Financial Integration, Specialization, and Systemic Risk*

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Abstract

This paper studies the stability implications of the cross-border integration of interbank markets. Integration enhances the diversification options of banks across borders and improves the resilience of the banking sector to idiosyncratic shocks. At the same time integration also increases the risk of contagion across borders given aggregate asymmetric shocks: A default of one bank due to a severe regional shock is transmitted over an integrated interbank market to banks across borders and might ultimately destabilize banks that were initially not affect be the regional shock. When analyzing this trade-off this paper takes into account that improved diversification options of idiosyncratic risks affect banks investment decisions leading to more specialization in lending. Apparently, the greater the specialization the larger is the need for risk sharing and the more reliant are regional financial institutions on the integrated financial market. Thus due to financial integration the exposure to other regions rises and increases the systemic risk.

Keywords: Financial integration, interbank market, specialization, financial contagion.

JEL Classification: D61, E44, G21

1 Introduction

While there is a broad literature on the welfare analysis of financial liberalization of developing countries the study of the costs and benefits of financial integration of developed countries has been widely neglected. In developing countries enforcement problems of financial contracts are typically seen as the reason for currency and maturity mismatches in the balance sheets of those countries' financial institutions which bring about financial fragility. Thus the welfare considerations for developing countries are whether the expected costs of potential financial crisis due to this fragility are outweighed by the benefits from improved risk sharing and from ex-ante capital inflows.[1]

In developed countries the enforcement of financial contracts is usually not a major concern. However, in those countries large financial institutions play a key role in the financial system. Those financial institutions are often the major players in the international financial markets looking for diversification options across borders. Those institutions foster financial integration and link the financial systems of different countries. However, because those institutions assume substantial risks a default of one such institute can have substantial negative externalities on other financial intermediaries across borders. This was, for instance, the major concern in the LTCM crisis. Thus for developed countries the most important welfare benefit from financial integration is that it enhances the scope for diversification of financial institutions and thereby fosters the resilience of the integrated financial system to idiosyncratic shocks. The costs of financial integration, however, are the risk of financial contagion between financial intermediaries that are the major players in these international financial markets. Larger exposures between financial institutions from different regions due to greater financial integration intensify the negative spill-overs of a crisis in one region and increase the risk that such a crisis also destabilizes financial institutions in other regions.

Theoretical studies that deal with this trade-off between the greater benefits from diversification and the expected costs from financial contagion focus on the integration through the interbank market, because banks are major players in the international financial markets. Furthermore this analysis also carries over to other

[1]See, for instance, the books by Tirole (2002) and Eichengreen (2003).

large financial intermediaries since they often face similar liquidity and contagion risks. But previous studies of the welfare implications of integrated interbank markets took the distribution of idiosyncratic liquidity shocks across regions as given.[2] However, already in the debate about optimal currency areas a widely held argument was that the criteria of what constitutes an optimal currency area is endogenous. According to the main proponents of that view–Frankel and Rose (1998)–the deeper economic integration that goes along with a greater monetary integration affects the correlation of business cycles across member countries which in turn affects the costs of a common monetary policy. One important effect that Frankel and Rose (1998) stress is that by reducing obstacles to international trade a monetary union enables countries to capture benefits from comparative advantages, fosters national specialization along the Ricardian trade theorem and ultimately leads to less correlated business cycles.

In this paper we follow this idea. We analyze the welfare effects of financial integration taking into account that the improved scope for risk sharing through integrated financial markets affects banks' specialization which in turn influences the cross regional distribution of bank specific shocks. Apparently, the greater the specialization the larger is the need for risk sharing and the more reliant are regional financial institutions on the integrated financial market. Thus due to financial integration the exposure to other regions rises, increasing the systemic risk.

More precisely, we develop a spatial model in which each regional bank has a comparative advantage in lending to a specific sector because this sectors is most productive in the respective bank's region.[3] Since the timing of loan repayments is uncertain across sectors a trade-off between specialization in lending and diversifying

[2] While Allen and Gale (2004a,b) and Fecht (2004) focus on interrelations between banks through the general asset market, Allen and Gale (2000), Freixas, Parigi, and Rochet (2000), Fecht and Grüner (2006), as well as Fecht, Grüner, and Hartmann (2007) focus on the interbank deposit market. All of these studies assume a given distribution of the idiosyncratic shocks. Those studies that account for an impact of an interbank market integration on banks investment choice typically focus on moral hazard problems and the incentives for peer monitoring. For instance, Rochet and Tirole (1996) and Freixas and Holthausen (2004) assess the implication of different institutional features of an integrated interbank taking the banks' moral hazard and peer monitoring incentives into account.

[3] See Acharya, Hasan, and Saunders (2006) for empirical evidence of these specialization benefits in banking.

liquidity risks arises. As the scope for diversification through an interbank market improves, banks can increase their lending to the most profitable sector in their region because the need to diversify through their loan portfolio diminishes. This endogenously raises banks' exposure to specific sectoral shocks and further increases the need for diversification through the interbank market. But if banks rely to a larger extent on the interbank market to buffer liquidity shocks the risk of contagion grows.

