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Limits to international banking consolidation

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Discussion Paper
Series 2: Banking and Financial Studies
No 11/2006

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ISBN 3–86558–243–5 (Printversion)
ISBN 3–86558–244–3 (Internetversion)

Abstract:

Heterogenous banking supervision and regulation is often considered as the most important impediment for Pan-European Bank mergers. In this paper we identify other more fundamental reasons for a limited degree of cross-country integration in retail banking. We argue that the distribution of regional liquidity shocks may pose a natural limit to the extent of cross-border bank mergers. The paper derives the impact of different underlying stochastic structures on the optimal structure of cross regional bank mergers. Imposing a symmetry restriction on the underlying stochastic structure of liquidity shocks we find that benefits from diversification and the costs of contagion may be optimally traded off if banks from some but not from all regions merge. Under an additional monotonicity assumption full integration is only desirable if the number of regions with diverse risks is sufficiently large.

Keywords: Bank Mergers, Financial Integration, Liquidity Transformation, Liquidity Crisis, Risk Sharing

JEL Classification: D61, E44, G21

Non technical summary

The lack of pan-European banks seem to be a major obstacle to an integration of the retail bank market in Europe. The main impediment to cross-country bank mergers is typically seen in the heterogeneity of banking regulation and supervision in the European Union that prevails despite the existing minimum harmonization.[1] This paper, however, shows that more fundamental economic reasons might also prevent the formation of pan-European banks.

The paper develops a model with different regions in which banks offer households deposit contracts that provide them with an insurance against idiosyncratic liquidity shocks. Since the fraction of households facing a liquidity shock in each region is uncertain banks cannot fully diversify liquidity risks within a region. But banks can decide to operate in several regions in order to diversify regional liquidity risk. However, integrating several regions in one multiregional bank brings about the risk of contagion within the bank: a regional liquidity shortage in one region might exceed the excess liquidity generated in the remaining regions creating a liquidity shortage in the multiregional bank. Given that the number of regions is limited, regional risks are not fully diversifiable and the impact of a regional liquidity shock on the liquidity stance of a multinational bank does not become negligible. Thus banks face a tradeoff when deciding about a cross-border penetration of the retail market.

The paper shows that under fairly general assumptions banks choose to expand their business to several but not all regions. Obviously, any system of cross regional financial integration within a multinational bank can be supported by certain assumptions regarding the correlation of regional liquidity shocks. However, this paper considers symmetric regions. This excludes positive or negative correlations of shocks across regions. But even in this case it is not necessarily optimal to have either a fully integrated or a nationally fragmented banking system.

To understand the intuition consider an economy with four regions and assume that if a liquidity shortage occurs in one region all other regions have an abnormal liquidity stance, i.e. have either a positive or a negative regional liquidity shock of the same size. In this case it is always preferable for a bank to operate in at least two regions, because if one region faces a liquidity shortage the second region could have an offsetting liquidity shock. If the second region is also hit by a negative liquidity shock the two regions are not worse off than if they were served by separate banks. Contagion does not occur in this case

[1] Barros, Berglöf, Fulghieri, Gual, Mayer, and Vives (2005) argue in their report on the integration of European banking along these lines.

with a two regional merger. Adding additional regions, however, brings about the risk of financial contagion. Whenever the two initial regions have offsetting liquidity shocks, a liquidity shortage in the additional regions would cause a failure of the multiregional bank. At the same time it is rather unlikely that the additional regions have sufficient excess liquidity to compensate a liquidity shortage in both initial regions. Thus it is optimal for banks to operate in only two of the four regions.

Nicht technische Zusammenfassung

Die geringe Anzahl an pan-europäischen Banken scheint die Integration im retail banking zu behindern. Dabei wird häufig die heterogene Bankenregulierung und -aufsicht innerhalb Europas, die trotz der bestehenden Mindestharmonisierung zu verzeichnen ist, als wesentliches Hindernis für grenzübergreifende Bankübernahmen gesehen.[2] Das vorliegende Papier zeigt dagegen, dass auch fundamentale ökonomische Gründe die Entwicklung pan-europäischer Banken verhindern könnten.

Das präsentierte Modell basiert auf einer Ökonomie mit mehreren Regionen, in denen Banken privaten Haushalten Einlagenverträge als Versicherung gegen idiosynkratische Liquiditätsrisiken anbieten. Da allerdings der Anteil derjenigen Haushalte, die tatsächlich einen Liquiditätsbedarf haben, unsicher ist, können Liquiditätsschocks innerhalb einer Region nicht vollkommen diversifiziert werden. Um eine effizientere Diversifikation zu erreichen, können Banken aber Regionen übergreifend operieren. Die Integration mehrerer Regionen durch eine multiregionale Bank birgt allerdings auch das Risiko von Regionen übergreifenden Ansteckungseffekten: Kann der Liquiditätsengpass einer Region innerhalb einer multiregionalen Bank nicht durch einen hinreichenden Liquiditätsüberhang einer anderen Region kompensiert werden, so führt dies in der gesamten multiregionalen Bank zu einer Liquiditätskrise. Ist die Zahl der Regionen begrenzt, sind Liquiditätsrisiken auch Regionen übergreifend nicht vollständig diversifizierbar und der Einfluss eines regionalen Liquiditätsschocks auf den Liquiditätsstatus einer multiregionalen Bank wird nicht verschwindend. Dementsprechend muss eine Bank bei der Entscheidung, überregional im retail banking tätig zu werden, den positiven Diversifikationseffekt gegen das Risiko Regionen übergreifender Ansteckungseffekte abwägen.

Das vorliegende Papier zeigt, dass es für Banken unter relativ allgemeinen Bedingungen optimal ist, in einigen aber nicht allen Regionen zu operieren. Natürlich lässt sich ein solches Ergebnis alleine durch eine bestimmte Korrelationsstruktur regionaler Schocks erzielen. Das vorliegende Papier geht aber von vollkommen symmetrischen Regionen aus. Es werden dementsprechend positive und negative Korrelationen zwischen Regionen ausgeschlossen. Aber auch in diesem Fall zeigt sich, dass weder ein vollständig regional integrierter Bankensektor noch vollkommen regional fragmentierte Bankensysteme optimal sind.

