The Threat of Systemic Risk in European Banking

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This paper attempts to assess changes in the systemic risk potential in European banking. Following De Nicolo and Kwast (2002), 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. 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 at the European level has increased.

Motivation

Banking activities are regulated and supervised throughout industrial countries. In general, the reasons for 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, p. 198) This is what is often referred to as *systemic risk* in banking.

In Europe banking regulation and supervision are organized at a national level. There may be a need for a European banking supervision authority, however, because 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 inter-

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[1] There are several different measures employed 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,s disclosure requirements, and capital regulation. See, for example, Davis (1992), Bartholomew and Whalen (1995), Kaufman and Scott (2000), Canoy et al. (2001).

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dependencies 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 nationally 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 examines cross-border contagion—there, the focus is primarily currency and debt crisis. This paper aims to assess changes in the systemic risk potential in European banking. Following De Nicolo and Kwast (2002), 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. National factors determining bank stock returns are eliminated by estimating a return-generating model.

The Concept of Systemic Risk

In general the banking or the financial sector is viewed as more vulnerable to contagion than other industries because 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 reason 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 fulfill 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 that may require the sale of earning assets to meet deposit obligations. Furthermore banks are highly interconnected through direct exposures in the interbank money market and the large-value payment and security settlement systems. These characteristics of banking give rise to concerns about systemic risk in banking.

There exists, however, no uniform definition of systemic risk in the literature. Loosely speaking, systemic risk means “the risk or probability of breakdowns in an

[2] The question that arises is whether the potential of systemic risk may be even worldwide 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 organized at a worldwide level. Thus, we merely analyze the potential of systemic risk at the European level and do not ask whether there also may be contagion between European and non-European banks.

entire system, as opposed to breakdowns in individual parts or components" (Kaufman and Scott, 2000, p. 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 adverse effects on several banks. Such a macro shock can either be a cyclical downturn or other aggregate shocks such as 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 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 other parties 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 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).

Despite a wide theoretical literature the empirical literature on systemic risk is relatively scarce.[5] This is particularly true in assessing the systemic risk potential in

[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).

[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, see De Bandt and Hartmann (2000).

an international context, such as the European one.[6] Looking at data on interbank lending would be a first effort to assess contagion risk. 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.[7] Unfortunately, European data on interbank lending are only available on an aggregate level, which does not allow for statements concerning contagion risk between individual banks. Therefore, we follow De Nicolo and Kwast (2002) and use correlations among bank stock returns as a measure for the interdependencies—and hence the potential of systemic risk among banks.

The Systemic Risk Potential in European Banking

Correlations of Bank Stock Returns

De Nicolo and Kwast (2002) 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 does such an externality exist–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 (2002) measure total interdependencies by the correlations of stock returns of large banking organizations. Because stock prices reflect market participants' collective evaluation of a firm's prospects in the future, they also include the impact of the firm's interdependencies with other institutions.[8] Consequently, one can assume that an observed increase in correlations among bank stock returns signals an increase in the systemic risk potential. No change in correlations or a decrease, therefore, would lead to the conclusion that the potential of systemic risk has not increased or has declined.

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[6] 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 currency or debt crisis.

[7] There are some studies for the U.S. that use this approach utilizing 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. In order to assess the risk exposure of the Austrian banking system, Elsinger et al. (2002) conduct an analysis based on a network model of the interbank market.

[8] Pozdena (1991) make a similar consideration; they regress the stock returns of various individual banks on each other in each period in order to get evidence of a contagion effect.

Note that by using the notion of *systemic risk potential* rather than *systemic risk*, we indicate that stronger interdependencies among European banks, i.e., higher correlations among bank stock returns, are a necessary—but not a sufficient—precondition for systemic risk.

Following this approach we calculate rolling-window correlations between pairs stock returns of the 54 largest European banks coming from 13 European countries. In an international context, we must consider a few more things. Estimating correlations between pairs of bank stock returns without controlling for common factors could result in incorrect conclusions with respect to interdependencies and, hence, the systemic risk potential. An increase in correlations may result merely from an increase in the comovement between the underlying common factors that has nothing to do with the development of systemic risk. Consequently, in an international context one needs to control for national determinants of stock returns. By estimating a return-generating model before calculating correlations, we address this issue.

Methodology and Data

The aim of this study is to measure changes in the systemic risk potential in the European banking market. We use mean rolling-window correlations of stock returns of the largest European banks as a measure. The analysis proceeds in four steps:

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. Second, 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 due to international influences. Third, pairwise rolling-window correlations are calculated between these residuals. And fourth, the mean is calculated over these pairwise rolling-window correlations as an indicator for the interdependencies among European banks and 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), and 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.[9] The concrete interest rate

[9] An additional argument in favor of the inclusion of the interest rate variable is that within the European Monetary Union (EMU) the convergence—and after the introduction of the Euro the

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:

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

where:

R_{it} = The rate of return on the stock of bank i at time t;
MR_t = 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 because 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 affect national indexes are also excluded. Such influences, for example, common shocks may cause systemic risk at the European level, however. The residuals from equation (1) do not contain such European influences.[10]

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

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

equality—of money market rates would lead to an increase in the correlations of unadjusted stock returns.