Our paper is strongly related to Allen and Gale (2000) and Freixas, Parigi, and Rochet (2000). They also show that financial integration through the interbank market allows to diversify regional liquidity shocks efficiently while entailing the risk of financial contagion between banks from different regions. But while in their model liquidity shocks result from stochastic withdrawals of depositor, in our model liquidity shocks stem form uncertainty in the timing of loan repayments (similar to the assumption underlying Diamond and Rajan (2005)). Non-performing loans are to a large extent not defaulting loans but are repaid later than expected. Those shocks seem to be a larger liquidity risk for many banks than the uncertainty about the withdrawal decision of retail depositors. But more importantly, in contrast to those previous studies in our approach banks affect the distribution of their liquidity shocks when choosing their loan portfolio. The option to diversify liquidity shocks through the interbank market induces banks not to diversify its loan portfolio but rather specialize in lending to certain sectors. Only this creates an exposure to diversifiable liquidity shocks whose severity obviously rises as banks' specialization increases.

In our model we also show that a spot money market as well as secured interbank deposits might not be sufficient to allow banks to diversify liquidity shocks and fully exploit benefits from specialization if bank specific liquidity shocks are unverifiable. Similar to the argument of Bhattacharya and Gale (1987) and Bhattacharya and Fulghieri (1994) banks in our model have an incentive to free ride on the liquidity provision through the interbank market and underinvest in liquidity holdings. But we show that unsecured interbank deposits can prevent this free-rider behavior and implement the constraint efficient allocation. The reason for this is closely related to the argument put forward in Leitner (2005) and Fecht and Grüner (2006). With unsecured interbank claims banks must fear to loose their interbank deposits if their counterparty collapses. Thus unsecured interbank deposits create an incentive for banks to provide their counterparty with liquidity in order to prevent its failure. This disciplines banks when managing their liquidity and avoids a free-riding on the liquidity in the interbank market.

2 Assumptions

Consider a three period economy $t = 0, 1, 2$ consisting of regions $j \in \{A; B\}$. In each region there is a continuum of households with the same utility function:

$$U(c_1; c_2) = c_1 + c_2.$$

Thus households are assumed to be risk-neutral.

In $t = 1$ a fraction $q > 1/2$ of households receives the blueprint of a production technology which produces a return $X > 1$ in $t = 2$. This investment opportunity is unobservable and only available to the respective household. In addition, there are two investment technologies available to banks. Technology S produces a region specific return S_j for each unit invested in $t = 0$ and technology R produces a return R_j, with $X > R_j, S_j > 1$. When exactly the return of both technologies will be realized is uncertain. Therefore investors face a liquidity risk. With probability e in both regions a sectoral shock hits sector R and the return of technology R cannot be realized before $t = 2$ while the returns from technology S are realized in $t = 1$. With the same probability a sectoral shock hits sector S and technology S produces late while technology R is early. In addition, with probability f a regional shock hits either region and both technologies in the respective region produce late, while only one technology is late in the other region. We assume that the probability for such a regional shock is close to zero. For simplicity we fix the probability that both technologies produce an early return at zero.[4] The joint probability distribution of

[4]A positive probability of early returns in both sectors would not affect any of our results unless this probability is too large.

return flows $(C_1; C_2)$ in $t = 1$ and $t = 2$ in the two regions can be summarized by:

			Region A	
		$(R_A; S_A)$	$(S_A; R_A)$	$(0; S_A + R_A)$
	$(R_B; S_B)$	e	0	f
Region B	$(S_B; R_B)$	0	e	f
	$(0; S_B + R_B)$	f	f	0

We assume that region A has an advantage in technology S while region B has the same advantage in using technology R:

$$S_B = R_A < R_B = S_A$$

On the one hand these regional advantages in the return from the two investment technology can be explained by differences in the resources available in the two regions. On the other hand it can also reflect specialization of regional banks in lending to different sectors.

When liquidated before maturity the return of both technologies is 0. Obviously,

$$2e + 4f = 1.$$

We assume that there is a storage technology available that allows to transfer funds between any two periods.

There is only one bank operating in each region. However, the regional banking markets are assumed to be contestable markets. Thus banks are forced to offer households the deposit contract that maximizes expected utility. A deposit contracts promises a repayment d_1 to depositors that withdraw in $t = 1$. If the remaining assets are more then sufficient to repay the patient depositors d_1 then the banks' remaining funds are distributed to the patient depositors. If remaining asset are insufficient to repay patient depositors $d_2 = d_1$ in $t = 2$ the bank is closed in $t = 1$, assets are liquidated and the liquidity distributed equally among *all* depositors.[5]

[5] Assume that in $t = 1$ the actual return of late projects is observable but non-verifiable. Then contingent deposit contracts are not available, but patient depositors can threaten to withdraw if they are not fully repayed the actual value of the assets. Impatient depositors withdraw anyway. Note also that we could assume that the bank manager can keep the extra profits without any effect on our results.

3 Optimal allocation with separate banks

3.1 Diversified banks

Suppose first that bank A wants to offer a deposit contract that it will be able to honor in all cases except those with a regional shock in region A which occur with probability $2f$.