Um die Intuition nachzuvollziehen, sei eine Ökonomie mit vier Regionen angenommen. Darüber hinaus wird unterstellt, dass sofern eine Region einen Liquiditätsschock erleidet, auch sämtliche andere Regionen einen abnormen Liquiditätsbedarf haben. Das heißt,

[2] Barros, et al. (2005) argumentieren beispielsweise dementsprechend.

dass sie jeweils einen positiven oder einen negativen regionalen Liquiditätsschock desselben Ausmaßes haben. In diesem Fall ist es immer vorteilhaft für eine Bank, mindestens in zwei Regionen präsent zu sein. Denn der negative Liquiditätsschock einer Region wird dann unter Umständen von einem positiven Schock in der anderen Region begleitet und kann hierdurch kompensiert werden. Ist die zweite Region dagegen auch von einem Liquiditätsengpass betroffen, so sind die beiden Regionen durch die Integration nicht schlechter gestellt als im Falle einer Autonomie. Ein Ansteckungseffekt tritt bei einem Bankenzusammenschluss über zwei Regionen nicht auf. Dies ist anders, wenn die Bank ihr Geschäft auf alle vier Regionen ausdehnt. Denn sobald die beiden ursprünglichen Regionen sich wechselseitig durch sich kompensierende Liquiditätsschocks stabilisieren, würde ein Liquiditätsengpass in den zusätzlichen Regionen eine Liquiditätskrise in der multiregionalen Bank auslösen. Sollten dagegen die beiden ersten Regionen gleichzeitig von einem Liquiditätsengpass betroffen sein, so führt die Integration mit weiteren Regionen nur in dem unwahrscheinlichen Fall zu einer Stabilisierung, in dem die beiden zusätzlichen Regionen einen Liquiditätsüberhang haben. Demzufolge ist es optimal für Banken, nur in zwei der vier Regionen zu operieren.

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Limits to International Banking Consolidation‡

1 Introduction

The integration of the European banking sector has so far mainly been limited to the wholesale market. The lack of pan-European banks however is the major obstacle to an integration of the retail bank market. It is often argued that large cross-country mergers of banks have mainly been impeded by the heterogenous banking regulation and supervision in the European union.[1]

This paper questions whether indeed the heterogeneity in the regulatory and supervisory regimes in Europe is the only reason why cross-country bank mergers in the European Union have been limited and have failed to create a truly pan-European bank. A banking system that relies on international institutions provides an insurance mechanism against national liquidity shocks. However, cross border transactions and mergers can bring about a risk of financial contagion, i.e. they may increase systemic risk. A liquidity shortage in a single region can spill-over to other regions if large financial institutions are fully liable for their foreign branches.

We develop a model of banks as managers of different liquidity risks related to Kashyap, Rajan, and Stein (2002). However, unlike Kashyap, Rajan, and Stein (2002) we follow Allen and Gale (2000) and assume regional liquidity shocks as the primary source of banks' liquidity risk. Banks can choose to operate in different regions.

Banks offer regional households with uncertain intertemporal consumption preferences a liquidity insurance through deposit contracts as in Diamond and Dybvig (1983). However, in each region there is some risk associated with the fraction of depositors having early consumption needs. A bank that operates in more than one region can insure depositors against regional liquidity risks. However, it risks that liquidity shortages in other regions spill over and adversely affect its entire business. Using this framework we show that a partial integration of the retail banking sector with banks operating in several but not all regions may actually be optimal given a certain fundamental stochastic structure of regional specific liquidity shocks.

‡We would like to thank Frank Heid, Michael Koetter, and Rowena Pecchenino as well as the conference participants of the 4th INFINITY Conference Dublin for helpful comments. The views expressed here are those of the authors and not necessarily those of the Deutsche Bundesbank.

[1]Barros, Berglöf, Fulghieri, Gual, Mayer, and Vives (2005) argue in their report on the integration of European banking along these lines.

Obviously, any system of cross regional financial integration can be supported by some underlying stochastic structure of liquidity needs. In order to gain further insights one needs to distinguish more and less realistic scenarios. In our paper we impose a symmetry assumption which excludes positive or negative correlations of shocks across regions. We show that even if all regions are entirely symmetric and no particular correlation between the liquidity shocks of specific regions is assumed, its is not necessarily optimal to have either a full integrated or a nationally fragmented banking system. On the contrary, we find that in many cases a multinational bank that optimally trades off the diversification benefits and the costs from negative cross-regional spillovers is only operating in several but not all countries. In other words we show that the problem of finding the optimal size of multinational banks often has an interior solution in which banks operate only in a subset of the countries of an economic area.

Of course, our results only hold if the number of regions with different risk structures is not abundant. If this was the case then - by the law of large numbers - a complete merger of banks in all existing regions would help to diversify away all risks. Moreover, financial distress in single regions would not cause the breakdown of the entire system because the excess liquidity need in one region would be relatively low. However, if the number of regions is limited, the financial distress in one region may cause a breakdown of a bank that operates in the entire economy. This is what we shall assume in this paper.

Similar to banks in Kashyap, Rajan, and Stein (2002) deposit institutes in our framework try to economize on their overall liquidity risk by combining negatively correlated liquidity risks across regions. Consequently, if it is very likely that two regions are hit by (offsetting) liquidity shocks a two-regional bank merger (or a bank operating in two regions, respectively) can reduce the overall liquidity risk of the financial institution. If it is on the other hand rather likely that a liquidity shock only occurs in one region at the same time, then the risk that such a regional shock might induce a collapse of the multinational banks is too high. Multinational banks are inefficient in this case–banks should operate only in one region. Financial risk that is concentrated on single regions makes it desirable to partition the economy completely.

In our paper we introduce the notion of financial turbulence. Financial turbulence is characterized by situations in which all regions simultaneously display unusually high or unusually low liquidity needs: A liquidity shortage in one region is always accompanied by an abnormal (positive or negative) liquidity stance of the same size in all other regions. We show that a high relative likelihood of financial turbulence makes limited financial integration particularly desirable.

To understand the intuition consider an economy with four regions. In this case it is always preferable for a bank to operate in at least two regions, because if one region faces a liquidity shortage the second region could have an offsetting liquidity shock. If the second region is also hit by a negative liquidity shock the two regions are not worst off than if they were served by separate banks. Contagion does not occur in this case with a two regional merger. Adding additional regions, however, brings about the risk of financial contagion. Whenever, the two initial regions have offsetting liquidity shocks a liquidity shortage in the additional regions would cause a failure of the multiregional bank. At the same time it is rather unlikely that the additional regions have sufficient excess liquidity to compensate a liquidity shortage in both initial regions. Moreover, in cases with excess liquidity in the two considered regions a merger with other regions leads very likely to a liquidity transfer to other regions with less liquidity. Thus given a high relative likelihood of financial turbulence it is optimal for banks to operate in only two of the four regions.

