of the table

[14]These countries are among the 10 countries that joined the EU in May 2004. Bulgaria and Romania, which joined the EU in January 2007, are not included in our data set.

[15]For the Czech Republic, Portugal and Spain the data with these exact definitions are not available, so that we have to resort to "problem loans".

have more limited liquidity risk in their banking systems and countries at the bottom more pronounced liquidity risk. As one could have expected, at the top of the table are larger countries such as France, Germany, Italy, UK and US, where there is more scope for sharing risks within the domestic banking sector. Smaller countries with more limited internal risk sharing possibilities such as the Czech Republic, Denmark, Finland, Latvia and Sweden are at the bottom. Their liquidity risk exceeds the one of the larger countries by a factor of 3 to 7. It is interesting to observe a cluster of Nordic countries in this group. We will check further below whether the Nordic countries may be able to share this risk among each other.

[INSERT TABLE 4 HERE]

Next we ask to which extent these national risks can be shared through international financial integration. One way of looking at this question is to also calculate the average variation coefficients for different groups of countries (pairs, triples, quadruples etc.) and then consider by how much they decrease as the number of countries increases. Figure 1 is showing the results of two such exercises in very condensed form. In one case (grey lines) the non-performing loans in each country are pooled at equal weights. In the other case (black lines) they are pooled in proportion to the sizes of loan markets. In other words, in the first case it is assumed that a bank investing in the respective countries does so in equal amounts, for example by taking over a bank abroad that has the same size. In the second case it invests in proportion to the sizes of the respective national banking sectors. The lines without rhombi reflect the total average variation coefficients for a given number of countries, i.e. the average variation coefficient is calculated from all possible combinations of countries provided their number is fixed. The lines with rhombi are based on the combinations of countries with the 10 lowest variation coefficients, so that they come closer to "optimal" diversification strategies.

[INSERT FIGURE 1 HERE]

Figure 1 clearly shows the benefits of pooling the different country risks, i.e. the value of either integrating retail loan markets or sharing those risks in the interbank market. From the values for single countries (variation coefficients of 0.41 for the total average and 0.26 for the best 10 average) both curves decline sharply to the values for 3 or 4 countries. Most diversification benefits seem to be exploited for 4 countries (average variation coefficients of 0.26 to 0.30 depending on the weighting and 0.06 to 0.07). Banks could take advantage of these benefits by lending across borders or taking over foreign banks. Alternatively, they could share these liquidity risks through the interbank market. The problem is, however, that as the number of countries forming a common interbank market increases the worse the incentives to provide private liquidity in this market and the less efficient this particular risk sharing mechanism may work (see the theoretical sections above).

The last question is which groups of countries are particularly valuable for diversification. We address this question in two different ways. First, we calculate the correlation matrix of non-performing loans for our country sample. Second, we look at the specific country groups as they entered the construction of figure 1.

Correlation coefficients for non-performing loans are displayed in table 5. From this one can identify only bilateral diversification benefits. But a few interesting observations can be made. First, non-performing loans seem highly correlated among the "old" EU member states. Interestingly, this picture is not very different between euro area countries and non-euro area countries. Many correlations are 0.9 and above. Only a few country pairs have a correlation coefficient below 0.5. The great exception in our dataset is Germany. Non-performing loans in Germany over the period 1997 to 2004 were negatively correlated with all "old" EU member states.

[INSERT TABLE 5 HERE]

In this regard Germany is quite similar to most of the "new" EU member states, which are mostly negatively or only mildly positively correlated with "old" member states. In other words, there seem to be ample opportunities for diversification between most "old" EU countries, on the one hand, and "new" EU countries (except perhaps the Czech Republic) plus Germany, on the other hand. The very extensive foreign bank entry to Central and Eastern European countries is consistent with these observation, and also the entry of large foreign banks such as ING, SEB and UniCredito into Germany. Finally, Switzerland resembles most "old" countries, whereas the US has a correlation structure similar to Germany.

To get a better picture about the groups of countries that are particularly attractive or unattractive for diversifying the risk of delayed loan repayments, we have a closer look at the results that led to the summary figure 1. In particular, for a given number of countries we identify the country combinations that have the 10 lowest and 10 highest variation coefficients. We do this for both the equally weighted investments and investments weighted by total loans per country.