Define l_0 as the fraction invested in $t = 0$ in liquidity holdings , $k = 1 - l_0$ as the fraction invested into the two production technologies, and x_A the fraction of k invested in the inferior production technology R.

Abstracting from regional shocks the minimum return in $t = 1$ bank A can realize from investments k_A in the production technologies is given by

$$\Phi_1 = Min\left[R_A x_A; S_A\left(1 - x_A\right)\right].$$

The maximum return in $t = 1$ from the production technologies available with certainty can be realized with a fraction $\hat{x}_A$ invested in R determined by

$$\begin{aligned} R_A \hat{x}_A &= S_A\left(1 - \hat{x}_A\right) \\ \hat{x}_A &= \frac{S_A}{R_A + S_A} > \frac{1}{2}. \end{aligned}$$

Note that such a portfolio with fully diversified sectoral cash flow shocks implies that bank A has to invest a larger fraction of its capital in the inferior technology R in order to maximize the minimum period 1 return. Graphically the state-contingent returns are given in figure 1.

Except for adverse regional shocks in region A, the expression $\Phi_1 k_A$ gives the liquidity inflow from investments in the production technologies that the bank can rely on in $t = 1$ when deciding about the optimal short-term repayment on the deposit contract. Because any higher liquidity inflow cannot be used for short-term repayments it will be stored to refinance long-term repayments on the deposit contract. Thus returns from production technologies available to refinance d_2 are given by $\Phi_2 k_A$ with

$$\Phi_2 = Max\left[R_A x_A; S_A\left(1 - x_A\right)\right].$$

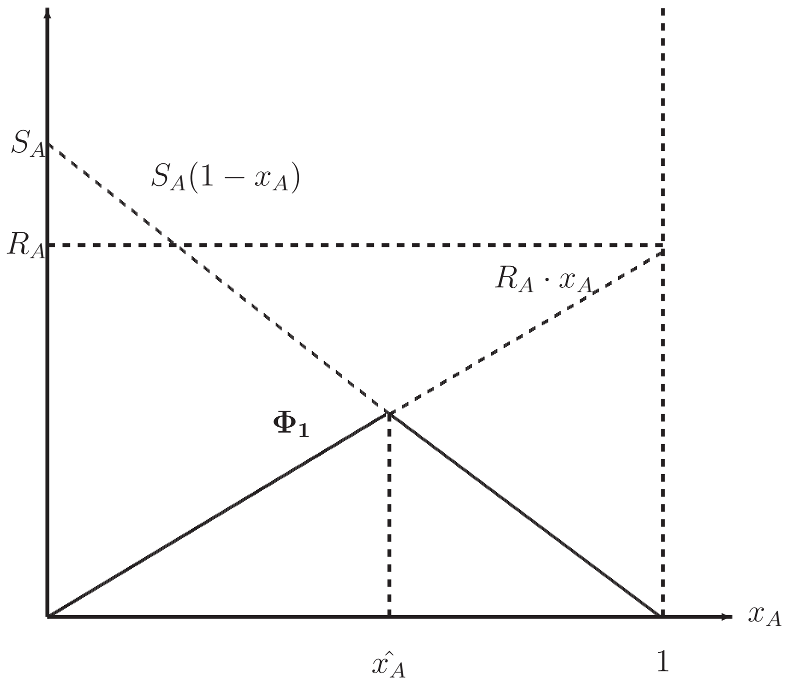

Figure 1: State-contingent Returns from Risky Investments

Obviously, for $x_A = \hat{x}_A$ the bank receives the same deterministic cash flow in $t = 1$ and $t = 2$ given no regional shocks. This deterministic cash flow is given by

$$\Phi = \Phi_1(\hat{x}_A) = \Phi_2(\hat{x}_A) = \frac{R_A S_A}{R_A + S_A}.$$

Apparently, the bigger the benefits from specialization, i.e. the bigger S/R, the smaller is this cash flow of a portfolio that fully diversifies sectoral shocks.

Besides the bank's decision about its capital investment the banks initial liquidity holding,l_0 ,also affects the feasible repayment in $t = 1$. A safe optimal deposit contract that can be offered by a separate bank solves $(P1)$

$$(P1)\left\{\begin{array}{lll} \max\limits_{d_1;d_2;l_0} & 2f\left(qX+(1-q)\right)l_0+(2e+2f)\left(qXd_1+(1-q)\,d_2\right) & \\ \text{s.t.} & qd_1=\Phi_1\left(1-l_0\right)+l_0 & (BC1) \\ & (1-q)\,d_2=\Phi_2\left(1-l_0\right) & (BC2) \\ & d_1\leq d_2 & (IC) \end{array}\right.$$

