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The threat of systemic risk in banking: Evidence for Europe

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The threat of systemic risk in banking – evidence for Europe

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Abstract

This paper attempts to answer the question whether the threat of systemic risk in banking exists only on a national or on a European level. Following De Nicolo and Kwast (2001), mean rolling-window correlations between bank stock returns are used as a measure for interdependencies among European banks, and hence for the systemic risk potential in Europe. National influences on stock returns are eliminated by estimating a return-generating model. There is some evidence that interdependencies among European banks have increased over the past 15 years and that the potential of systemic risk has shifted from a national level to a European level.

JEL-Classification: G21, F34

Keywords: systemic risk, banking, contagion, Europe

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Non-Technical Summary

Banking activities are regulated and supervised throughout the industrial countries. In general, the reasons for this regulation and supervision are controversial. "A central issue in this controversy is the extent to which a negative event, occurring at a specific bank, that implies an increase in the probability of its failure, generates negative externalities for the banking system." (Slovin et al., 1999: 198) This is what is often referred to as systemic risk in banking.

The analysis in this paper attempts to answer the question whether the threat of systemic risk in banking is a national threat or rather a Europe-wide threat. Following De Nicolo and Kwast (2001), mean rolling-window correlations between bank stock returns are used as a measure for the interdependencies among European banks, and hence for the systemic risk potential in Europe.

At first, weekly rolling-window correlations are calculated between stock returns of the 60 largest European banks without controlling for national factors. These give evidence that interdependencies have increased within the last two decades. However, since national factors determine to a large extent stock returns this result can only be seen as preliminary.

Thus, in the second part of the analysis we estimate – on a monthly basis – a return generating model in order to eliminate national influences from bank stock returns. The national market returns and the European market return as well as the change in national interest rates are used as the regressors. The unanticipated change in interest rates is calculated using an ARIMA model. The return generating model is estimated for every country in a panel with fixed effects using least squares. Based on the residuals from these regressions the part of the bank stock returns that is not due to national influence is calculated.

Thereafter, rolling-window correlations are calculated using the adjusted bank stock returns. Again, we find evidence that interdependencies among European banks have increased over the last 15 years. This indicates that the potential for systemic risk at the European level has risen and that there may have been a shift in the systemic risk potential from a national level to a European level.

The evidence on the rise in systemic risk potential found for Europe provides an argument in favour of Europe-wide banking regulation and supervision. Whether the existing forms of cooperation between the national authorities is an appropriate way in securing financial stability or whether a single European supervisor is needed is up to further research.

1 Motivation

Banking activities are regulated and supervised throughout the industrial countries. In general, the reasons for this regulation and supervision are controversial. “A central issue in this controversy is the extent to which a negative event, occurring at a specific bank, that implies an increase in the probability of its failure, generates negative externalities for the banking system.” (Slovin et al., 1999: 198) This is what is often referred to as systemic risk in banking.

In Europe banking regulation and in particular supervision is organised at a national level. There is nothing such as a European Financial Services Authority (FSA). However, there may be the need for such a single European banking supervision authority since the threat of systemic risk may have shifted from the national level to the European level.[1] Integration of financial markets in Europe has increased rapidly not just since the introduction of the Euro. This development may have increased interdependencies among financial institutions of different countries which in turn may have led to a rise in the potential of cross-border contagion, i.e. systemic risk at a European level. If this is true a bank failure in one country could potentially trigger further failures not only in the same country but also in other countries. The danger of the current nation-based system is that a national banking supervisor would possibly undervalue or even disregard such a cross-border contagion effect. Thus, a single European supervisor or at least strong coordination among national supervisors could be needed.[2]

There are many theoretical studies on systemic risk in banking, however, hardly any empirical work exists – at least not for Europe. In particular there are no studies that focus on the trans-border aspect of systemic risk in banking and the consequences for banking supervision in Europe. Closely related is the financial crisis literature that looks at cross-border contagion, however, there the focus is primarily on currency and debt crisis. This paper aims to assess the threat of systemic risk in European banking. Following De Nicolo and Kwast (2001),

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[1] There are a number of different measures employed in order to contain systemic risk in banking that are often part of banking supervision and regulation. The main measures are lender of last resort, deposit insurance, disclosure requirements and capital regulation. See, for example, Davis (1992), Bartholomew and Whalen (1995), Kaufman and Scott (2000), Canoy et al. (2001).

[2] The question that arises is whether the potential of systemic risk may be even world-wide and not just Europe-wide. The analysis in this paper is motivated from banking supervision that – at least in the short and medium run – will not be organised at a world-wide level. Thus, we merely analyse the potential of systemic risk at the European level and do not ask whether there may be also contagion between European and non-European banks.

rolling-window correlations among bank stock returns are used as an indication for the development of interdependencies among banks over time and hence for the systemic risk potential. Beforehand, national factors determining bank stock returns are eliminated by estimating a return generating model.

The paper is organised as follows. Section 2 defines systemic risk and gives a brief review of the (empirical) literature. Section 3 attempts to assess the systemic risk potential in Europe. Section 3.1 gives some first insights using descriptive methods. Sections 3.2-3.6 describe our correlation analysis both with and without controlling for national factors determining bank stock returns. Finally, section 4 concludes.

2 Systemic risk

2.1 What is systemic risk?

No uniform definition of systemic risk exists in the literature. Loosely speaking, systemic risk means “the risk or probability of breakdowns in an entire system, as opposed to breakdowns in individual parts or components” (Kaufman and Scott, 2000: 1). Beyond dispute is that systemic risk can occur in banking as well as in other parts of the financial sector, e.g. in payment and settlement systems or in securities markets – in financial markets in general. Furthermore, there is consensus on the existence of different channels through which systemic risk can occur in banking. Instead of giving a comprehensive definition of systemic risk these different channels are discussed in order to explain the concept of systemic risk in banking.[3]

There are two ways in which systemic risk can occur in the banking market (Staub, 1999). First, a macro shock can simultaneously have averse effects on several banks. Such a macro shock can either be a cyclical downturn or other aggregate shocks like interest rate or exchange rate shocks or a stock market crash.

Second, systemic risk can occur as a result of contagion in the banking market, i.e. an initial shock causes one bank to fail which subsequently leads to the failure of other banks (“micro channel”). Such contagion in banking can work through two channels (de Bandt and Hartmann, 2000): the exposure channel and the information channel. The former results from real exposures in the interbank market and/or in payment systems. Thus, insolvency problems of one bank can

[3] The definitions for systemic risk given so far all refer to one or more parts of this whole concept of systemic risk. For a comprehensive definition of systemic risk see de Bandt and Hartmann (2000).

trigger a chain reaction leading to other bank failures. This channel refers to the so called “domino effect”. The information channel, in contrast, refers to ways through which bad news from one bank lead to the conclusion in the market that other banks are also in trouble. This will lead to adjustments of contracts with other partners or – on the depositor level – to contagious withdrawals (bank runs). A central concept of this channel is that depositors and also other counterparties have only imperfect information about (a) the type of shocks hitting a bank, i.e. whether it is idiosyncratic or systemic and (b) the real exposures to other banks.

In this paper the focus is on the micro channel of systemic risk. Thus, in the context of this paper a macroeconomic shock that causes several banks to fail is not regarded as systemic risk. As a consequence the terms systemic risk and contagion risk are used interchangeably. This view is in line with the definitions of systemic risk given, for example, by Kaufman (1995)[4] or the Bank for International Settlements (BIS).