As this would lead to 14 additional tables, we do not display the full results here. We rather report the main conclusions that emerge from this exercise.[16] As regards the most unattractive combinations of countries, it turns out that these are mostly composed of the smaller countries in our sample. In particular, the Czech Republic appears in most of the "worst" country combinations. Beyond two countries this also applies to Denmark and to a lesser extent to Latvia. It is also noteworthy that other Nordic countries, such as Finland and Sweden, also sometimes appear in this group. In relation to the high individual variation coefficients found for them individually, this means that banks from Nordic countries may be well advised to look for diversification opportunities outside the region. Large countries appear in the low diversification combinations only in the equally weighted results, as one would expect, for two or many countries. This concerns particular the United Kingdom and the United States.

Among the best groups for diversification large countries play a more important role. For the results weighted by total loans this is obvious, as large countries have already the lowest variation coefficients individually (see table 4) and receive a high weight. So we do not dwell very much on these cases. We only note that France and Germany appear dominantly in all groups beyond two countries and the UK appears regularly for 5 countries and more. Small countries are mixed in together with these large countries.

Perhaps more interesting in this exercise are the results for equally weighted data. Interestingly, the largest countries remain also here very present. France figures prominently in all combinations except for two and four countries. Germany and Italy are very attractive for small groups, such as two or three countries. For larger groups of countries also smaller countries appear regularly in the combinations with

[16]The full results are available from the authors upon request.

the lowest variation coefficients for non-performing loans. This concerns particularly Cyprus, Estonia and Switzerland.

Overall, it can be concluded that there is considerable room for diversifying the risk of late loan repayment across many of the countries considered. There are many was to do this and results depend a lot on specific cases. Nevertheless, a number of general observations can be made. While the uncertainty about servicing loans is already lower for banks that operate within large countries, they can further diversify non-performing loans by moving across borders. Interestingly, this seems particularly attractive for French and German banks. Banks from small countries do not seem to gain very much from moving to other small countries. Quite the contrary, in many cases this would appear very far from "optimal" diversification strategies. Banks from certain smaller countries (including for example Cyprus and Estonia) would, however, benefit a lot by entering or doing business with certain groups of larger countries.[17] Generally, our data suggest that the best combinations for smoothing the repayment of non-performing loans are available in Europe and not in combinations with US banks.

7 Conclusion

In this paper we have discussed how different forms of financial integration affect the welfare and stability of economic areas of different sizes. Our focus is on how banking systems share risk across regions or countries, either through the interbank money market (both unsecured and secured) or through the penetration of retail markets. To this end we present a mechanism design type of model in which banks possess private information about delays in loan repayments and have to decide how to share this risk. We can then rank the resulting equilibria by their overall welfare level and the stability of the banking system. To the theoretical argument we add an empirical illustration about the extent with which such risk can be shared among European countries and the United States.

Our theoretical results suggest that the relative desirability of risk sharing through unsecured and secured interbank trading depends on the size of the interbank mar-

[17]It should, however, be kept in mind that many of these banks are already foreign-owned, since we had to use unconsolidated data.

ket. Unsecured trading provides incentives for banks against understating liquidity shocks, as an aggregate liquidity shortage could bring them down. As the interbank market grows, however, for example as a consequence of the extension of a monetary union, each banks' incentives to truthfully reveal liquidity shocks decrease as its own contribution to aggregate liquidity becomes smaller. So, integration through risk sharing in the unsecured interbank market is relatively efficient, unless the interbank market is too large. Importantly, this mechanism is relatively efficient even though it implies the risk of contagion among banks.

Differently from unsecured interbank deposits secured (repo) trading does not imply any contagion risk, as in the case of a failure the collateral can be used. This, however, reduces incentives for providing liquidity to the interbank market and therefore banks may understate their private liquidity shocks. This effect is at work even in a relatively small interbank market.

There is a size of an economic area for which the integration of retail markets dominates both secured and unsecured interbank trading as a risk sharing mechanism. As an economic area becomes larger both the benefits of widespread retail integration in terms of diversification gains and the opportunity costs of not integrating retail markets through adverse free-riding on general liquidity in the interbank market increase.