Taking into account that for the optimal deposit contract (IC) holds with equality it follows from $(BC1)$ and $(BC1)$ that

$$(1-q)\,\Phi_1\left(1-l_0\right)+(1-q)\,l_0=q\Phi_2\left(1-l_0\right)$$

Consequently the optimal liquidity holding is

$$l_0^D = \frac{q\Phi_2 - (1-q)\,\Phi_1}{q\Phi_2 - (1-q)\,\Phi_1 + (1-q)}.$$

Reinserting yields

$$d_D = d_1 = d_2 = \frac{\Phi_2}{q\Phi_2 - (1-q)\,\Phi_1 + (1-q)}. \tag{1}$$

From (1) it is easy to see that

$$\frac{\partial d_D}{\partial \Phi_1} = \frac{(1-q)\,\Phi_2}{q\Phi_2 - (1-q)\,\Phi_1 + (1-q)} > 0$$

and

$$\frac{\partial d_D}{\partial \Phi_2} = -\frac{(1-q)\,\Phi_1 + (1-q)}{\left[q\Phi_2 - (1-q)\,\Phi_1 + (1-q)\right]^2} < 0$$

for $\Phi_1 > 1$. Consequently, d_D is maximized subject to (IC) if Φ_1 is maximized and Φ_2 is minimized which is the case at $x_A = \hat{x}_A$ as long as

$$\frac{R_A S_A}{R_A + S_A} > 1$$

Investing in the portfolio $\left(l_0^D; \hat{x}_A\right)$ with

$$l_0^D = \frac{(2q-1)}{(2q-1) + (1-q)\,\Phi^{-1}}$$

the bank can offer an optimal deposit contract

$$d_D^* = \frac{1}{(2q-1) + (1-q)\,\Phi^{-1}}$$

Since $\partial\Phi/\partial(S/R) < 0$, it is easy to see that increasing benefits from specialization lead to lower repayments of a diversified bank:

$$\frac{\partial d_D^*}{\partial \Phi} \frac{\partial \Phi}{\partial S/R} < 0$$

Lemma 1 *The optimal deposit contract of bank that wants to stay solvent in all cases but those in which it suffers from a regional shock is characterized by* $d_1 = d_2 = d_D^*$. *The repayments on this optimal deposit contract decline with increasing benefits from specialization.*

Graphically, the optimal deposit contract d_D^* that a diversified bank can offer is derived in figure 2. Feasible contracts are to the lower left of the budget line FHG. Incentive compatible contracts are located to the upper left of $(IC) : d_1 = d_2$. Point G is characterized by no liquidity holding of the bank and total early (late) repayment on deposits that is just given by the early (late) returns on the diversified capital investments. Since we assume that on aggregate there are more early that late withdrawals the feasible early per capita repayment d_1 in point G is smaller than the late repayment d_2. Because depositors have a higher expected return form early repayments the bank will increase the early repayments an the expense of the late repayments by increasing its liquidity investments up to point H. Point H is the optimal contract and is characterized by the highest incentive compatible short-term repayment.

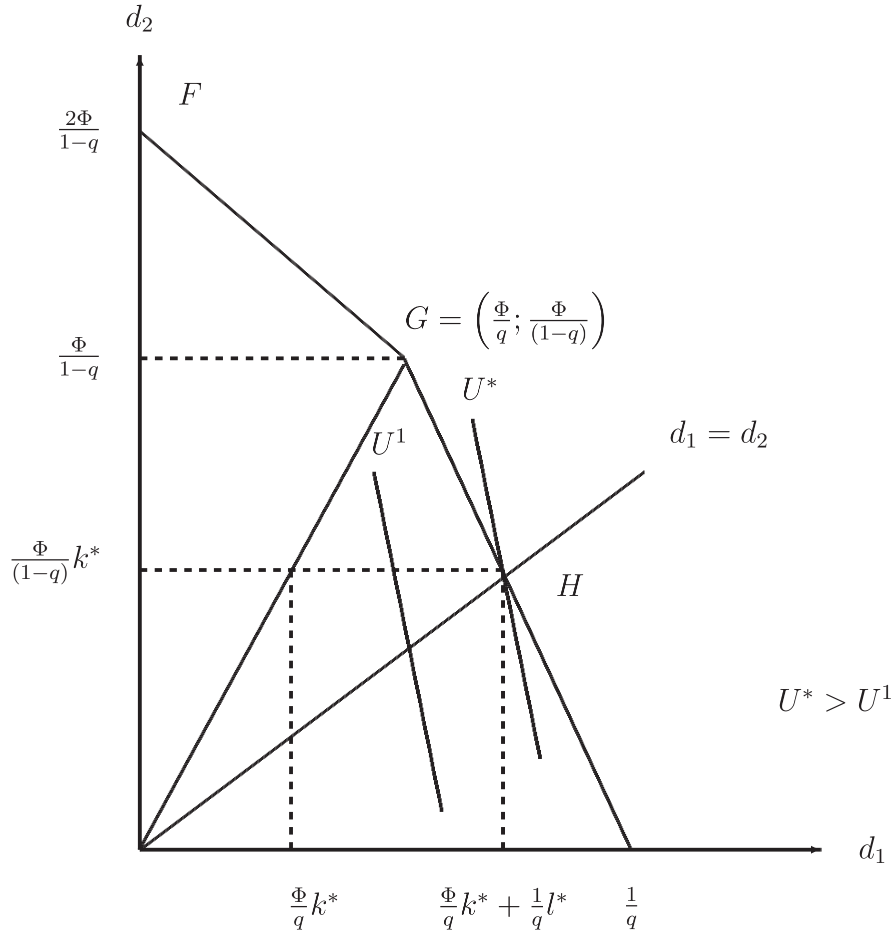

Figure 2: Optimal deposit contract of a diversified bank

Given this maximum repayment that the bank can promise in $t = 1$ the expected utility of households in the respective regions is

$$EU^D = 2f\left(qX + (1-q)\right)l_0^* + (2e+2f)\left(qX + (1-q)\right)d_D^* \tag{2}$$