In general the banking or the financial sector is viewed as more vulnerable to contagion than other industries since banks are viewed as more susceptible to failures (Kaufman 1995, 1996, Goodhart et al., 1998, de Bandt and Hartmann, 2000). In this sense, banks are special for several reasons:

One reasons lies in the structure of the banks. Banks are vulnerable to runs due to fractional reserve banking, i.e. in the case of high withdrawals the banks may not be able to fulfil deposit obligations. Furthermore, banks are highly leveraged, i.e. they have a low capital-to-assets ratio. Thus there is only little room for losses. In addition, they exhibit low cash-to-assets ratios which may require the sale of earning assets to meet deposit obligations. Furthermore banks are highly interconnected through direct exposures in the interbank money market, the large-value payment and security settlement systems.

2.2 Review of literature

There is a wide theoretical literature on systemic risk starting from the classical bank run models following Diamond and Dybvig (1983) and extensions of these models of single banks’ fragility to models of multiple bank systems, leading to the modern bank contagion literature.[5]

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[4] Kaufman (1995: 47) defines systemic or contagion risk as “the probability that cumulative losses will occur from an event that sets in motion a series of successive losses along a chain of institutions or markets comprising a system.”

[5] For a good survey on the theoretical as well as the empirical literature on systemic risk see de Bandt and Hartmann (2000).

Also, there are empirical studies on systemic risk and contagion in the banking sector that utilise several different approaches. The predominant part of these studies examine specific bank failures of the past either by looking at intertemporal correlations of bank failures or by doing event studies.[6] Since today – i.e. in times of deposit insurance's and lenders of last resort – bank runs and accumulated bank failures do not actually occur in industrial countries such methods can not be applied in order to empirically examine systemic risk. Also the use of historical data – for example from the free banking era in the United States – is not appropriate when assessing the actual threat of systemic risk and contagion in banking. Hence, an indicator for the potential of systemic risk is needed.

Focusing exclusively on the potential threat stemming from interbank lending, i.e. on the exposure channel of systemic risk one approach is to directly examine exposures in the interbank market and simulate contagious effects following the hypothetical failure of one bank. There are some studies for the US that use this approach utilising data, for example, from the Federal Reserve's large-value transfer system, Fedwire, or the Clearinghouse Interbank Payments System (CHIPS) (Kaufman, 1994, Humphrey, 1986, Furfine, 1999). For Europe, Michael (1998), reports some exposures from London interbank markets, Angelini et al. (1996) from the Italian netting system, and Sheldon and Maurer (1998) base their simulations on accounting data drawn from banks that operate in Switzerland. All of these studies report a relatively small threat to financial market stability from the failure of one bank.

Unfortunately, for whole Europe data on interbank lending is only available on an aggregate level which does not allow for statements concerning contagion risk between individual banks. Nevertheless, such an analysis on an aggregate basis is made in section 3.1 in order to gain a first insight.

Contrary to former studies this study attempts to assess the threat of systemic risk in banking in an international context.[7] In particular, this paper attempts to answer the question whether systemic risk in Europe can be regarded as a country specific threat – or if it should rather be regarded as a Europe-wide threat. To answer this question is of crucial importance for banking regulation and supervision. We attempt to answer this question using correlations among bank stock returns as a measure for the interdependencies – and hence the potential for systemic risk among banks. Before correlations are calculated a

[6] See, for example, Aharony and Swary (1983), Swary (1986), Schoenmaker (1996), Slovin et al. (1999), Bessler and Nohel (2000), Akhigbe and Madura (2001).

[7] Of course there is the financial crisis literature that looks at cross-border contagion (see, e.g., Dornbusch et al., 2000). But their focus is primarily on currency or debt crisis.

return generating model is estimated in order to control for national factors determining bank stock returns.

3 The threat of systemic risk in European banking

3.1 Some insights from cross-border banking

When focusing on the exposure channel of systemic risk the claims and liabilities among banks in the interbank market give evidence on the systemic risk potential. Unfortunately, such data is not available on a bank-to-bank basis at the European level. However, the BIS International Banking Statistics contains aggregate data on the international claims of reporting banks on individual countries.[8] Table 1 shows a matrix containing these claims as a percentage of total assets of Monetary Financial Institutions (MFI's)[9] (as of end June 2001). Claims vis-à-vis one country above 5 % are indicated by grey highlighting.

[8] Bank for International Settlement, Quarterly reviews, Table 9B.

[9] The definition of MFI's conforms to that of reporting banks by the BIS.

Table 1 – Consolidated international claims of reporting banks on individual countries as a percentage of total assets of MFI's (amounts outstanding as of End June 2001)

	Country A													
Country B	*AT*	*BE*	*DK*	*FI*	*FR*	*DE*	*IE*	*IT*	*NL*	*PT*	*ES*	*SE*	*CH*	*UK*	*Total*
AT		0.00741	0.00065	0.00033	0.01141	0.12966	0.00076	0.00678	0.00873	0.00050	0.00298	0.00156	0.01106	0.01491	0.19673
BE	0.00099		0.00165	0.00015	0.04568	0.05873	0.00082	0.01420	0.03211	0.00036	0.00936	0.00331	0.01884	0.01733	0.20353
DK	0.00136	0.00950		0.02008	0.00640	0.05239	0.00169	0.00249	0.01771	0.00019	0.00195	0.01850	0.00978	0.01463	0.15667
FI	0.00253	0.01109	0.04283		0.02202	0.09473	0.00222	0.00348	0.01193	0.00028	0.00525	0.06235	0.00871	0.01912	0.28653
FR	0.00039	0.00909	0.00027	0.00008		0.02805	0.00036	0.00625	0.00565	0.00053	0.00310	0.00062	0.00608	0.01072	0.07119
DE	0.00251	0.00593	0.00080	0.00038	0.01260		0.00069	0.00347	0.00763	0.00030	0.00292	0.00125	0.00772	0.00794	0.05416
GR	0.00331	0.01963	0.00037	0.00102	0.05461	0.10463	0.00000	0.01073	0.02589	0.00206	0.01180	0.00108	0.01264	0.02420	0.27196
IE	0.00430	0.02808	0.00083	0.00057	0.02122	0.08507		0.01023	0.00988	0.00152	0.00380	0.00274	0.00764	0.03434	0.21021
IT	0.00173	0.02258	0.00006	0.00053	0.03841	0.06692	0.00104		0.02039	0.00052	0.00626	0.00088	0.01366	0.02306	0.19603
LU	0.00227	0.01866	0.00590	0.00016	0.02259	0.12717	0.00028	0.03221	0.00836	0.00199	0.00320	0.00186	0.01244	0.01032	0.24743
NL	0.00178	0.02477	0.00102	0.00021	0.03072	0.07058	0.00098	0.00975		0.00090	0.00698	0.00214	0.01233	0.02342	0.18557
NO	0.00092	0.00492	0.00842	0.00676	0.00678	0.03998	0.00047	0.00192	0.00871	0.00014	0.00085	0.01858	0.00661	0.01446	0.11952
PT	0.00110	0.01148	0.00066	0.00051	0.01347	0.05345	0.00000	0.02638	0.01005		0.01483	0.00071	0.00343	0.01522	0.15129
ES	0.00026	0.00857	0.00035	0.00012	0.02070	0.04243	0.00083	0.00550	0.00663	0.00288		0.00022	0.00526	0.00945	0.10320
CH	0.00129	0.00510	0.00084	0.00010	0.01879	0.03483	0.00013	0.00262	0.00592	0.00063	0.00133	0.00097		0.00745	0.08000
UK	0.00156	0.01427	0.00311	0.00067	0.02099	0.06485	0.00549	0.00833	0.01798	0.00109	0.00657	0.00430	0.03001		0.17924

Reports cross-border claims of banks in country B vis-à-vis country A as a percentage of total assets of MFI's in country B

Source: Bank for International Settlement, ECB, own calculations; Note: AT = Austria, BE = Belgium, DK = Denmark, FI = Finland, FR = France, DE = Germany, GR = Greece, IE = Ireland, IT = Italy, LU = Luxembourg, NL = The Netherlands, NO = Norway, PT = Portugal, ES = Spain, SE = Sweden, CH = Switzerland, UK = United Kingdom; Claims vis-à-vis one country above 5 % are indicated by grey highlighting.