While our model shares the common feature of banks as managers of liquidity risks with Kashyap, Rajan, and Stein (2002), our model differs from theirs in several respects. Most important is probably that in Kashyap, Rajan, and Stein (2002) banks' main objective when combining liquidity risks is to minimize costly cash holdings. In contrast, in our model banks try to smooth consumption for their stake holders taking negatively correlated liquidity risks. In this respect our paper is also closely related to models that analyze the costs and benefits of integrated interbank bank markets like Allen and Gale (2000) and Freixas, Parigi, and Rochet (2000). They show that an integrated interbank market may serve as a means for banks to mutually insure against negatively correlated bank specific liquidity shocks. But when deciding to integrate through the interbank market banks do not take into account the risk of financial contagion. For a two regional economy Fecht and Grüner (2004) analyze the decision of banks to integrate through the interbank market trading off the benefits from diversifying idiosyncratic liquidity shocks against the costs from contagion in case of aggregate liquidity shortages. Fecht and Grüner (2004) also show that interbank integration does not capture all benefit from financial integration even if regional specific liquidity shocks are the only benefit from integration. A cross-regionally active bank could provide even smoother consumption possibilities than regional banks being insured over the interbank market. This paper extends the framework of Fecht and Grüner (2004) to multiple regions but focuses only on financial integration through cross-country bank merger. Intriguingly, we find that even though cross-country mergers allow to reap the maximum benefits from cross-border integration (as compared to interbank market integration) depending on the distribution of the regional liquidity shocks it is still not necessarily optimal for banks to operate in all regions of an economy.

The remainder of the paper is organized as follows. Section 2 describes the basic settings of the model. In section 2.4 we derive the optimal deposit contract that banks offer to households. If states with liquidity shocks are sufficiently unlikely this deposit contract is independent of the degree of international integration chosen by banks. Thus we can take the optimal deposit contract as given, when deriving the optimal degree of cross-country integration of the banking sector in section 3 for different parameter settings. Section 4 provides some simulation results and section 5 concludes.

2 The Model

2.1 Households

The economy consists of four regions $I = 1, .., 4$. Each region consists of a mass 1 of households with the same stochastic utility function

$$U_i\left(c_1; c_2\right) = \tilde{\theta}_j u\left(c_1\right) + \left(1 - \tilde{\theta}_j\right) u\left(c_2\right),$$

with

$$u\left(c_t\right) = \frac{1}{1-\gamma} c_t^{1-\gamma} \quad \text{and} \quad \gamma > 1 \quad \text{and} \quad \tilde{\theta}_j \in \{0; 1\}$$

In each region I households do not know whether they can derive utility from consumption in $t = 1$ or $t = 2$. They only know that with a probability $\tilde{q}_I$ they will turn out to be impatient and want to consume in $t = 1$. The probability $\tilde{q}_I$ of becoming an impatient household (which is at the same time the regional fraction of impatient households) is itself stochastic:

$$\int \tilde{\theta}_j dj = \tilde{q}_I \quad \text{with} \quad \tilde{q}_I \in \left\{0; \frac{1}{2}; 1\right\}.$$

With probability a the fraction of impatient consumers in all four regions equals 1/2. With probability $(1 - a)$ in at least one of the regions $q_I \neq \frac{1}{2}$. This means that in one or more regions either a high (1) or a low (0) fraction of households wants to consume early.

2.2 Stochastic structure

In an economy with four regions and two types of liquidity shocks there are $3^4 = 81$ possible realizations of the shocks. The set of possible probability distributions is given by the unit simplex with 81 dimensions. In order to impose some further structure on the problem we assume that each situation with a given number of shocks is equally likely. This implies that shocks are not correlated across regions. Call the conditional probabilities of each event with i shocks ρ_i , $i = 1, 2, ..4$. I.e. ρ_1 is the conditional (on the fact that there is a liquidity shock somewhere) probability that there is an early (or late) liquidity shock in one particular region and no shock in the other three regions. In this analysis we restrict our attention to the limit case with $a \approx 0$. We have:

$$8\rho_1 + 24\rho_2 + 32\rho_3 + 16\rho_4 = 1,$$

i.e. there are 8 possible constellations with one single shock, 24 possible constellations with 2 shocks and so on. Four prototype situations will be distinguished:

1. financial risk $\rho_1 = 1/8$ ($\rho_2 = \rho_3 = \rho_4 = 0$).
2. limited turbulence $\rho_2 = 1/24$ ($\rho_1 = \rho_3 = \rho_4 = 0$).
3. significant turbulence $\rho_3 = 1/32$ ($\rho_1 = \rho_2 = \rho_4 = 0$).
4. turbulence $\rho_4 = 1/16$ ($\rho_1 = \rho_2 = \rho_3 = 0$).

Any other stochastic structure is a convex combination of these 4 regimes.

Our second, stronger assumption is that liquidity shocks which affect a smaller number of regions are more likely. Under such a *monotonous risk structure* $8\rho_1 > 24\rho_2 > 32\rho_3 > 16\rho_4$. This assumption will only be needed for one particular result on the desirability of full financial integration.

2.3 Technology

There is one direct investment technology available in the economy. In $t = 0$ households can invest in the technology. Because it is not observable whether a particular household is patient or impatient, there is no direct insurance mechanism against liquidity risks available. Furthermore, there is no financial market in $t = 1$ available in which households from the four regions could participate.

	$t = 0$	$t = 1$	$t = 2$
finished	-1	0	$R > 1$
liquidated	-1	$+1$	0

We assume that the long-term returns are sufficiently large and/or that the degree of households' risk aversion is sufficiently high that

$$\frac{3}{2} > R^{(1-\gamma)/\gamma}.$$

As we shall see below this assumption ensures that a bank operating in all four regions and offering the optimal deposit contract will collapse even if only in one of the four regions an early liquidity shock occurs.

Besides direct investment households can invest their endowment at a bank. Banks offer deposit contracts with alternative repayments in both periods, $\{d_1; d_2\}$. There is one bank in each region. However, banking markets are contestable. Therefore banks are forced to offer the deposit contract that maximizes the expected utility of depositors.

If banks cannot repay all depositors withdrawing in $t = 1$ all depositors (even those initially not withdrawing in $t = 1$) receive the same pro-rata repayment. Thus we abstract for sequential service constraints and thereby exclude purely expectation driven bank runs.

2.4 The optimal deposit contract

Given our assumption that liquidity shocks are sufficiently unlikely ($a \approx 0$) the optimal deposit contract maximizes households expected utility

$$E[U(d_1; d_2)] = \frac{1}{2}u(d_1) + \frac{1}{2}u(d_2)$$

subject to the budget constraint

$$\frac{1}{2}d_1 + \frac{1}{2}\frac{1}{R}d_2 \leq 1,$$

and is always given by

$$d_1^M = \frac{2}{R^{(1-\gamma)/\gamma} + 1},$$

which yields a regular payoff at date 2 of

$$d_2^M = \frac{2R^{1/\gamma}}{R^{(1-\gamma)/\gamma} + 1}.$$

3 The optimal degree of financial integration

3.1 Useful results

It is useful to note that there are cases in which only the likelihood of a bank's bankruptcy determines the ranking of consumer utility. This holds if the risk aversion parameter γ is sufficiently large.