It is easy to see that bank B will offer the same deposit contract and will hold the same amount of liquidity as bank A. The only difference is that bank B will invest more of its capital into technology R: $\hat{x}_A = 1 - \hat{x}_B$ Thus following this diversified strategy both banks are forced to invest the larger fraction of their capital into the technology in which they have a comparative *dis*advantage.

3.2 Undiversified banks

Assume now that bank A follows a more risky strategy and offers a deposit contract that it can only honor if the more productive technology generates the cash flow already in $t = 1$. Since the liquidation value is zero for both production technologies the portfolio decision x_A does not matter for bankruptcy returns. Thus it is optimal for the bank to invest only in liquidity and technology S. Consequently, the optimal deposit contract here simply solves

$$(P1')\begin{cases} \max\limits_{d_1;d_2;l_0} & (e+3f)\left(qX+(1-q)\right)l_0 + (e+f)\left(qXd_1 + (1-q)\,d_2\right) \\ \text{s.t.} & qd_1 = S_A\left(1-l_1\right)\left(1-l_0\right) + l_0 & (BC1) \\ & (1-q)\,d_2 = S_A l_1\left(1-l_0\right) & (BC2) \\ & d_1 \leq d_2 & (IC) \end{cases}$$

Taking again into account that (IC) will hold with equality it follows from $(BC1)$ and $(BC2)$ that

$$(1-q)\,S_A\left(1-l_1\right)\left(1-l_0\right) + (1-q)\,l_0 = qS_A l_1\left(1-l_0\right).$$

Thus the optimal risky deposit contract is determined by

$$l_1 = (1-q)\,\frac{S_A\left(1-l_0\right)+l_0}{S_A\left(1-l_0\right)}$$

and

$$d_U = S_A\left(1-l_0\right)+l_0.$$

This risky strategy provides depositors with an expected utility given by

$$EU^R(l_0) = (e+3f)(qX+(1-q))\,l_0 + (e+f)(qX+(1-q))(S_A-(S_A-1)\,l_0). \tag{3}$$

Hence

$$\frac{\partial EU^R}{\partial l_0} = [(e+3f)-(e+f)(S_A-1)](qX+(1-q)).$$

Consequently, the optimal risky strategy of an autarkic bank involves $l_0 = 0$ if

$$2f-(e+f)(S_A-2) < 0$$

$$\Leftrightarrow S_A > 2+\frac{2f}{(e+f)}. \tag{4}$$

Thus assuming that (4) holds[6] and it is optimal for the bank to follow the risky instead of the extremely safe strategy, then the expected utility that can be archived by the risky deposit contract $d_U^* = S_A$ is

$$EU^U = (e+f)(qX+(1-q))\,S_A \tag{5}$$

3.3 Safe deposit contract

Alternatively the bank could also offer a deposit contract that it could honor even if it is hit by a regional shock. Apparently, in order to follow that strategy the bank has to hold sufficient liquidity to repay early withdrawals even if both technologies provide a late return. But given that it holds sufficient liquidity there is no need for the bank to invest into a diversified portfolio. Thus following this strategy bank A will choose $x_A = 0$ and offer the deposit contract that solves

$$(P1'')\begin{cases} \max\limits_{d_1;d_2;l_0} & (2e+4f)(qXd_1+(1-q)\,d_2) & \\ \text{s.t.} & qd_1 = l_0 & (BC1) \\ & (1-q)\,d_2 = S_A(1-l_0) & (BC2) \\ & d_1 \leq d_2 & (IC) \end{cases}$$

[6]Note that if (4) does not hold, then the bank would prefer to invest only in liquidity ($l_0 = 1$) which implies $d = 1$ and would make the bank redundant. The expected utility in that case is

$$EU^A = (2e+4f)(qX+(1-q))$$

Taking again into account that (IC) will hold with equality it follows from $(BC1)$ and $(BC2)$ that

$$l_0^S = \frac{qS_A}{(1-q)+qS_A}$$

and

$$d_S^* = d_1 = d_2 = \frac{S_A}{(1-q)+qS_A}.$$

The expected utility from such a deposit contract is

$$EU^S = (2e+4f)\,(qX+(1-q))\,d_S^*.$$

3.4 Optimal deposit contract

We focus on parameter settings in which banks choose a diversified portfolio and offer d_D^*. Thus we consider cases in which

$$EU^D > EU^U \tag{6}$$

and

$$EU^D > EU^S. \tag{7}$$

Condition (6) requires that

$$(2e+4qf)\,d_D^* > (e+f)\,S_A$$

which can be simplified to

$$\frac{2e+4qf}{e+f} > (2q-1)\,S_A + (1-q)\left(1+\frac{S_A}{R_A}\right).$$

Thus separate banks prefer to diversify instead of specialize if 1) S_A is not too large and 2) the benefits from specialization (S/R) are not too large.