The figures in table 1 indicate that international bank lending takes only a very small portion of total assets. For almost all countries international claims do not exceed 5 % – often not even 1 % of total MFI assets. Only vis-à-vis Germany some countries have international claims of above 5 %. These figures do not give evidence for substantial international bank lending relative to total assets.

However, the significance of these figures for systemic risk should not be overestimated. The figures contain international claims on individual countries, i.e. not just on banks in that country but also on government and private households. Furthermore, these figures do not tell us anything about the bank-to-bank exposures that are one main channel for contagion in banking. Thus, despite the low interdependencies on the aggregate level there may be substantial interbank lending on a bank-to-bank basis which causes systemic risk at the European level.

3.2 Correlations of bank stock returns

De Nicolo and Kwast (2001) argue that estimation of the systemic risk potential may be achieved using a measure of the interdependencies of financial institutions. For an economic shock to become systemic a negative externality must exist, i.e. a negative shock at a single bank must be highly likely to have contagious effects on other financial institutions. Only if the financial institutions are interdependent in some way such an externality exists – i.e. there is the threat of systemic risk. Such interdependencies can be either direct, i.e. through direct exposures or indirect, i.e. they arise from correlated exposures to non-financial sectors and financial markets.

De Nicolo and Kwast (2001) measure total interdependencies by the correlations of stock returns of large and complex banking organisations (LCBOs).[10] Since stock prices reflect market participants' collective evaluation of a firms prospects in the future they also include the impact of the firms interdependencies with other institutions.[11] Consequently one can assume that an observed increase in correlations among bank stock returns signals an increase in systemic risk potential. No change in correlations or a decrease would therefore lead to the conclusion that the potential of systemic risk has not increased or has declined.

There are several problems that limit the interpretation of correlations among bank stock returns in regard to the potential for systemic risk:

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[10] In the United States LCBOs are identified by the Federal Reserve supervisors. For details see De Nicolo and Kwast (2001: 4-5). To my knowledge such a classification does not exist for Europe. Thus, we merely use the group of the largest European banks according to total assets.

[11] A quite similar consideration was already made by Pozdena (1991) who regressed the stock returns of various individual banks on each other in each period in order to get evidence for contagious effect.

- In general variations in correlations between returns can have manifold reasons (see e.g., Goetzmann et al., 2001). For example, observed correlations can be higher in periods of high stock return volatilities than when measured in periods of low stock return volatilities even though the underlying correlation is constant (Boyer et al., 1997). As a consequence, De Nicolo and Kwast (2001) estimate a GARCH constant conditional correlation model (Bollerslev, 1990, Longin and Solnik, 1995) with a time trend and test for the significance of the time trend as an indication of an increase in interdependencies – and hence in the systemic risk potential.

- The correlation structure may be sensitive to extreme events such as the October 1987 stock market crash. However, such one-time events will cause only a temporary increase in correlations.

- An increase in the mean correlation in the European sample may be due to a change in investors behaviour in the sense that with the introduction of the Euro investors have started to operate Europe-wide in general.

- An additional problem occurs when using correlations between bank stock returns in an international context, since there are many national factors determining the stock prices and hence the correlations. Thus, on the one hand, high correlations may simply be due to the co-variation in national stock indices or in fundamental economic variables such as interest rates and dividend yields. On the other hand, different developments of national influences may cause lower correlations between stock returns leading falsely to the conclusion that interdependencies have decreased.[12] Consequently, in an international context one needs to control for national determinants of stock returns.

Despite these shortcomings and in consideration of the lack of appropriate data and other analysis tools mentioned above, the analysis of correlations of bank stock returns seems to be an appropriate tool for giving some indication concerning the potential for systemic risk in European banking.

In a first step mean weekly rolling-window correlations of bank stock returns[13] are calculated for several samples without controlling for national factors. In a further step a return generating model is estimated to control for national factors and

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[12] For example, the new law concerning capital profits in Germany will probably lead to a temporary increase in the stock returns of German banks causing higher correlations between German banks whereas at the same time correlations in the European sample will decline.

[13] More precisely speaking, pairwise rolling-window correlations between weekly bank stock returns are calculated and then for each weekly observation the mean is calculated over these pairwise correlations.

residuals are calculated that do not contain the part of stock returns that is due to national influences. Rolling-window correlations among these adjusted bank stock returns are then taken as a measure for the interdependencies and the systemic risk potential.

This approach addresses most of the above listed problems. By comparing the results for the banking sector to other industries the problem with investors behaviour can to some extent be eliminated. Estimation of the return generating model before calculating correlations eliminates national influences from bank stock returns. Furthermore, this will partially control for events such as the 1987 stock market crash.

3.3 Mean weekly rolling-window correlations of bank stock returns

To start with, correlations between bank pairs from 1980 to 2001 are calculated for a European sample and several national sub-samples using a 52-week rolling window.[14] In this first step no adjustments are made concerning national determinants of stock returns. The samples include the 60 largest European banks according to total assets. For a list of the banks included in the sample see table A1 in the appendix.[15] Thus for the "European" sample that includes all possible pairwise combinations the mean weekly rolling-window correlation was calculated out of 1770 pairwise correlations. The "Europe cross-border only" sample includes only correlations between banks of different countries which gives a number of 1545 pairwise combinations. The mean rolling-window correlations for these two samples are shown in Figure 1a. Figure 1b shows mean rolling window correlations for six national samples.

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[14] Weekly stock prices P are taken from Thomson Financial Datastream and returns R calculated by subtracting the logarithmic stock prices, i.e. $R_t = \log(P_t) - \log(P_{t-1})$.

[15] Note that not all bank stock series are available from 1980 on. For the starting dates of the series see also table A1.

Figure 1a – Mean rolling-window correlations of bank stock returns (52-week rolling window) – European samples

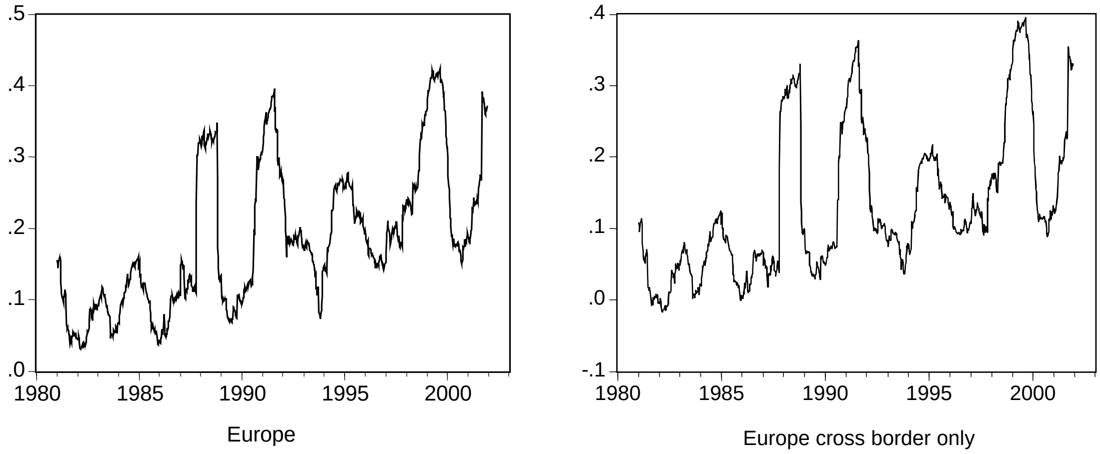


Figure 1b – Mean rolling-window correlations of bank stock returns (52-week rolling window) – national samples