Proposition 1 *Consider two banks* $1, 2$ *that go bankrupt with some probability* a_1, a_2, *provide customers with normal payoffs* $\left(d_1^M, d_2^M\right)$ *with probability* b_1, b_2, *and provide the* *normal payoff d_1^M at date 1 and R at date 2 with probability c_1, c_2. For all $R < \infty$ and $0 \leq b_{1,2}, c_{1,2} < 1$ there is a $\underline{\gamma}$ such that for all $\gamma \geq \underline{\gamma}$ bank 1 is preferable to bank 2 if it only has a low default probability, i.e. if $a_1 < a_2$.*

Proof. An individual who is extremely risk averse maximizes his minimum payoff. The optimal contract fixes identical payoffs in both periods.

$$\lim_{\gamma \to \infty} d_1^M = \lim_{\gamma \to \infty} d_2^M = \frac{2}{R^{-1} + 1}.$$

Moreover, for γ going to infinity utility is larger if and only if the probability of the lowest payoff, 1 is minimized. To see this verify that the utility of bank 1's customers may be written:

$$a_1 \frac{1}{1-\gamma} 1^{1-\gamma} + \sum_{j=1..4} x_j \frac{1}{1-\gamma} c_j^{1-\gamma}$$

with $c_j = d_1^M, d_2^M, d_1^M, R > 1$ and $x_j = 2b_1, 2b_1, 2c_1, 2c_1$.The result follows from

$$\lim_{\gamma \to \infty} a_1 \frac{1}{1-\gamma} 1^{1-\gamma} + \sum_{j=1..4} x_j \frac{1}{1-\gamma} c_j^{1-\gamma}$$
$$= \frac{1}{1-\gamma} \left(a_1 + \lim_{\gamma \to \infty} \sum_{j=1..4} x_j c_j^{1-\gamma} \right) = \frac{1}{1-\gamma} a_1.$$

■

Thus for sufficiently risk averse households banks' prior aim is to minimize the probability of a default due to a liquidity shortage. Achieving or efficiently distributing excess liquidity becomes subordinated.

Our second result relates to situations of low risk aversion. In such cases there is almost no consumption smoothing since $c_1 \approx 1$ and $c_2 \approx R$. The loss from a financial crises in a single region is negligible because all consumers would optimally consume one unit anyway. However, in other regimes there may be contagion in cases in which some consumers prefer to consume at the later date. Therefore , for low values of γ separation is strictly preferred to any other regime.

Proposition 2 *For all R there is a $\bar{\gamma} > 1$ such that for all $\gamma \leq \bar{\gamma}$ separation is strictly preferred to any other regime.*

Proof. For a risk-neutral individual the optimal contract fixes $d_1^M = 1$, $d_2^M = R$. To see this, consider the ratio of the maximum date 2 payoff R and normal date 2 payments,

$d_2^M = \frac{2R^{1/\gamma}}{R^{(1-\gamma)/\gamma}+1}$:

$$\begin{aligned}\frac{R}{d_2^M} &= \frac{R}{\frac{2R^{1/\gamma}}{R^{(1-\gamma)/\gamma}+1}} \\ &= \frac{R^{1/\gamma}+R}{2R^{1/\gamma}} \\ &= \frac{R^{1/\gamma}}{2R^{1/\gamma}} + \frac{R}{2R^{1/\gamma}} \\ &= \frac{1}{2} + \frac{R^{1-\frac{1}{\gamma}}}{2} \\ &= \frac{1}{2} + \frac{R^{\frac{\gamma-1}{\gamma}}}{2}.\end{aligned}$$

$$\lim_{\gamma\to 1} \frac{1}{2} + \frac{R^{\frac{\gamma-1}{\gamma}}}{2} = 1.$$

Hence, under separation, early consumers realize their desired consumption even in the event of a crises. Late consumers realize the maximum payoff R, i.e. there is no potential gain from late liquidity sharing. All other forms of integration yield lower payoffs because there is a risk of liquidation for late consumers due to financial contagion. The rest follows from the continuity of utilities in γ. ■

We now use the first result to derive the optimal structure of the banking sector in cases with highly risk averse depositors.

3.2 Separation

Financial integration is particularly costly if shocks are limited to single regions ($\rho_1 = \frac{1}{8}$). In such a situation a financial merger has two effects: (i) a positive liquidity sharing effect in case of a positive liquidity shock in one region and (ii) a contagion effect which is particularly likely. This is due to the fact that in half of all cases the aggregate liquidity shortage leads to a collapse of a cross-regionally active bank.[2] Liquidity shocks can never offset each other in this case.

Proposition 3 *(i) Consider an economy with only financial risk ($8\rho_1 = 1$). For all R there is a $\underline{\gamma}$ such that for all $\gamma \geq \underline{\gamma}$ separation strictly maximizes expected household utility. Utility strictly decreases in the order of integration. (ii) Consider an economy under limited financial turbulence. For all R there is a $\underline{\gamma}$ such that for all $\gamma \geq \underline{\gamma}$ separation and full integration maximizes expected household utility. Intermediate integration yields inferior results.*

[2]Keep in mind that we assume that each region is large enough to induce a financial collapse of the entire system.

Table 1: Regionally concentrated financial risk, $\rho_1 = \frac{1}{8}$.

Case/Region	1	2	3	4
1	■	0	0	0
2	0	■	0	0
3	0	0	■	0
4	0	0	0	■
5	□	0	0	0
6	0	□	0	0
7	0	0	□	0
8	0	0	0	□

Proof. (i) Table 1 relates to a situation with regionally concentrated financial risk. In this case $\rho_1 = \frac{1}{8}$. Each row represents one situation in which one particular region is affected by a shock. A black square (■) represents excessive liquidity ($q_I = 0$), an empty square (□) too little liquidity ($q_I = 1$). A zero represents normal liquidity. Separation yields maximum utility. 2-integration introduces a loss due to contagion in case 6. 3-integration introduces a loss due to contagion in cases 6 and 7, and so on.

(ii) Table 2 relates to a situation with limited financial turbulence, i.e. two regions are affected by a shock. Consider the risk of bankruptcy for consumers in region 1 in a merger with region 2. Bankruptcy occurs in 9 cases (4,6,11,14,16,18,20,23,24). Under separation bankruptcy occurs in 6 cases. Under 3 integration in 9 and under full integration in 6 cases. ■

3.3 Existence of an interior solution

A limited merger of only two banks may be the optimal solution when an abnormal liquidity demand in all regions is the most likely type of shock. In our model this corresponds to the case where $16 \cdot \rho_4 = 1$. We refer to such situations as cases with likely *financial turbulence.*

Proposition 4 *Consider an economy with likely financial turbulence ($16\rho_4 = 1$). For all $R > 1$ there is a lower bound γ such that for all $\gamma \geq \gamma$ 2-integration strictly maximizes expected household utility.*

Proof. Table 3 relates to a situation with financial turbulence: there is a shock in every region. Consider the risk of bankruptcy for consumers in region 1 in a merger with