Condition (7) holds if

$$(2e+4qf)\,d_D^* > (2e+4f)\,d_S^*.$$

Reinserting d_D^* and d_S^* yields

$$\frac{(1-q)S^{-1}+q}{(2q-1)+(1-q)\Phi^{-1}} > \frac{e+2f}{e+2qf}.$$

Therefore, banks will not follow the safe strategy but rather diversify if 1) S_A is not too large and 2) because of $\partial\Phi/\partial(S/R) < 0$ if the benefits from specialization are not too large.

Thus we can summarize the findings in the following proposition:

Proposition 2 *If the advantages from specialization are not too large, then a separate bank will invest into a diversified portfolio of technology S and R. It invests the larger fraction into the inferior technology.*

4 Optimal allocation with integrated banks

4.1 Complete interbank market

Now assume that there is an interbank market available. In this interbank market banks exchange $t = 1$-liquidity against the future ($t = 2$) cash flow from some capital investment at an equilibrium interest rate. Since there is no investment alternative to the storage technology for excess liquidity in $t = 1$ (cash that is already available in $t = 1$ but is only needed in $t = 2$ to refinance the repayment to patient depositors) banks will offer any excess cash holdings in the interbank market at a riskless interest rate $i \geq 0$. To start with we assume that regional liquidity shocks are observable and verifiable, i.e. banks can observe regional liquidity shocks in both regions and can write contracts contingent on these variables.

The following contractual arrangement ensures efficiency. Both banks only invest in the technology in which they have a comparative advantage in lending: $x_A = 0$ and $x_B = 1$. Taking $S_A = R_B$ into account the optimal deposit contract that both banks can offer solves $(P2)$

$$(P2)\left\{\begin{array}{lll} \max\limits_{d_1;d_2;l_0} & 3f\left(qX + (1-q)\right)l_0 + (2e+f)\left(qXd_1 + (1-q)\,d_2\right) & \\ \text{s.t.} & 2qd_1 = S_A\left(1-l_0\right) + 2l_0 & (BC1) \\ & 2\left(1-q\right)d_2 = S_A\left(1-l_0\right) & (BC2) \\ & d_1 \leq d_2 & (IC) \end{array}\right.$$

Since again (IC) hold with equality at the optimal deposit contract it follows from $(BC1)$ and $(BC2)$ that

$$qS_A\left(1-l_0\right) = \left(1-q\right)S_A\left(1-l_0\right) + \left(1-q\right)2l_0.$$

Thus the optimal liquidity holding of each bank must be

$$l_0^I = \frac{(2q-1)\, S_A}{2\,(1-q) + (2q-1)\, S_A},$$

and the optimal deposit contract is

$$d_I = d_1 = d_2 = \frac{S_A}{2\,(1-q) + (2q-1)\, S_A}.$$

Given this portfolio and deposit contract the complete interbank market can allow a complete diversification of sectoral shocks. In order to implement this allocation the interbank contract signed in $t = 0$ must state that in case of a sectoral shock in sector R (S) bank A (B) receives $IB = \left(1 - l_0^I\right) S_A/2$ in $t = 1$ in exchange of a repayment of $IB = \left(1 - l_0^I\right) S_A/2$ in $t = 2$. In case of a regional shock no interbank payment is due.

Since $d_I > d_S^*$ because of $S_A > R_A$ and $S_B < R_B$ both banks can provide depositors with a higher expected repayment in cases of only sectoral shocks.

It is easy to see that banks following this strategy rely on the liquidity provision through the interbank market in case the technology that they are specialized generates returns not before $t = 2$. If, for instance, bank A cannot raise IB funds in the interbank market in $t = 1$ when technology S is delayed a run on bank A is unavoidable. Consequently, following a specialization in lending banks expose themselves to a liquidity risk in the interbank market. This generates the risk of spill-overs of regional liquidity shocks and cross-regional contagion. If region B is hit by a regional shock and all investments repay late while also technology S is delayed in region A, bank A will collapse simply because it exposed itself to liquidity inflow from the interbank market due to its specialization. This effect is already taken into account in the objective function in $(P2)$.

The resulting allocation is constraint Pareto optimal. Moreover, social surplus is evenly distributed among regions. Therefore, we expect this contractual arrangement to be the outcome of the interbank market with verifiable regional shocks.

These findings are summarized in the following proposition:

Proposition 3 *When regional shocks are verifiable financial integration through an interbank market enables banks to fully specialize ($x_A = 0$; $x_B = 1$) without being exposed to sectoral shocks. However, specialization brings about the risk of contagion.*

Given that financial integration and specialization brings about the risk of contagion it depends on the expected costs of contagion relative to the gains from specialization whether financial integration through the interbank market will actually occur.