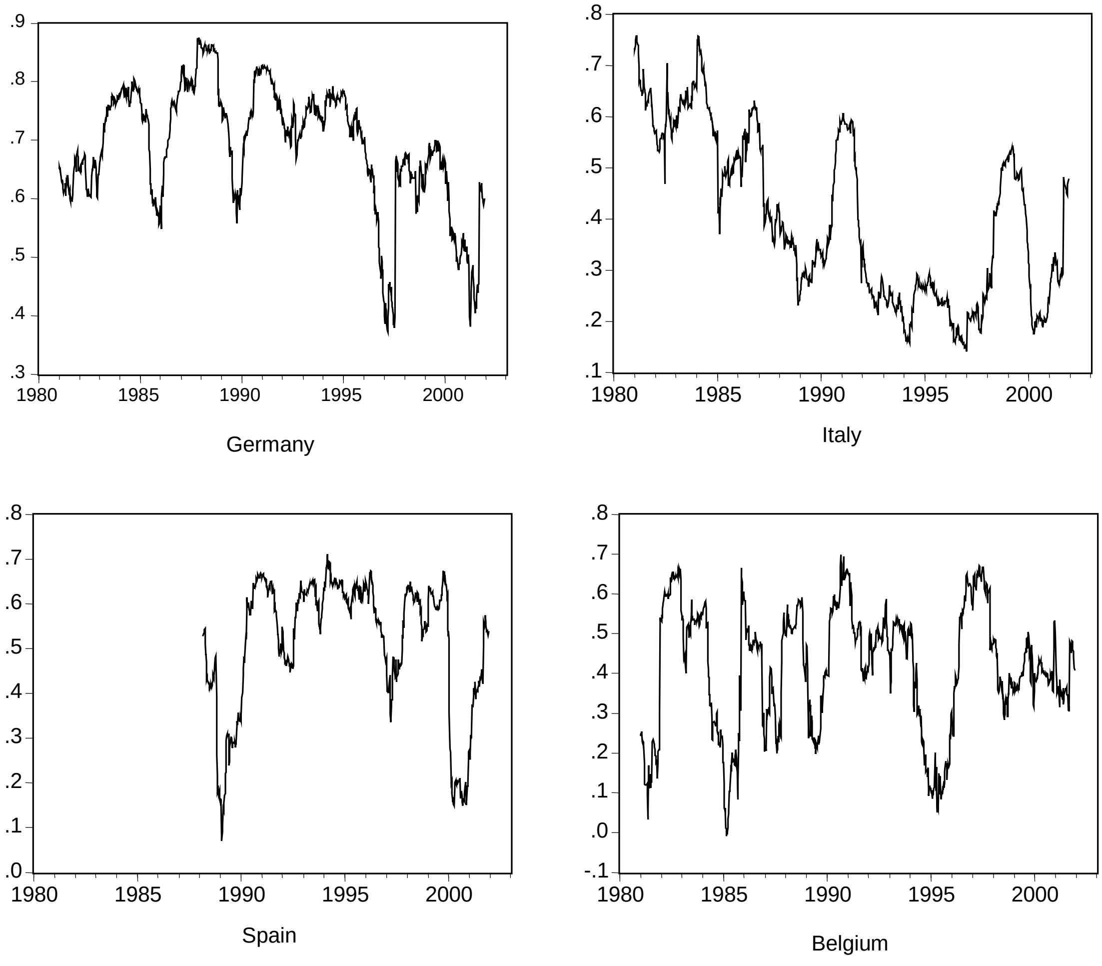
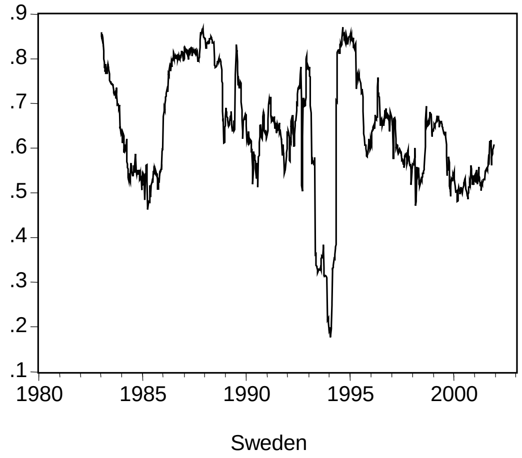
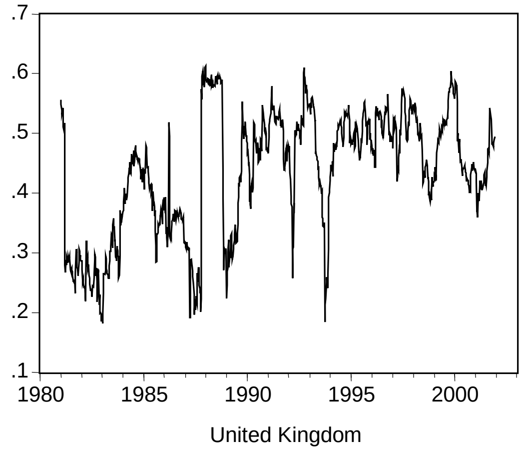


Figure 1b – Mean rolling-window correlations of bank stock returns (52-week rolling window) – national samples – continued





As can be seen from the figures, mean correlations vary heavily over time. Not surprisingly, there are substantial increases in mean correlations in all samples in the time following the stock market crash in 1987. Other peaks can be seen in the beginning and the end of the 1990s which might be due to the Scandinavian banking crisis and the near-failure of the hedge fund Long-Term Capital Management (LTCM) in September 1998 following the Russian crisis, respectively.

The mean correlations in both European samples are substantially lower than in the national samples, especially low are the correlations in the "Europe cross-border only" sample. This is probably due to the fact that national factors determine to quite an amount stock prices and hence returns.

For the European sample the average correlations clearly increase over time, whereas for the national samples the average correlations don't seem to change over time – or in the case of Germany and Italy they even decrease over time. This indicates increasing interdependencies among European banks and hence gives some preliminary evidence that the potential for systemic risk in European banking may have increased during the last two decades.

Table 2 shows the means of average correlations for the different samples calculated separately for the period before and after the introduction of the Euro.[16]

[16] Note that in May 1998 the exchange rates between the EMU member countries were irrevocable fixed. Thus, this date is taken as the starting date of the Euro, although the Euro was officially introduced on January 1, 1999.