In line with the source of uncertainty in the theoretical model we choose the variability of non-performing loans in specific countries and groups of countries as a measure of how much room there is for risk sharing through the banking system (either through cross-border retail transactions or interbank trading). As expected smaller countries exhibit more important variability in non-performing loans than larger countries that have more extensive internal risk sharing possibilities. A bit more surprising, a number of large countries form part of the best diversification groups. In particular, France and Germany among each other as well as with other large and small countries seem to be attractive sources or destinations of bank diversification. Attractive smaller countries for diversification are Cyprus and Estonia, even though it should be kept in mind that many of their banks are already foreign-owned. Overall, the empirical illustration underlines forcefully the great room for diversifying risk in Europe and the US.

Our analysis may contain a number of important more practical messages. Most importantly, we highlight the great importance of integrating markets for retail financial services in large economic areas. For example, the harmonization of different national or regional retail regulations and or the removal of activity restrictions could pave the way for banks to cut across borders and reap the benefits of retail integration. Whereas the United States has made significant progress in this direction through the removal of branching restrictions within and across states during the 1980s and early 1990s, the European Union has still a long way to go in this direction. Our analysis provides support to the EU's financial services policies 2005-2010, which put the integration of retail markets at center stage. Second, knowing how difficult it is to lend or supply other retail financial services at long distances, the most realistic form of achieving efficient risk sharing in a large economic area such as the EU or the US is probably through cross-border or cross-regional mergers among financial institutions. While this merger activity has picked up across US states after the Riegle-Neal Act in 1994, cross-border mergers such as the ones between UniCredito and HypoVereinsbank, HSBC and Credit Commerciale or Banco Santander and Abbey National remain the exception rather than the rule in Europe. Third, the emergence of new channels for contagion should not be taken as an argument against further financial integration. For example, the sharing of liquidity risk through unsecured interbank trading may be more efficient than its alternative through secured interbank trading, even though the latter is free of contagion risk. In this regard, the recently observed growth of the euro area repo market relative to the unsecured money market should be watched with some caution. Having said that, however, the relationship between financial integration and financial stability is ambiguous. For example, in the theoretical framework presented here integration through the unsecured interbank market will be associated with more room for instability, whereas integration through retail markets or the secured interbank market (the latter at the cost of inefficiency in large areas) does not have this risk.

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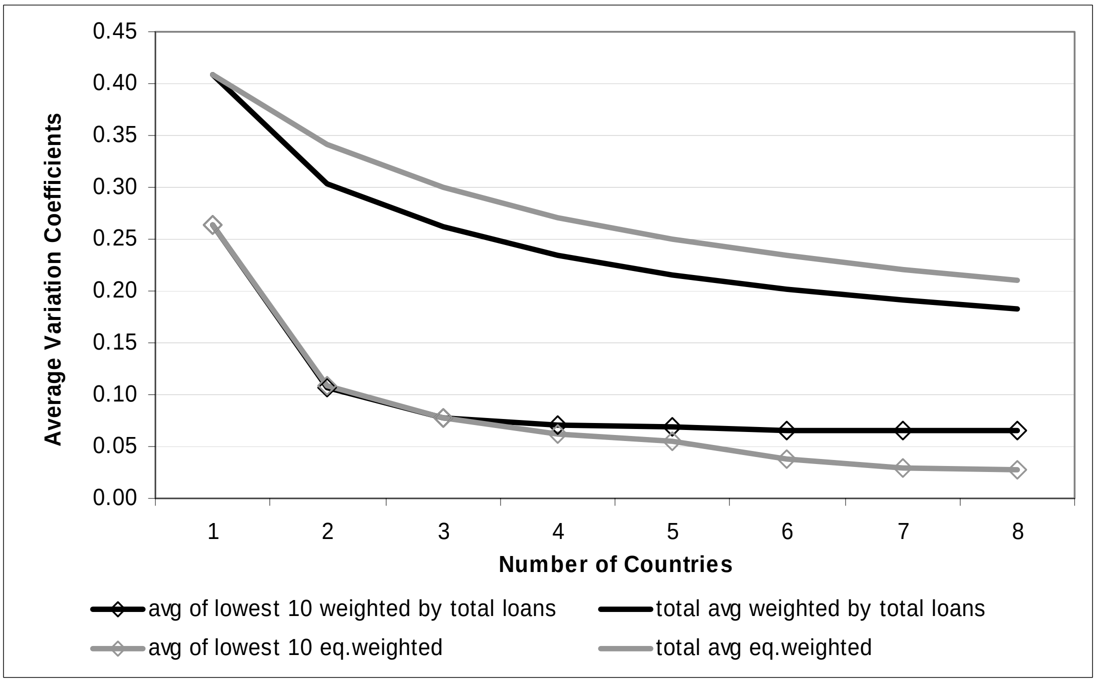
Figure 1: International risk sharing of non-performing loans



Source: Bankscope and own calculations.