The depositors expected utility under integration and specialization is given by

$$EU^{I} = 2f\left(qX + (1-q)\right) l_0^I + (2e + 2f)\left(qX + (1-q)\right) d_I. \tag{8}$$

Thus banks and depositors benefit from integrate if

$$EU^{I} > EU^{S}$$

which can be rewritten as

$$2fl_0^I + (2e + 2f)\, d_I > 2fl_0^* + (2e + 2f)\, d_S^*.$$

From reinserting (d_S^*, l_0^*) and $\left(d_I; l_0^I\right)$ it is obvious that this always holds since

$$(e + f) > -(2q - 1)\, f.$$

Because the probability f of regional shocks is the same in both regions in our set-up the expected welfare losses due to contagion are always overcompensated. Financial integration and specialization also increase diversification such that the probability of a regional bank's collapse following a shock in that region is reduces f. While bank A will fail due to contagion in case of a delay in technology S simultaneously with a regional shock in region B, financial integration enables it to sustain late returns from technology S together with a regional shock in region A. Already this beneficial effect outweighs the expected costs from financial contagion.

Proposition 4 *Since regional shocks occur with the same probability f in both regions financial integration through a complete interbank market is always preferable, even though financial contagion may occur.*

4.2 Interbank market failure with asymmetric information

It is important to note that this allocation can only be implemented through an interbank market if banks can observe regional shocks in the other region. Consider the same contractual arrangment as in the previous section. If, for instance, bank B could not observe whether bank A is hit by a regional shock, then bank A could always claim that it is hit by a regional shock. Doing so bank A could avoid the liquidity provision to bank B in case of a delay of technology S. This would allow bank A to reduce its liquidity holdings and thereby increase its depositors expected utility. To see this assume that bank B behaves properly: holds the portfolio l_0^I, offers the deposit contract d_I, and provides bank A with liquidity IB if technology R is delayed and expects the same liquidity provision of bank A if technology S is late. Furthermore assume that bank A does not invest any funds in the storage technology in $t = 0$ but invest a certain fraction x_A^C in technology R.

Given a delay of technology S and no regional shock bank A faces the following budget constraint regarding its d_1 and d_2 repayment on deposits:

$$
\begin{aligned}
qd_1^C &= R_A x_A^C + IB & (BC1)\\
(1-q)\, d_2^C &= S_A\left(1 - x_A^C\right) - IB & (BC2)\\
d_1 &\leq d_2 & (IC)
\end{aligned}
$$

Since again (IC) holds with equality and $R_A/S_A = \phi$

$$x_A^C = \frac{q - \left(1 - l_0^I\right)/2}{(1-q)\,\phi + q}$$

If bank A would not cheat the budget constraints that it faced were

$$
\begin{aligned}
qd^I &= l_0 + IB\\
(1-q)\, d^I &= S_A\left(1 - l_0\right) - IB
\end{aligned}
$$

Consequently, it is easy to see that the repayments that bank A could promise in case of a delay of technology S and no regional shock are bigger than are bigger if it cheats than if it behaves because[7]

$$l_0 > x_A^C > l_0/R_A \tag{9}$$

On the other hand if technology R is late and no regional shock occurs bank A's budget constraint is

$$
\begin{aligned}
qd_1^C &\leq S_A\left(1 - x_A^C\right) - l_1\\
(1-q)\, d_2^C &\leq R_A x_A^C + l_1
\end{aligned}
$$

[7]See a formal proof in the appendix.

and is also met for $d_1^C; d_2^C > d^I$ given that (9) holds.

However, it is easy to see that following this strategy bank A increases its exposure to regional shocks in region A. If technology S is late in region B and region A is hit by a regional shock causing a delay in all technologies banks A receives liquidity from bank B. However, because the investment in technology R does not pay out in $t = 1$ the available liquidity is insufficient to repay early withdraws. If bank A behaves and holds l_0^I instead of investing in technology R it would not be exposed to the regional shocks in this state of the world. Thus banks will only cheat and free-ride on the liquidity provision from the interbank market if the probability f of regional shocks is sufficiently small. Consequently, we have:

Proposition 5 *If regional liquidity shocks are not verifiable but are also not too likely financial integration through the interbank market does not necessarily enable banks to capture the benefits form specialization. Given a sufficiently low f banks will try to free-ride on the liquidity provision of the interbank and not withhold sufficient liquidity themselves.*

4.3 Unsecured interbank market

Now assume that instead of trading in the interbank spot market in $t = 1$ banks invest into unsecured deposits with each other. *Unsecured* here means that these deposits are junior to the households deposits. Just like in the case of households' deposits banks can withdraw these deposits (or part of it) in $t = 1$ or keep them until $t = 2$. Assume for simplicity that each bank holds with the other bank deposits that entitle it to withdraw up to d^I in $t = 1$. The fraction of deposits not withdrawn in $t = 1$ will be repayed in $t = 2$.