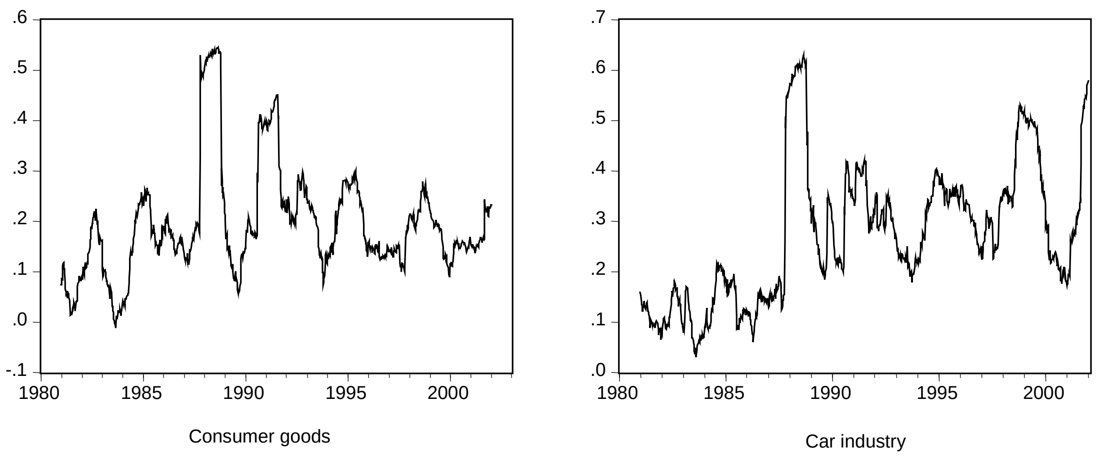
Table 2 – Mean correlations of bank stock returns

Period	*Europe*	*Europe cross-border only*	*Germany*	*Italy*	*Spain*	*Belgium*	*Sweden*	*United Kingdom*
1980:01 – 1998:04	0.1620	0.1104	0.7117	0.4074	0.5361	0.4178	0.6571	0.4259
1998:05 – 2001:11	0.2887	0.2406	0.5818	0.3652	0.4471	0.3893	0.5677	0.4663

For almost all national samples the mean correlation calculated over the EMU period is lower or at least not higher than the mean correlation calculated over the pre-EMU period. In contrast, the mean correlation of the European samples increased substantially after the introduction of the Euro. This indicates that the Euro and the accompanied financial market integration has led to an increase in correlations among banks at the European level which may indicate an increase in interdependencies among European banks. Possibly, as mentioned above, this increase in correlations may simply be due to a change in investors behaviour. However, looking at figure 1a shows that mean correlations increase over the whole sample period and not just after 1999. In this context comparing the results for the banking sector with other industries may provide additional insight.

Figure 2 shows mean rolling-window correlations between the leading European firms in the consumer goods industry and the car industry, respectively.

Figure 2 – Mean rolling-window correlations of stock returns of other industry firms (52-week rolling window)



Again, there are relatively high correlations directly after the stock market crash in 1987. Apart from that mean correlations are relatively low over the whole sample period. In contrast to the European banking sample mean correlations do not increase substantially over time – for the car industry at least not after the peak in 1987.

Up to this point our analysis gives some preliminary evidence that interdependencies among European banks have increased over the past years, and hence that systemic risk potential in Europe has increased.

However, as mentioned above, there is an interpretation problem when correlations are calculated between stock returns without controlling for national influences. Since the aim is to measure systemic risk in a European context controlling for national influences becomes necessary. Ignoring such influences could result, for example, in increasing mean correlation over time that is simply due to increasing correlations of the underlying national determinants of stock returns.

3.4 Further proceeding and methodology

In the following a two step approach is employed: First, to control for national factors influencing stock returns a return generating model is estimated. The return on the aggregate market portfolio and the unanticipated interest rate change are used as determining factors. From these regressions, residuals are calculated that contain the part of the returns that cannot be explained by national factors. Hence, these residuals should contain the part of returns that is priced in due to international influences.

Second, pairwise rolling-window correlations are calculated between these residuals and the mean is calculated over all pairs as an indicator for the interdependencies among European banks, and hence for the systemic risk potential in Europe.

The return generating model – eliminating national influences

Empirical research by, among others, Stone (1974), Flannery and James (1984a,b), Aharony et al. (1986), Sweeney and Warga (1986), Yourougou (1990), Benink and Wolff (2000) has shown that the inclusion of an interest rate factor adds substantial explanatory power to the single-factor market model when explaining bank stock returns. The interest rate variable is important for the valuation of stocks of financial institutions because the accounting returns and costs of financial institutions are directly dependent on interest rates.[17] The interest rate sensitivity depends on the characteristics of the bank's asset and liability positions. In the literature the following two-factor return generating model is usually estimated:

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[17] An additional argument in favour of the inclusion of the interest rate variable is that within EMU the convergence – and after the introduction of the Euro the equality – of money market rates would lead to an increase in the correlations of unadjusted stock returns.

$$R_{it} = \beta_{oi} + \beta_{mi} MR_t + \beta_{Ii} UI_t + \varepsilon_{it}. \quad (1)$$

Where R_{it} is the rate of return on the stock of bank *i* at time *t*, MR_t is the rate of market return, UI_t the unexpected change in interest rate levels, and ε_{it} the error term.

The unexpected change in interest rates serves as the second factor in the model since in efficient financial markets, the expected value of the relevant interest variable will have already been reflected in asset values and returns. Hence, only the unexpected component should have an effect on asset returns (Choi et al., 1992). The forecasting error from an ARIMA model is used as the unexpected change in interest rate.

The aim of the estimation of the return generating model in the context of this paper is to exclude all national influences on bank stock returns that may limit interpretation of the following correlation analysis. If the model is estimated according to (1), i.e. bank stock returns are regressed on a respective national stock market index and a national interest rate, European influences that effect national indexes are also excluded. However, such influences, for example, common shocks, may cause systemic risk at the European level. The residuals from equation (1) do not contain such European influences.

Therefore the following adjustment to the above two-factor model are made. Equation (1) is extended by the return of a European index (European market return: *EMR*). Thus, the following return generating model is estimated:

$$R_{it} = \beta_{oi} + \beta_{mi} MR_t + \beta_{ei} EMR_t + \beta_{Ii} UI_t + \varepsilon_{it}. \quad (2)$$

As a consequence, the coefficient β_{ei} represents the influence of the European market on the individual bank stock return and therefore this influence is excluded from the national market return.[18]

The part of the bank stock return that is not due to national influence is calculated as

$$\tilde{R}_{it} = R_{it} - \beta_{oi} - \beta_{mi} MR_t - \beta_{Ii} UI_t \quad (3)$$

[18] Clearly, there exists multicollinearity between the regressors MR_t and EMR_t. However, this only limits hypothesis testing but does not influence our proceeding since we are only interested in eliminating national influences from stock returns.

In a following step pairwise rolling-window correlations between these residuals $\tilde{R}_{it}$ are calculated as a measure for the interdependencies among European banks, and hence as an indication for the potential of systemic risk in Europe.

The data

For a list of the banks included in the sample see table A1 in the appendix. Unfortunately, for Greece and Denmark interest rate data and data on market returns were incomplete. Thus, banks from these countries were dropped from the sample of the 60 largest European banks. This reduces the sample size to 54 banks from the countries Germany, France, the Netherlands, Spain, Italy, Ireland, Austria, Belgium, Portugal, Sweden, Switzerland, Norway, and the United Kingdom.

Bank stock prices are taken from Thomson Financial Datastream – more precisely the return indexes are used that show a theoretical growth in value of a share holding, assuming that dividends are re-invested to purchase additional units of an equity. Returns R_{it} are then calculated as the logarithmic differences between two values of the return index.

National market returns MR_t are calculated using the MSCI National Stock Indexes that can be downloaded from the MSCI webpage. The European index EMR_t is also taken from the MSCI database. All indexes used are performance indexes, i.e. their calculation corresponds with the return indexes taken for the bank stocks. The unanticipated change in interest rates UI_t is calculated using the money market rate taken from the IMF’s International Financial Statistics.

In contrast to the correlation analysis in section 3.3 monthly data is used since the MSCI National Stock Indexes are only available on a monthly basis for longer periods. The sample period is between January 1980 and July 2001.