Table 2: Limited turbulence, $24\rho_2 = 1$

Case/Region	1	2	3	4	Case/Region	1	2	3	4
1	■	□	0	0	13	■	0	■	0
2	□	■	0	0	14	□	0	□	0
3	■	■	0	0	15	0	■	■	0
4	□	□	0	0	16	0	□	□	0
5	■	0	□	0	17	■	0	0	□
6	□	0	■	0	18	□	0	0	■
7	0	0	■	□	19	■	0	0	■
8	0	0	□	■	20	□	0	0	□
9	0	0	■	■	21	0	■	0	□
10	0	0	□	□	22	0	■	0	■
11	0	□	■	0	23	0	□	0	□
12	0	■	□	0	24	0	□	0	■

region 2. Bankruptcy occurs in 4 cases (13-16). Under separation bankruptcy occurs in 8 cases, under 3-integration in 8 cases, under 4 integration in 5 cases. ■

Table 3: Financial turbulence, $16\rho_4 = 1$

Case/Region	1	2	3	4	Case/Region	1	2	3	4
1	■	□	□	□	9	■	■	■	■
2	■	□	■	■	10	■	■	□	□
3	■	□	□	■	11	■	■	□	■
4	■	□	■	□	12	■	■	■	□
5	□	■	□	□	13	□	□	■	■
6	□	■	■	■	14	□	□	□	■
7	□	■	□	■	15	□	□	■	□
8	□	■	■	□	16	□	□	□	□

The possible welfare gain from 2-integration (versus separation) arises when there are opposite liquidity shocks in those two regions. A possible cost arises when region 1 is characterized by a high liquidity need and region 2 has a normal liquidity status. In this case liquidity is transferred from region 1 to region 2. However, as seen in section 3.1. for sufficiently risk averse households these costs are always overcompensated by the benefit from the reduced default risk.

Adding two more regions (i.e. a complete merger of all four regional banks) raises the cost of financial contagion significantly but adds little to the positive insurance effect. If financial turbulence is the most likely outcome (meaning that all four regions have different liquidity needs than usual) then adding two more regions can only help in those cases where the two initial regions have been subject to the same - early - liquidity shock. If the two regions have an excess liquidity they would be forced to share this excess liquidity with the two additional regions if they have less liquidity. But more importantly, given that the two initial regions have offsetting liquidity shocks expanding the bank to two additional regions increases the risk that a liquidity shortage from the other regions causes a default of the entire bank.

A similar result is obtained for a case of significant financial turbulence.

Proposition 5 *Consider an economy under significant financial turbulence ($32\rho_3 = 1$). For all $R > 1$ there is a lower bound $\underline{\gamma}$ such that for all $\gamma \geq \underline{\gamma}$ 3-integration strictly maximizes expected household utility.*

Proof. Table 4 relates to a situation with significant financial turbulence: there is always a shock in 3 of the 4 regions. Consider the risk of bankruptcy for consumers in region 1 in a merger with region 2 and 3. Bankruptcy occurs in 10 cases (cases: 1,3,5,7,13,16,21,22,29, and 32). Under separation bankruptcy occurs in 12 cases, under 2-integration in 12 cases, under 4 integration in 16 cases. ■

3.4 Full integration

Proposition 6 *(i) Full integration can only be uniquely optimal under a risk structure which is a convex combination of limited turbulence and turbulence. (ii) Under a monotonous risk structure full integration can never be optimal.*

Proof. (i) Under financial risk and significant turbulence full integration is the worst of all options. It is optimal under limited turbulence and preferred to separation under turbulence. From what we have learned so far under full separation the conditional probability a liquidity shortage at the bank is:

$$\pi_1 = \rho_1 + 6\rho_2 + 12\rho_3 + 8\rho_4.$$

Under 2-integration it is:

$$\pi_2 = 2\rho_1 + 9\rho_2 + 12\rho_3 + 4\rho_4.$$

Under 3-integration it is:

$$\pi_3 = 3\rho_1 + 9\rho_2 + 10\rho_3 + 8\rho_4.$$

Table 4: Significant financial turbulence, $32\rho_3 = 1$

Case/Region	1	2	3	4	Case/Region	1	2	3	4
1	■	□	□	0	17	■	0	■	■
2	□	■	■	0	17	■	0	■	□
3	□	□	■	0	19	■	0	□	■
4	■	□	■	0	20	□	0	■	■
5	□	■	□	0	21	□	0	□	□
6	■	■	□	0	22	□	0	□	■
7	□	□	□	0	23	□	0	■	□
8	■	■	■	0	24	■	0	□	□
9	■	■	0	■	25	0	■	■	■
10	■	■	0	□	26	0	■	■	□
11	■	□	0	■	27	0	■	□	■
12	□	■	0	■	28	0	□	■	■
13	□	□	0	■	29	0	□	□	■
14	□	■	0	□	30	0	■	□	□
15	■	□	0	□	31	0	□	■	□
16	□	□	0	□	32	0	□	□	□

Under full integration it is:

$$\pi_4 = 4\rho_1 + 6\rho_2 + 16\rho_3 + 5\rho_4.$$

An appropriate convex combination of $\rho 2$ and ρ_4 yields the following bankruptcy risk.

Under separation it is:

$$p_1 = \alpha\frac{6}{24} + (1-\alpha)\frac{8}{16} = \frac{1}{2} - \frac{1}{4}\alpha$$

Under 2-integration it is:

$$p_2 = \alpha\frac{9}{24} + (1-\alpha)\frac{4}{16} = \frac{1}{8}\alpha + \frac{1}{4}$$

Under 3-integration it is:

$$p_3 = \alpha\frac{9}{24} + (1-\alpha)\frac{8}{16} = \frac{1}{2} - \frac{1}{8}\alpha$$

Under full integration it is:

$$p_4 = \alpha\frac{6}{24} + (1-\alpha)\frac{5}{16} = \frac{5}{16} - \frac{1}{16}\alpha$$

For $\alpha \lessapprox 1$ full integration is uniquely optimal.

(ii) Under a monotonous risk structure $8\rho_1 > 24\rho_2 > 32\rho_3 > 16\rho_4$. One can easily verify that this is incompatible with full integration dominating separation. ■

It is important to note that complete integration is particularly bad in those situations in which regions one and two are hit by a positive shock (see table 3). In most situations it is not good to integrate them because they would have to share their excess liquidity with the two other regions (cases 10-12). If by contrast regions one and two are both hit by a negative shock then integration usually does not help (cases 14-16). It only helps in the case where the two remaining regions are affected by a positive shock (case 13). If the shock in regions one and two offset one another then integration does not help if liquidity is balanced in the rest of the economy and it is bad if there is a need for liquidity in the rest of the economy (case 1 and 5). Only if there is excess liquidity in the rest of the economy integration has a benefit (case 2).

Consequently, when financial risk is dominant, separation is a good option. When financial turbulence is likely, less than complete integration may be a good choice. Under a monotonous risk structure full integration is not desirable for risk averse consumers.