If banks hold these unsecured interbank deposits their incentive to cheat is substantially reduced. To see this assume that technology R is late but there is actually no regional liquidity shock. In order to implement the optimal allocation bank B should withdraw IB of its interbank deposits from bank A, while bank A should keep all of its deposits with bank B until $t = 2$. If bank A could try to cheat and pretend to suffer from a regional shock. It could also withdraw IB from bank B in $t = 1$. Doing so bank A could avoid a net liquidity provision to bank B. However, bank B is unable to honor the short-term repayments to private depositors and the withdrawal of bank A. Thus bank B will be liquidated. Since the liquidity plus the liquidisation returns are insufficient to repay all households' deposits bank A will not receive anything on its unsecured (junior) interbank debt. Consequently, while bank A still has to pay d^I in total to the bank B's depositors it will not receive anything on its interbank claims. Thus bank A will itself no longer be able to honor all households' deposits and will be liquidated, too.

To sum up, if banks mutually hold sufficient unsecured interbank deposits and bank A cheats (tries to avoid the liquidity provision to bank B in case of a delay in technology R and underinvests in liquidity) it will only be able to sustain those states in which it receives a liquidity provision from bank B and technology R is late. Therefore, given sufficient unsecured interbank deposits bank A will hold sufficient liquity and reveal any actual regional shock if

$$(2e + 2f)\left(qX - (1-q)\right) d^I + 2f\left(qX - (1-q)\right) l_0^I > e\left(qX - (1-q)\right) d^C$$

As shown in the appendix this always holds if

$$2 + \frac{1-q}{2q-1} > R_A$$

Proposition 6 *Sufficiently large mutual unsecured interbank deposit holdings can allow banks to financially integrate and fully capture the benefits from specialization even in an incomplete interbank market.*

It is interesting to note that also interbank deposits that are senior to households' deposits could have a disciplining effect here. If bank A would claim that it is hit by a regional shock and cannot honor interbank deposits in $t = 1$ it cannot repay early withdrawing private depositors and would have to close. Consequently, this would prevent bank A from pretending to suffer from a regional liquidity shock in order to avoid to provide liquidity to bank B.

However, given that technology shocks are not verifiable bank A could cheat with a different strategy: Using secured interbank deposits bank A would always have an incentive to claim that returns of technology S are late and it therefore needs liquidity provision from bank B. Following this behavior bank A could also avoid having to supply liquidity to bank B.[8]

[8] See **?** for a more detailed exposition of this argument.

5 Conclusion

When assessing the benefits from financial integration it has to be taken into account that the greater scope for diversification through financial integration may foster specialization which in turn increases the need for diversification. Thus the status quo of cross-country correlations does not allow the assess the risks and benefits from financial integration. It underestimates the benefits but it also undervalues the risk of financial contagion.

Appendix

Proof that $l_0 > x_A^C > l_0/R_A$: On the one hand reinserting x_A^C yields

$$l_0^I > \frac{q - \left(1 - l_0^I\right)/2}{(1-q)\,\phi + q}$$

$$l_0^I\,(1-q)\,\phi > \left(q - \frac{1}{2}\right)\left(1 - l_0^I\right)$$

$$\frac{2\,(1-q)\,\phi}{2q-1} > \frac{1 - l_0^I}{l_0^I}$$

Reinserting l_0^I and ϕ gives

$$\frac{2\,(1-q)}{2q-1}\frac{R_A}{S_A} > \frac{2\,(1-q)}{(2q-1)\,S_A}$$

$$R_A > 1$$

On the other hand

$$\frac{q - \left(1 - l_0^I\right)/2}{(1-q)\,\phi + q} > \frac{l_0^I}{R_A}$$

$$\frac{qS_A - \left(1 - l_0^I\right)S_A/2}{(1-q)\,R_A + qS_A} > \frac{l_0^I}{R_A}$$

$$(2q-1)\,S_A R_A + l_0^I S_A R_A > 2l_0^I\,(1-q)\,R_A + 2l_0^I q S_A$$

$$(2q-1)\,R_A S_A > 2\left((1-q)\,R_A + qS_A - R_A S_A\right) l_0^I$$

$$(2q-1)\,R_A S_A > 2\left((1-q)\,R_A + qS_A - R_A S_A\right)\frac{(2q-1)\,S_A}{2\,(1-q) + (2q-1)\,S_A}$$

$$2\,(1-q)\,R_A + (2q-1)\,R_A S_A > 2\left((1-q)\,R_A + qS_A - R_A S_A\right)$$

$$R_A > \frac{2q}{2q+1}$$

Proof that $2\left(e+2qf\right)d^{I}>ed^{C}$**:**

$$2\left(e+2qf\right)d^{I}>ed^{C}$$

holds if

$$2d^{I}>d^{C}$$
$$2l_{0}^{I}+IB>R_{A}x_{A}^{C}$$

$$IB>\left(R_{A}-2\right)l_{0}^{I}$$

$$S_{A}>\left(2R_{A}+S_{A}-4\right)l_{0}^{I}$$

$$2\left(1-q\right)S_{A}+\left(2q-1\right)S_{A}^{2}>\left(2R_{A}+S_{A}-4\right)\left(2q-1\right)S_{A}$$
$$2+\frac{1-q}{2q-1}>R_{A}$$

Since LHS goes to infinity as q approaches $1/2$ there is always an upper bound for q below which the above condition is met.

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