3.5 Estimation

Estimation of unanticipated changes in interest rates

In order to generate the monthly observations of unexpected changes in the interest rate UI_t for every country an ARIMA(*p,1,q*) methodology of the general form

$$\Phi(B)\Delta I_t = \mu + \Theta(B)z_t \qquad (4)$$

is used. Where ΔI_t represents the first difference of the money market interest rate series I_t and z_t is a shock term.[19] B is the back-shift operator and $\Phi(B)$ and $\Theta(B)$ represent the autoregressive (AR) and moving average (MA) components, respectively.

The particular orders p and q of the AR and MA components, respectively, were chosen according to the minimum Schwarz-criterion. The particular ARIMA models estimated for every country with the respective estimation results are shown in table A2 in the appendix.

The unexpected component of the interest rates is determined by subtracting the predicted values in equation (4) from the actual values. Hence,

$$UI_t = I_t - E(I_t) \qquad (5)$$

where $E(I_t)$ is the expected interest rate, predicted by the ARIMA model.

Estimation of the return generating model

Since for most of the countries there is more than one bank in the sample estimation of equation (2) can be accomplished in different ways. Obviously, a single equation framework would disregard the fact that bank stock returns are interrelated. On the European level these interdependencies contribute to the systemic risk potential that is assessed by calculating rolling-window correlations. To control for these interdependencies in the estimation procedure would therefore not be appropriate in the context of this paper. However, it should be controlled for such interdependencies among banks within one country. Thus, for every country equation (2) is estimated in a panel with fixed effects using least squares.[20] The estimation results for these regressions are shown in table 3.

[19] Unit root tests indicated that all money market rates are I(1) series.

[20] As a consequence, there is a fixed effect coefficient β_{oi} estimated for every bank (which is not reported in table 3) and one coefficient on the national market return, the European market return and the interest rate change for every country, respectively. Note that estimation was done with the computer package Eviews, that computes the fixed effects by subtracting the "within" mean from each variable and estimating OLS using the transformed data.

Table 3 – Estimation results of the return generating model for every country

Country	*Number of banks included in the panel*	β_{mi}	β_{ei}	β_{Ii}	$adj.R^2$	*DW*
Germany	4	1.002	0.068	-0.002	0.59	2.12
		(23.094)**	(1.241)	(-0.367)		
France	2	1.148	0.001	0.010	0.48	2.06
		(7.319)**	(0.004)	(1.062)		
The Netherlands	1	1.322	-0.037	0.000	0.58	2.23
		(6.469)**	(-0.181)	(0.016)		
Spain	4	0.904	0.097	0.003	0.55	2.21
		(16.874)**	(1.282)	(0.908)		
Italy	18	0.677	0.142	0.022	0.33	2.04
		(26.243)**	(3.613)**	(7.609)**		
Ireland	2	0.920	0.127	0.000	0.48	2.06
		(11.949)**	(1.300)	(0.057)		
Austria	1	0.759	0.052	-0.039	0.36	2.05
		(4.006)**	(0.225)	(-0.665)		
Belgium	3	0.908	0.004	-0.005	0.49	2.24
		(17.267)**	(0.067)	(-1.964)		
Portugal	2	0.774	-0.016	-0.002	0.41	2.16
		(11.057)**	(-0.160)	(-0.453)		
Sweden	4	0.598	0.226	-0.003	0.25	1.81
		(7.728)**	(1.779)	(-3.654)**		
Switzerland	2	1.043	0.241	0.000	0.53	2.17
		(13.259)**	(2.830)**	(0.117)		
Norway	2	0.467	0.078	-0.039	0.25	1.98
		(3.188)**	(0.370)	(-5.313)**		
United Kingdom	9	0.681	0.309	-0.001	0.28	1.98
		(7.671)**	(3.120)	(-0.310)		

Fixed effects panel estimation of the model $R_{it} = \beta_{oi} + \beta_{mi}MR_t + \beta_{ei}EMR_t + \beta_{Ii}UI_t + \varepsilon_{it}$ *using least squares. The fixed effect coefficients* β_{oi} *are not reported. t-statistics are indicated between parentheses. One (two) asterisk(s) indicate significance at the 0.05 (0.01) level.*

As expected the coefficient on the national market return β_{mi} is highly significant for every country. It usually lies between 0.6 and 1.0 which indicates a moderate impact on the return of the respective national market index on bank stock returns. The coefficient associated with the interest rate change β_{Ii} is insignificant in most of the cases. Only for Italy, Sweden and Norway β_{Ii} is significantly different from zero.

This is partly in line with former research that found for the US decreasing interest rate sensitivity of bank stock returns in the late 1980s and early 1990s (Choi and Elyasiani, 1996, Benink and Wolff, 2000).

The coefficient on the European market return is – with the exception of Italy and Switzerland – insignificant for all countries. However, since our aim is not to explain bank stock returns but rather to eliminate all national influences the insignificance of this coefficient is not decisive.[21] Also, adjusted R-squares are relatively low compared to multi-factor-model regressions in the literature (Flannery and James, 1984a, 1984b, Sweeney and Warga, 1986, Yourougou, 1990, Saunders and Yourougou, 1990). Again, with respect to the aim of the regressions this is irrelevant.

In a further step the estimation results of the return generating model are used to calculate the part of the bank stock returns $\tilde{R}_{it}$ that could not be explained by national factors (see equation (3) above).

3.6 New Evidence for systemic risk potential in Europe – Correlation results

In the second step of the analysis, rolling-window correlations between the adjusted stock returns $\tilde{R}_{it}$ of the 54 European banks are calculated over the whole sample period from March 1980 to July 2001.[22] A 12-month backward looking window is used. From these 1431 pairwise rolling-window correlations the mean is calculated as an indication for the development of the interdependencies among European banks, and hence of the potential for systemic risk in European banking. Figure 3a shows this mean rolling-window correlation for the whole sample of 54 banks. Figure 3b shows the mean of all pairwise rolling-window correlations between banks of different countries, i.e. the mean cross-border correlation.[23] Unfortunately, prior to 1986 bank stock return data is relatively scarce. As a consequence, the mean correlation is dominated by a few outliers, which leads to some peaks that cannot be explained by economic reasoning. Thus, we report in figures 3a and 3b mean rolling-window correlations for the time after 1986.

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[21] Note that low t-statistics may also be a result of the multicollinearity between MR_t and EMR_t that can cause high variances of the OLS estimates.

[22] Some data at the beginning of the sample period are lost due to the ARIMA estimations.

[23] In this "cross-border only"-case the mean correlation is calculated on the basis of 1216 pairwise rolling-window correlations.