4 Simulation results

We complete the paper with a simulation analysis for those intermediate parameter values for which no clear welfare analysis can be provided. We have to start by specifying households' expected utility in the different arrangements. Under separation, households expected utility conditional on the occurrence of a shock in some region of the economy can be calculated as:

$$\begin{aligned} U\left(d_1^M; d_2^M\right) = & \\ & (6\rho_1 + 12\rho_2 + 8\rho_3)\left(\frac{1}{2(1-\gamma)}\left(d_1^M\right)^{1-\gamma} + \frac{1}{2(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right) \\ & + (\rho_1 + 6\rho_2 + 12\rho_3 + 8\rho_4)\frac{1}{(1-\gamma)} \\ & + (\rho_1 + 6\rho_2 + 12\rho_3 + 8\rho_4)\frac{1}{(1-\gamma)}R^{1-\gamma}. \end{aligned}$$

The first line corresponds to normal liquidity, the second to a financial crises and the third to excess liquidity. Under 2-integration excess liquidity may be shared with the other region in a number of cases (third line). We have:

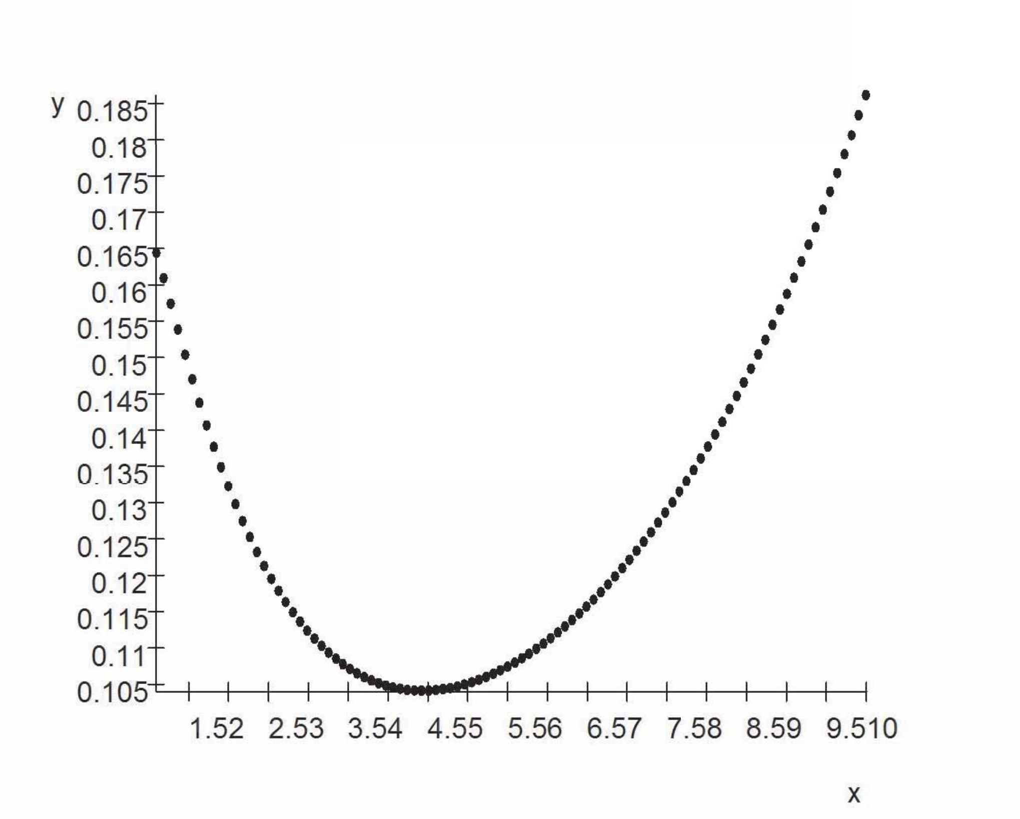
$$
\begin{aligned}
&U\left(d_1^M; d_2^M\right) = \\
&\qquad (4\rho_1 + 6\rho_2 + 8\rho_3 + 8\rho_4) \\
&\qquad \left(\frac{1}{2\,(1-\gamma)}\left(d_1^M\right)^{1-\gamma} + \frac{1}{2\,(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right) \\
&\qquad + (2\rho_1 + 9\rho_2 + 12\rho_3 + 4\rho_4)\,\frac{1}{(1-\gamma)} \\
&\qquad + (2\rho_1 + 8\rho_2 + 8\rho_3)\,\frac{1}{(1-\gamma)} \cdot \left(\frac{3}{4}\left(R\frac{1-\frac{1}{2}d_1^M}{\frac{3}{4}}\right)^{1-\gamma} + \frac{1}{4}\left(\frac{1}{2}d_1^M\right)^{1-\gamma}\right) \\
&\qquad + (\rho_2 + 4\rho_3 + 4\rho_4)\,\frac{1}{(1-\gamma)}R^{1-\gamma},
\end{aligned}
$$

Similarly, under 3-integration three levels of average excess liquidity may obtain. Household utility is given by:

$$
\begin{aligned}
&U\left(d_1^M; d_2^M\right) = \\
&\qquad (4\rho_1 + 6\rho_2 + 12\rho_3)\left(\frac{1}{2\,(1-\gamma)}\left(d_1^M\right)^{1-\gamma} + \frac{1}{2\,(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right) \\
&\qquad + (3\rho_1 + 9\rho_2 + 7\rho_3 + 8\rho_4)\,\frac{1}{(1-\gamma)} \\
&\qquad + (3\rho_1 + 6\rho_2 + 3\rho_3 + 6\rho_4)\,\frac{1}{(1-\gamma)}\left(\frac{2}{3}\left(R\frac{3-d_1^M}{2}\right)^{1-\gamma} + \frac{1}{3}\left(d_1^M\right)^{1-\gamma}\right) \\
&\qquad + (3\rho_2 + 7\rho_3)\,\frac{1}{(1-\gamma)}\left(\frac{5}{6}\left(R\frac{3-\frac{1}{2}d_1^M}{\frac{5}{2}}\right)^{1-\gamma} + \frac{1}{6}\left(d_1^M\right)^{1-\gamma}\right) \\
&\qquad + (2\rho_2 + 2\rho_3 + 2\rho_4)\,\frac{1}{(1-\gamma)}R^{1-\gamma},
\end{aligned}
$$

Finally, under full integration household utility is given by:

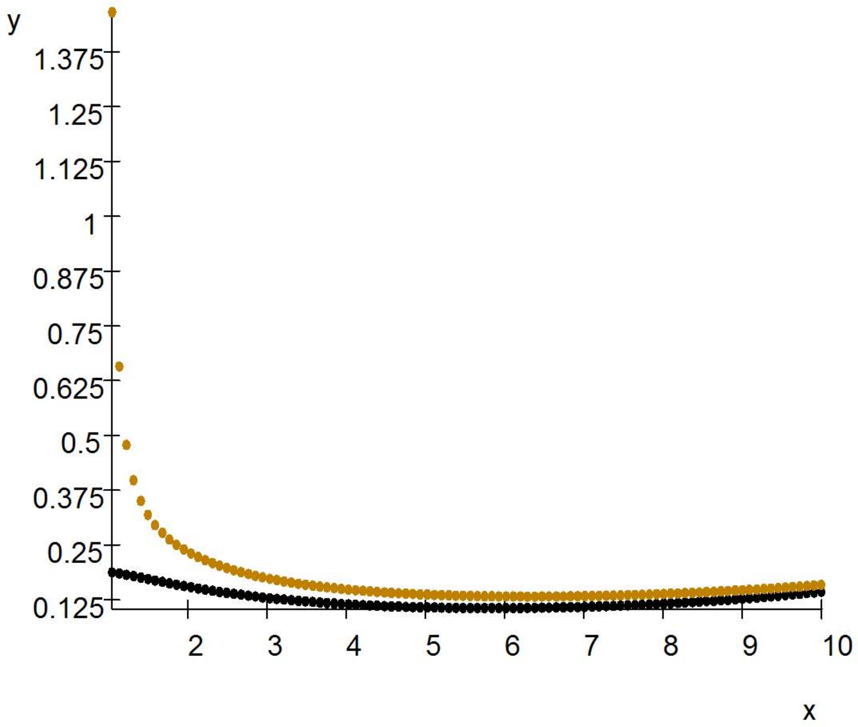
Figure 1:



$$
\begin{aligned}
U\left(d_1^M;d_2^M\right) = & \\
& \left(12\rho_2+6\rho_4\right) \\
& \left(\frac{1}{2\left(1-\gamma\right)}\left(d_1^M\right)^{1-\gamma}+\frac{1}{2\left(1-\gamma\right)}\left(d_2^M\right)^{1-\gamma}\right) \\
& +\left(4\rho_1+6\rho_2+18\rho_3+5\rho_4\right)\frac{1}{\left(1-\gamma\right)} \\
& +\left(4\rho_1+12\rho_3+4\rho_4\right)\frac{1}{\left(1-\gamma\right)}\left(\frac{5}{8}\left(R\frac{1-\frac{3}{8}d_1^M}{\frac{5}{8}}\right)^{1-\gamma}+\frac{3}{8}\left(\frac{1}{2}d_1^M\right)^{1-\gamma}\right) \\
& +6\rho_2\frac{1}{\left(1-\gamma\right)}\left(\frac{3}{4}\left(R\frac{1-\frac{1}{4}d_1^M}{\frac{3}{4}}\right)^{1-\gamma}+\frac{1}{4}\left(\frac{1}{2}d_1^M\right)^{1-\gamma}\right) \\
& +4\rho_3\frac{1}{\left(1-\gamma\right)}\left(\frac{7}{8}\left(R\frac{1-\frac{1}{8}d_1^M}{\frac{7}{8}}\right)^{1-\gamma}+\frac{1}{8}\left(\frac{1}{2}d_1^M\right)^{1-\gamma}\right) \\
& +\rho_4\frac{1}{\left(1-\gamma\right)}R^{1-\gamma}.
\end{aligned}
$$

Our simulation results complement the previous analysis for intermediate values of the risk aversion parameter γ. Figure 1 relates to a situation of financial turbulence. It displays the utility difference between a regime of limited (2)- integration and full integration as a

Figure 2:



function of γ for a value of $R = 3$. The difference remains positive for the entire parameter range.

Figure 2 relates to a situation of financial risk. It displays the utility difference between a regime of separation and 2-integration as a function of γ for a value of $R = 3$ and 4. The difference remains positive for the entire parameter range.

5 Conclusion

This paper has analyzed the welfare effects of financial integration. According to our analysis international bank integration may yield welfare losses for risk neutral and for strongly risk averse depositors when too many banks merge. The reason is that contagion is particulary likely under a fully integrated banking system - almost independently of whether financial turbulences are limited to a subset of regions or not.

Any welfare analysis of this kind needs to impose some restrictions on the underlying stochastic structure. Otherwise, trivially, any structure of the banking sector can be optimal under appropriate assumptions about the correlation of shocks. We have imposed two major restrictions on the underlying stochastic structures in order to organize our analysis efficiently: (i) the uncorrelatedness of shocks across regions and in one case (ii) the decreasing order on the likelihood of multiple shocks. In this concluding section we would like to briefly discuss two alternative scenarios.

A positive correlation of shocks across regions is a scenario that may result when aggregate demand is correlated e.g. due to trade liberalization. In such cases very little can be said in favor of any sort of financial integration because the scope for diversification is reduced. What would speak in favor of full integration are scenarios with a strong negative correlation which actually is not too intuitive. Due to a low degree of real and political integration in the European union individual shocks to specific countries are still most likely. More widespread shocks – in particular, counterbalancing shocks in several countries that could result from significant cross-border portfolio shifts – are still comparably unlikely. Accordingly limits to cross border activities or financial mergers may naturally arise.

One should however keep in mind that the present analysis relies on the assumption that a complete diversification is excluded. Large scale financial integration is always desirable when risk can be fully diversified away through appropriate arrangements such as mergers or cross border activity of financial institutions. However, when the number of regions is not large enough, partial financial integration may be the optimal choice from depositors' point of view. This may explain why financial integration across European regions is still limited.

The present paper is also skeptical about gradualism in financial integration. Even if a large financial institution that diversifies away all risks is feasible in practice, the present analysis points out that a cost has to be borne along the way to such a conglomerate if the merger process evolves gradually.

6 Appendix. Formulas used in simulations

In this appendix we report the formulas that we used in our simulation analysis.

6.1 Financial risk

Depositors' expected utility under separation is:

$$\frac{6}{8}\left(\frac{1}{2(1-\gamma)}\left(d_1^M\right)^{1-\gamma}+\frac{1}{2(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right)$$
$$+\frac{1}{8}\frac{1}{(1-\gamma)}+\frac{1}{8}\frac{1}{(1-\gamma)}R^{1-\gamma}.$$

Depositors' expected utility under 2-integration is:

$$\frac{4}{8}\left(\frac{1}{2(1-\gamma)}\left(d_1^M\right)^{1-\gamma}+\frac{1}{2(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right)$$
$$+\frac{2}{8}\frac{1}{(1-\gamma)}+\frac{2}{8}\frac{1}{(1-\gamma)}\cdot\left(\frac{3}{4}\left(R\frac{1-\frac{1}{2}d_1^M}{\frac{3}{4}}\right)^{1-\gamma}+\frac{1}{4}\left(\frac{1}{2}d_1^M\right)^{1-\gamma}\right).$$

Depositors' expected utility under 3-integration is:

$$\frac{4}{8}\left(\frac{1}{2(1-\gamma)}\left(d_1^M\right)^{1-\gamma}+\frac{1}{2(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right)+\frac{3}{8}\frac{1}{(1-\gamma)}+$$
$$\frac{3}{8}\frac{1}{(1-\gamma)}\left(\frac{2}{3}\left(R\frac{3-d_1^M}{2}\right)^{1-\gamma}+\frac{1}{3}\left(d_1^M\right)^{1-\gamma}\right)+\frac{2}{8}\frac{1}{(1-\gamma)}R^{1-\gamma}.$$