Table 4: Variation of non performing loans

Rank	Country	Variation coefficient	
1	FR	0.15	
2	IT	0.17	
3	GB	0.17	
4	US	0.22	
5	DE	0.30	
6	CY	0.31	
7	HU	0.32	
8	PL	0.33	
9	ES	0.34	
10	MT	0.34	
11	IE	0.36	
12	PT	0.36	
13	CH	0.39	
14	EE	0.43	
15	GR	0.45	
16	DK	0.47	
17	SE	0.53	
18	FI	0.64	
19	LV	0.90	
20	CZ	1.03	
Simple average		0.41	
Groups		equally weighted	weighted by total loans
All Countries		0.14	0.15
Euro Area		0.20	0.11
DK, SE, UK		0.33	0.24
Old EU		0.21	0.12
New EU		0.20	0.14
EU		0.14	0.12

Source: Bankscope and own calculations

Table 5: Correlation matrix for non-performing loans

	DE	ES	FI	FR	GR	IE	IT	PT	DK	SE	UK	CY	CZ	EE	HU	LV	MT	PL	CH	US
DE	1.00																			
ES	-0.74	1.00																		
FI	-0.84	0.97	1.00																	
FR	-0.73	0.96	0.94	1.00																
GR	-0.54	0.71	0.76	0.78	1.00															
IE	-0.80	0.93	0.93	0.98	0.75	1.00														
IT	-0.71	0.59	0.70	0.70	0.87	0.75	1.00													
PT	-0.67	0.90	0.93	0.92	0.89	0.85	0.71	1.00												
DK	-0.71	0.94	0.96	0.88	0.78	0.82	0.59	0.95	1.00											
SE	-0.86	0.97	0.98	0.96	0.75	0.96	0.72	0.91	0.92	1.00										
UK	-0.66	0.88	0.83	0.89	0.45	0.90	0.48	0.71	0.71	0.86	1.00									
CY	0.80	-0.75	-0.74	-0.76	-0.32	-0.86	-0.51	-0.51	-0.55	-0.79	-0.90	1.00								
CZ	-0.80	0.66	0.78	0.62	0.61	0.70	0.80	0.62	0.67	0.73	0.57	-0.65	1.00							
EE	0.56	-0.78	-0.78	-0.81	-0.86	-0.71	-0.64	-0.92	-0.84	-0.80	-0.51	0.31	-0.42	1.00						
HU	0.34	-0.36	-0.30	-0.39	0.01	-0.40	0.12	-0.20	-0.25	-0.36	-0.41	0.48	0.18	0.18	1.00					
LV	-0.47	0.22	0.31	0.14	0.14	0.30	0.49	0.07	0.16	0.27	0.27	-0.48	0.81	0.16	0.40	1.00				
MT	0.94	-0.77	-0.87	-0.75	-0.75	-0.79	-0.82	-0.79	-0.80	-0.88	-0.55	0.63	-0.83	0.72	0.17	-0.43	1.00			
PL	0.98	-0.73	-0.84	-0.72	-0.62	-0.80	-0.75	-0.67	-0.72	-0.85	-0.59	0.75	-0.81	0.57	0.33	-0.49	0.96	1.00		
CH	-0.91	0.85	0.90	0.87	0.67	0.93	0.82	0.76	0.75	0.93	0.83	-0.88	0.87	-0.60	-0.20	0.56	-0.88	-0.89	1.00	
US	0.73	-0.49	-0.52	-0.33	-0.10	-0.41	-0.36	-0.26	-0.40	-0.54	-0.43	0.62	-0.71	0.20	-0.03	-0.68	0.65	0.69	-0.66	1.00

Source: Bankscope and own calculations.