Figure 3a – Mean 12-month-rolling-window correlations of European bank stock returns after controlling for national factors – whole sample of 54 banks

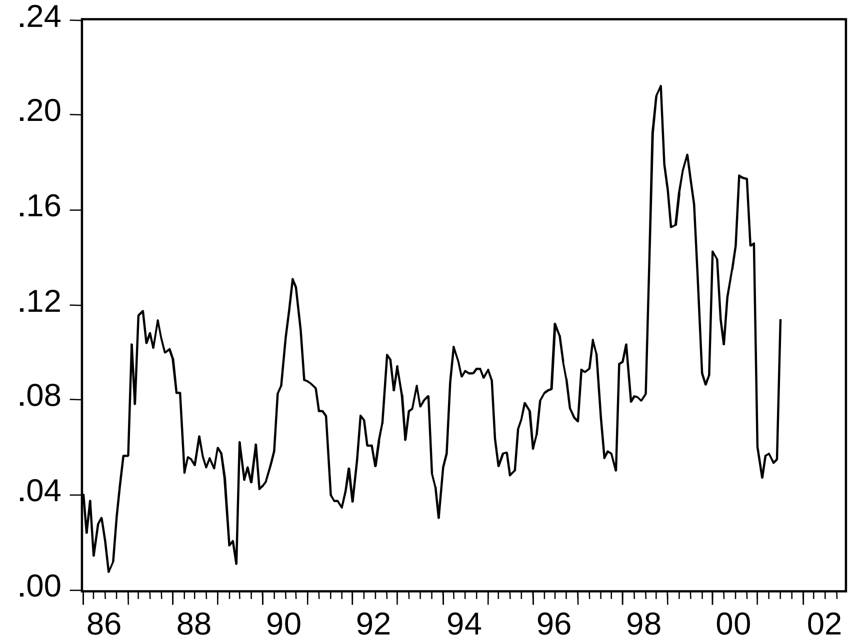
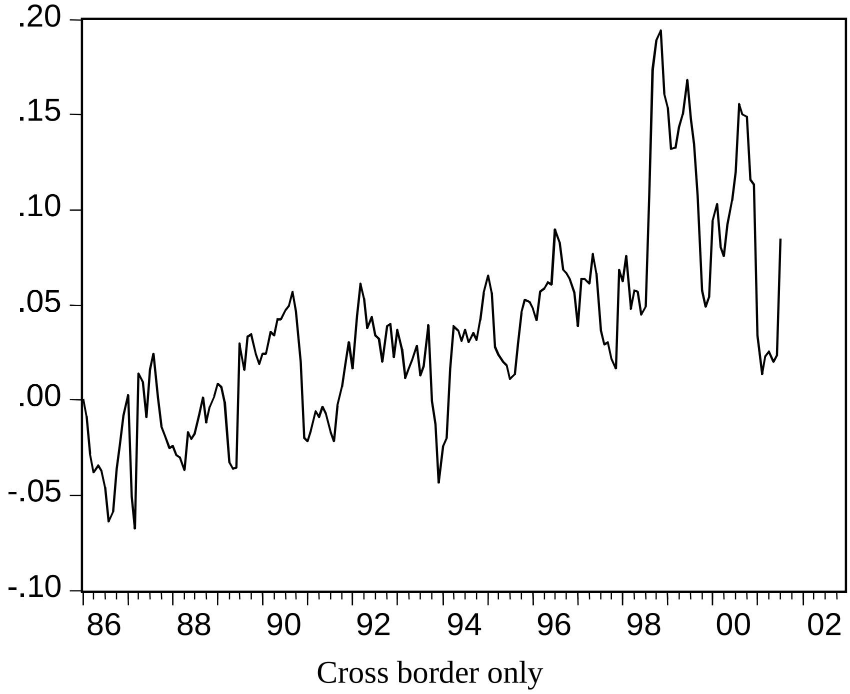


Figure 3b – Mean 12-month-rolling-window correlations of European bank stock returns after controlling for national factors – only cross-border correlations included



After controlling for national factors mean correlations vary less heavily over time. Not surprisingly, correlations in the sample where only cross-border correlations are taken into account (figure 3b) are smaller than in the sample with all pairwise correlations. As expected, the increase in mean correlation in response to the stock market crash in 1987 is less pronounced, since the respective national market return in the return generating model controls for this event.

The temporary increases in mean correlations in the early 1990s are probably due to banking crisis in some European countries: Norway 1987-93, Sweden 1990-93, Finland 1991-94 and Italy 1990-94 (Demirgüc-Kunt and Detragiache, 1998). These peaks are less pronounced in the “cross-border only”-sample which shows that the increases are mainly due to high correlations between stock returns of banks within one country. This indicates that at the beginning of the 1990s the threat of contagion across countries was relatively moderate.

A substantial increase in mean correlations can be observed around 1999. This is probably a result of the near-failure of the hedge fund Long-Term Capital Management (LTCM) in September 1998 that followed the Russian crisis. This peak is also considerable in the “cross-border only”-sample which indicates that in the late 1990s the threat of contagion across countries existed to a greater amount than at the beginning of the 1990s.

Overall there is evidence that mean correlations have increased in the past 15 years. Table 4 shows the results of a simple least squares regression of the mean correlations on a constant and a time trend.

Table 4 – Regressions of mean correlations on a constant and a time trend

Sample	*Number of pairwise combinations*	*Sample period*	*Intercept*	*Time trend*
Whole sample	1431	1986:01 – 2001:07	0.0236 (3.185)**	0.0004 (8.462)**
Cross border correlations only	1216	1986:01 – 2001:07	-0.0732 (-9.829)**	0.0007 (15.467)**

t-statistics are indicated between parentheses. One (two) asterisk(s) indicate significance at the 0.05 (0.01) level.

For both samples the coefficient associated with the time trend is highly significant. For the sample where the mean was calculated from cross-border correlations only, the time trend coefficient is even higher than for the sample where correlations between banks of the same country where also taken into account.

In summary this analysis provides some evidence that interdependencies among European banks of different countries have become stronger within the past 15 years. Thus, the potential for systemic risk in banking has increased at the European level.

However, absolute mean correlations among stock returns of European banks from different countries still are relatively low compared with correlations in the national samples (see figure 1b). At the European level (figure 3b) mean correlations range from a low of -0.068 to a high of 0.194 with a mean of 0.035. For the national samples mean correlations often reach values of up to 0.7 or even as high as 0.9. This indicates that the threat of systemic risk is still higher at a national level than at the European level. Unfortunately, we cannot make a more exact statement concerning the absolute threat of systemic risk at the European level compared to the national level. Nevertheless, the analysis above provides evidence that the potential for systemic risk in European banking has increased within the past 15 years. This indicates that at least to some extent a shift of systemic risk from the national level to the European level has occurred.

4 Conclusion

The analysis in this paper attempts to answer the question whether the threat of systemic risk in banking is a national threat or rather a Europe-wide threat. Following De Nicolo and Kwast (2001), mean rolling-window correlations between bank stock returns are used as a measure for the interdependencies among European banks, and hence for the systemic risk potential in Europe. At first, weekly rolling-window correlations are calculated between bank stock returns without controlling for national factors. These give evidence that interdependencies have increased within the last two decades. However, since national factors determine to a large extent stock returns this result can only be seen as preliminary.

Thus, in the second part of the analysis we estimate a return generating model in order to eliminate national influences from bank stock returns. Thereafter, rolling-window correlations are calculated using the adjusted bank stock returns. Again, we find evidence that interdependencies among European banks have increased over the last 15 years. This indicates that there has been a shift in the systemic risk potential from a national level to a European level.

However, there are several caveats of our study. Mainly, there are a number of shortcomings of the correlation approach that limit interpretation. Furthermore, no direct comparison can be made between the potential of systemic risk at the national level and the European level. The analysis allows merely for statements concerning the development of the threat of systemic risk over time. Nevertheless, recalling the lack of empirical studies in particular for Europe and the lack of data available on interbank lending at an international level the analysis in this paper is appropriate.

The evidence on the rise in systemic risk potential found for Europe provides an argument in favour of Europe-wide banking regulation and supervision. Whether the existing forms of cooperation between the national authorities is an appropriate way in securing financial stability or whether a single European supervisor is needed is up to further research.