[10] For example, if a big European bank would fail with systemic consequences, this would lead to a decrease not just of the individual bank stock returns but also of the European stock market return. Without controlling for the European market return, i.e., according to model (1), one would only exclude the national market influence from the bank stock return. But this national market return may be influenced by the European market return. Hence, by estimation of (1) one would falsely exclude also this European influence in the national index from the individual bank stock return. As a consequence, the residuals from model (1) would not include all European influences, and the following correlation analysis would be based on falsely calculated bank stock returns

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.[11]

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

$$\widetilde{R}_{it} = R_{it} - \beta_{oi} - \beta_{mi}MR_t - \beta_{Ii}UI_t = \varepsilon_{it} + \beta_{ei}EMR_t. \quad (3)$$

Contrary to the residual from model (1) this calculated bank stock return $\widetilde{R}_{it}$ should contain all European influences. By excluding the influence of these identified factors we analyze only that part of the bank stock returns that is explained by the risk exposure to bank specific factors. The international correlations of these factors, for example, comprise the exposure to other banks (e.g., due to interbank lending) or the interdependencies to other banks via third companies. In short, these (unidentified) factors should comprise the potential of systemic risk. Changes in the correlations between these residuals $\widetilde{R}_{it}$ therefore can be interpreted as changes in the systemic risk potential.

The Data

Our starting points were the 60 largest European banks according to total assets in 1999. 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 Germany, France, the Netherlands, Spain, Italy, Ireland, Austria, Belgium, Portugal, Sweden, Switzerland, Norway, and the United Kingdom. For a list of the banks included in the sample, see Table A1 in the appendix.

Two samples are used: a *Europe sample* that includes all 1431 possible pairwise combinations and a *Europe cross-border only* sample including only correlations between banks of different countries which gives a number of 1216 pairwise combinations.

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 web page. 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

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

stocks. The unanticipated change in interest rates UI_t is calculated using the money market rate taken from the IMF's International Financial Statistics.

Monthly data are used because 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.[12]

Estimations

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

$$\Phi(B)\Delta I_t = \mu + \Theta(B)z_t \tag{4}$$

is used where:

ΔI_t	=	The first difference of the money market interest rate series I_t;
z_t	=	A shock term;[13]
B	=	The back-shift operator; and
$\Phi(B)$ and $\Theta(B)$	=	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,

$$UI_t = I_t - E(I_t) \tag{5}$$

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

Estimation of the Return-Generating Model

Because 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. At 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. It should be controlled for such interdependencies among banks within one country, however. Thus, for every coun-

[12] Note that not all bank stock series are available from 1980. For the starting dates of the series, see also Table A1.

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

try equation (2) is estimated in a panel with fixed effects using least squares.[14] The estimation results for these regressions are shown in Table 1.

Table 1—Estimation Results of the Return-Generating Model for Every Country

Country	Number of Banks Included in the Panel	β_{mi}	β_{ei}	β_{Ii}	Adjusted 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 $R_{it} = \beta_{oi} + \beta_{mi}MR_t + \beta_{oi}EMR_t + \beta_{Ii}UI_t + \varepsilon_{it}$ 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 is β_{Ii} significantly different

[14] 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.

from zero. This is partly in line with former research that found decreasing interest rate sensitivity of bank stock returns in the late 1980s and early 1990s for the U.S. (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. Because our aim is not to explain bank stock returns but to eliminate all national influences, however, the insignificance of this coefficient is not decisive.[15] Also, adjusted R^2s 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 [equation (3)].

Changes in the Systemic Risk Potential in Europe–Correlation Results

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.[16] A 12-month backward looking window is used. As mentioned above, we have two samples: a *Europe* sample where we include all 1431 pairwise correlations and a *Europe cross-border only* sample where we include only the 1216 bivariate correlations between banks of different countries.