Depositors' expected utility under full integration is:

$$\frac{4}{8}\frac{1}{(1-\gamma)}+\frac{4}{8}\frac{1}{(1-\gamma)}\left(\frac{5}{8}\left(R\frac{1-\frac{3}{8}d_1^M}{\frac{5}{8}}\right)^{1-\gamma}+\frac{3}{8}\left(\frac{1}{2}d_1^M\right)^{1-\gamma}\right).$$

The utility difference of 1 versus 2 (1-2) integration is given by:

$$\frac{1}{4}\left(\frac{1}{2(1-\gamma)}\left(d_1^M\right)^{1-\gamma}+\frac{1}{2(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right)-\frac{1}{8}\frac{1}{(1-\gamma)}$$
$$+\frac{1}{8}\frac{1}{(1-\gamma)}R^{1-\gamma}$$
$$-\left(\frac{2}{8}\frac{1}{(1-\gamma)}\cdot\left(\frac{3}{4}\left(R\frac{1-\frac{1}{2}d_1^M}{\frac{3}{4}}\right)^{1-\gamma}+\frac{1}{4}\left(\frac{1}{2}d_1^M\right)^{1-\gamma}\right)\right).$$

The utility difference of 1 versus 3 (1-3) integration is given by:

$$\frac{1}{4}\left(\frac{1}{2(1-\gamma)}\left(d_1^M\right)^{1-\gamma}+\frac{1}{2(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right)-\frac{1}{4}\frac{1}{(1-\gamma)}+\frac{1}{8}\frac{1}{(1-\gamma)}R^{1-\gamma}$$
$$-\left(\frac{3}{8}\frac{1}{(1-\gamma)}\left(\frac{2}{3}\left(R\frac{3-d_1^M}{2}\right)^{1-\gamma}+\frac{1}{3}\left(d_1^M\right)^{1-\gamma}\right)+\frac{2}{8}\frac{1}{(1-\gamma)}R^{1-\gamma}\right).$$

The utility difference of 1 versus 4 (1-4) integration is given by:

$$\frac{6}{8}\left(\frac{1}{2(1-\gamma)}\left(d_1^M\right)^{1-\gamma}+\frac{1}{2(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right)$$
$$-\frac{3}{8}\frac{1}{(1-\gamma)}+\frac{1}{8}\frac{1}{(1-\gamma)}R^{1-\gamma}$$
$$-\left(+\frac{4}{8}\frac{1}{(1-\gamma)}\left(\frac{5}{8}\left(R\frac{1-\frac{3}{8}d_1^M}{\frac{5}{8}}\right)^{1-\gamma}+\frac{3}{8}\left(\frac{1}{2}d_1^M\right)^{1-\gamma}\right)\right).$$

6.2 Financial turbulence

Fix $16\rho_4 = 1$. Under separation depositors' expected utility is given by:

$$U\left(d_1^M;d_2^M\right)=\frac{1}{2}\left(\frac{1}{(1-\gamma)}+\frac{1}{(1-\gamma)}R^{1-\gamma}\right).$$

Under 2-integration depositors' expected utility is:

$$U\left(d_1^M;d_2^M\right)=$$
$$\frac{1}{2}\left(\frac{1}{2(1-\gamma)}\left(d_1^M\right)^{1-\gamma}+\frac{1}{2(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right)$$
$$+\frac{1}{4}\left(\frac{1}{(1-\gamma)}+\frac{1}{(1-\gamma)}R^{1-\gamma}\right),$$

under 3-integration depositors' expected utility is:

$$U\left(d_1^M;d_2^M\right)=$$
$$+\frac{1}{2}\frac{1}{(1-\gamma)}+\frac{6}{16}\frac{1}{(1-\gamma)}\left(\frac{2}{3}\left(R\frac{3-d_1^M}{2}\right)^{1-\gamma}+\frac{1}{3}\left(d_1^M\right)^{1-\gamma}\right)$$
$$+\frac{1}{8}\frac{1}{(1-\gamma)}R^{1-\gamma},$$

Under full integration depositors' expected utility is:

$$U\left(d_1^M; d_2^M\right) =$$

$$\frac{6}{16}\left(\frac{1}{2(1-\gamma)}\left(d_1^M\right)^{1-\gamma} + \frac{1}{2(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right)$$
$$+\frac{5}{16}\frac{1}{(1-\gamma)}$$
$$+\frac{1}{4}\frac{1}{(1-\gamma)}\left(\frac{5}{8}\left(R\frac{1-\frac{3}{8}d_1^M}{\frac{5}{8}}\right)^{1-\gamma} + \frac{3}{8}\left(\frac{1}{2}d_1^M\right)^{1-\gamma}\right)$$
$$+\frac{1}{16}\frac{1}{(1-\gamma)}R^{1-\gamma}.$$

The utility differences are (2-1 integration):

$$\frac{1}{2}\left(\frac{1}{2(1-\gamma)}\left(d_1^M\right)^{1-\gamma} + \frac{1}{2(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right)$$
$$-\frac{1}{4}\left(\frac{1}{(1-\gamma)} + \frac{1}{(1-\gamma)}R^{1-\gamma}\right).$$

2-4 integration:

$$\frac{1}{2}\left(\frac{1}{2(1-\gamma)}\left(d_1^M\right)^{1-\gamma} + \frac{1}{2(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right)$$
$$-\frac{1}{16}\frac{1}{(1-\gamma)} + \frac{3}{16}\frac{1}{(1-\gamma)}R^{1-\gamma}$$
$$-\frac{6}{16}\left(\frac{1}{2(1-\gamma)}\left(d_1^M\right)^{1-\gamma} + \frac{1}{2(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right)$$
$$-\frac{1}{4}\frac{1}{(1-\gamma)}\left(\frac{5}{8}\left(R\frac{1-\frac{3}{8}d_1^M}{\frac{5}{8}}\right)^{1-\gamma} + \frac{3}{8}\left(\frac{1}{2}d_1^M\right)^{1-\gamma}\right).$$

2-3 integration:

$$\frac{1}{2}\left(\frac{1}{2(1-\gamma)}\left(d_1^M\right)^{1-\gamma} + \frac{1}{2(1-\gamma)}\left(d_2^M\right)^{1-\gamma}\right)$$
$$-\frac{1}{4}\frac{1}{(1-\gamma)} + \frac{1}{8}\frac{1}{(1-\gamma)}R^{1-\gamma}$$
$$-\frac{6}{16}\frac{1}{(1-\gamma)}\left(\frac{2}{3}\left(R\frac{3-d_1^M}{2}\right)^{1-\gamma} + \frac{1}{3}\left(d_1^M\right)^{1-\gamma}\right).$$

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