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Appendix

Table A1 – Banks included in the samples

	Name of the bank	*Country*	*Data available since*
1	Deutsche Bank	Germany	01/1980
2	HypoVereinsbank	Germany	01/1980
3	Dresdner Bank	Germany	01/1980
4	Commerzbank	Germany	01/1980
5	BNP Paribas	France	10/1993
6	Societé Générale	France	07/1987
7	ABN Amro	The Netherlands	09/1990
8	BSCH Santander	Spain	03/1987
9	BBV Argent..	Spain	03/1988
10	Banco Popular	Spain	03/1987
11	Bankinter	Spain	03/1987
12	Intesa BCI	Italy	01/1980
13	Unicredito Italiano	Italy	01/1980
14	San Paolo IMI	Italy	04/1992
15	Banca di Roma	Italy	01/1980
16	Monte die Paschi di Siena	Italy	06/1999
17	Banca Nazionale del Lavro	Italy	09/1998
18	Rolo Banca	Italy	02/1992
19	BIPOP- Carire	Italy	01/1986
20	Banca Popular di Verona	Italy	06/1998
21	Banca Popular di Bergamo	Italy	01/1986
22	Banca Popular di Milano	Italy	01/1986
23	Banca Lombarda	Italy	01/1986
24	Banca Popular di Lodi	Italy	01/1986
25	Banca Popular di Novara	Italy	01/1986
26	Banca Popular dell Emilia Rom.	Italy	12/1991
27	Banca Fideuram	Italy	01/1987
28	Banca Pop. Com. e Industr.	Italy	01/1986
29	Banca Popular di Sondrio	Italy	08/1995
30	Bank of Ireland	Ireland	01/1980

Note: Included are the 60 largest European banks according to total assets in 1999. Source: www.manager-magazin.de. Sorted by country.

Table A1 – Banks included in the samples – continued

	Name of the bank	*Country*	*Data available since*
31	Allied Irish Banks	Ireland	01/1980
32	Erste Bank	Austria	12/1997
33	Almanij	Belgium	01/1980
34	Dexia	Belgium	11/1996
35	KBC	Belgium	01/1980
36	Banco Comercial Portuges	Portugal	01/1988
37	Banco Esprito Santo	Portugal	10/1992
38	Nordea	Sweden	12/1997
39	SEB	Sweden	01/1982
40	Svenska Handelsbanken	Sweden	01/1982
41	Föreningssparbanken	Sweden	06/1995
42	UBS	Switzerland	01/1980
43	Julius Bär	Switzerland	10/1980
44	Den Norske Bank (DNB Hldg)	Norway	09/1992
45	Spardebanken Nord-Norge	Norway	09/1995
46	HSBC	United Kingdom	07/1992
47	Royal Bank of Scotland	United Kingdom	01/1980
48	Barclays Bank	United Kingdom	01/1980
49	HBOS (Halifax & Bank of Scotland)	United Kingdom	05/1997
50	Abbey National	United Kingdom	07/1989
51	Standard Chartered	United Kingdom	01/1980
52	Alliance & Leicester	United Kingdom	04/1997
53	Northern Rock	United Kingdom	09/1997
54	Lloyds TSB	United Kingdom	12/1995
55	Den Danske Bank	Denmark	01/1980
56	National Bank of Greece	Greece	01/1988
57	EFG Eurobank	Greece	01/1988
58	Commercial Bank of Greece	Greece	01/1988
59	Bank of Piraeus	Greece	04/1988
60	Alpha Bank	Greece	01/1988

Note: Included are the 60 largest European banks according to total assets in 1999. Source: www.manager-magazin.de. Sorted by country.

Table A2 – Estimation results of the ARIMA(p,1,q) models for the national interest rates

		AR components					*MA components*		
Country	μ	ϕ_1	ϕ_2	ϕ_3	ϕ_4	ϕ_5	θ_1	θ_2	θ_3
Germany	-0.025	1.292	-0.698				-1.162	0.625	0.170
	(0.025)	(0.072)**	(0.063)**				(0.091)**	(0.107)**	(0.070)**
France	-0.041	-1.007	-0.935				1.275	1.181	0.171
	(0.044)	(0.020)**	(0.019)**				(0.067)**	(0.075)**	(0.065)**
The Netherlands	-0.027	-0.144	-0.440				0.145	0.598	0.220
	(0.029)	(0.126)	(0.111)**				(0.136)	(0.102)**	(0.070)**
Spain	-0.040	0.769	-0.953	-0085	-0.035	-0.119	-0.988		
	(0.057)	(0.062)**	(0.075)**	(0.096)	(0.073)	(0.058)**	(0.015)**		
Italy	-0.054	0.188							
	(0.039)	(0.061)**							
Ireland	-0.045	0.471	0.338	-0.179	-0.036		-1.162	0.727	-0.611
	(0.014)**	(0.108)**	(0.124)**	(0.092)	(0.090)		(0.097)**	(0.153)**	(0.092)**
Austria	-0.033	-0.126	-0.443	0.650	-0.010	0.086	0.076	0.470	-0.684
	(0.028)	(0.287)	(0.237)	(0.268)*	(0.061)	(0.060)	(0.281)	(0.216)*	(0.285)*
Belgium	-0.033	1.595	-1.104	0.397	-0.256		-1.981	1.427	-0.250
	(0.027)	(0.174)**	(0.247)**	(0.134)**	(0.072)**		(0.181)**	(0.312)**	(0.179)
Portugal	-0.050						-0.129	-0.255	
	(0.032)						(0.060)*	(0.060)**	

Estimation of the ARIMA(p,1,q) model $(1-\phi_1 B-\phi_2 B^2-\phi_3 B^3-\phi_4 B^4-\phi_5 B^5)\Delta I_t=\mu+(1-\theta_1 B-\theta_2 B^2-\theta_3 B^3)z_t$*. Where* ΔI_t *represents the differencing of the money market interest rate series* I_t*, and* z_t *is a shock term. B is the back-shift operator and* $\Phi(B)$ *and* $\Theta(B)$ *represent the autoregressive (AR) and moving average (MA) components, respectively. Standard errors are given in parenthesis. One (two) asterisk(s) indicates significance at the 0.05 (0.01) level. Cells left blank indicate that the respective AR and/or MA component was not part of the model that was selected according to the minimum Schwarz-criterion.*

Table A2 – Estimation results of the ARIMA(p,1,q) models for the national interest rates – continued

		AR components					*MA components*		
Country	μ	ϕ_1	ϕ_2	ϕ_3	ϕ_4	ϕ_5	θ_1	θ_2	θ_3
Sweden	-0.034						-0.862		
	(0.042)						(0.031)**		
Switzerland	-0.006	-2.084	-1.589	-0.476			1.774	0.796	-0.019
	(0.034)	(0.083)**	(0.136)**	(0.065)**			(0.085)**	(0.131)**	(0.055)
Norway	0.013	0.092	-0.948	-0.261	-0.233		-0.535	1.078	
	(0.055)	(0.058)	(0.057)**	(0.051)**	(0.054)**		(0.037)**	(0.037)**	
United Kingdom	-0.030	0.028	-0.068	0.724	0.142		-0.198	0.024	-0.816
	(0.011)**	(0.094)	(0.066)	(0.056)**	(0.061)*		(0.072)**	(0.071)	(0.064)**

Estimation of the ARIMA(p,1,q) model $(1-\phi_1 B-\phi_2 B^2-\phi_3 B^3-\phi_4 B^4-\phi_5 B^5)\Delta I_t=\mu+(1-\theta_1 B-\theta_2 B^2-\theta_3 B^3)z_t$*. Where* ΔI_t *represents the differencing of the money market interest rate series* I_t*, and* z_t *is a shock term. B is the back-shift operator and* $\Phi(B)$ *and* $\Theta(B)$ *represent the autoregressive (AR) and moving average (MA) components, respectively. Standard errors are given in parenthesis. One (two) asterisk(s) indicates significance at the 0.05 (0.01) level. Cells left blank indicate that the respective AR and/or MA component was not part of the model that was selected according to the minimum Schwarz-criterion.*