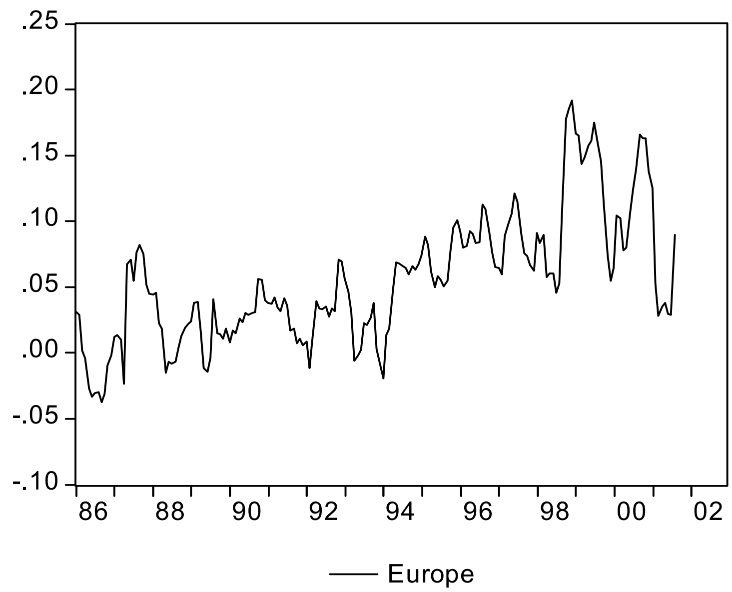
From the pairwise rolling-window correlations the mean is calculated as an indication for the development of the interdependencies among European banks and of the potential of systemic risk in European banking. In order to avoid a bias due to the fact that the number of banks in the sample from the same country differs, we first calculate the mean over all correlations between banks from one country and all other banks. Consequently, we get 13 country means. From these country means we calculate the mean rolling-window correlation for the whole sample. Figure 1 shows the mean rolling-window correlation for the *Europe* sample and for the *Europe cross-border only* sample. Unfortunately, prior to 1986 bank stock return data are 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.[17] Thus, we report in Figure 1 mean rolling-window correlations for the time after 1986. Table 2 gives summary statistics for the two series.

[15] 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.

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

[17] For the same reasoning, we erased all mean correlation values that relied on less than ten observations.

Figure 1—Mean 12-Month-Rolling-Window Correlations of European Bank Stock Returns



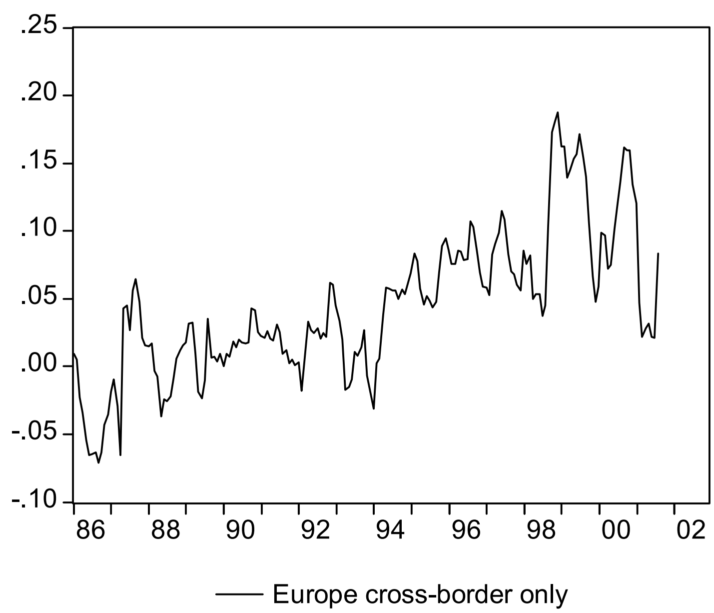


Table 2—Summary Statistics for Mean Monthly Rolling-Window Correlations

Sample	Mean	St. Dev.	Min.	Max.
Europe	0.0546	0.0492	-0.0374	0.1920
Europe Cross-Border Only	0.0436	0.0539	-0.0707	0.1873

Sample period: 1986:01-2001:07

Not surprisingly, correlations in the sample where only cross-border correlations are taken into account are smaller than in the sample with all pairwise correlations. In other respects there are no obvious differences in mean correlations between the *Europe* and the *Europe cross-border only* sample.

There is a substantial temporary increase in mean correlation in the time following the stock market crash in 1987. There is a less pronounced temporary increase in mean correlations in the early 1990s that is probably due to the banking crises in some European countries: Norway 1987-93, Sweden 1990-93, Finland 1991-94, and Italy 1990-94. A substantial temporary 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.

Overall, there is evidence that mean correlations have increased in the past 15 years. Table 3 shows the results of a simple least squares regression of the mean correlations on a constant and a time trend.

Table 3—Regressions of Mean Correlations on a Constant and a Time Trend

Sample	Intercept	Time Trend
Europe	-0.0531030**	0.0006468**
	(-6.548)	(13.966)
Europe Cross-Border Only	-0.0824542**	0.0007572**
	(-10.034)	(16.136)

Sample period: 1986:01-2001:07. 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, although small in absolute terms. For the sample where the mean was calculated from cross-border correlations only, the time trend coefficient is higher than for the sample where correlations between banks of the same country were also taken into account.

Furthermore, there seems to be a jump in mean correlations around 1994 which is probably a result of the completion of the internal banking market in the EU as a consequence of the second banking directive that was implemented in 1993. A test for equality of means shows that the means before and after the implementation of the second banking directive are significantly different from each other.

In summary, the analysis provides some evidence that interdependencies among European banks of different countries have become stronger within the past 15 years. Part of this increase in interdependencies can be attributed to the completion of the

Figure 2—Mean 12-Month Rolling-Window Correlations of European Bank Stock Returns–National Samples

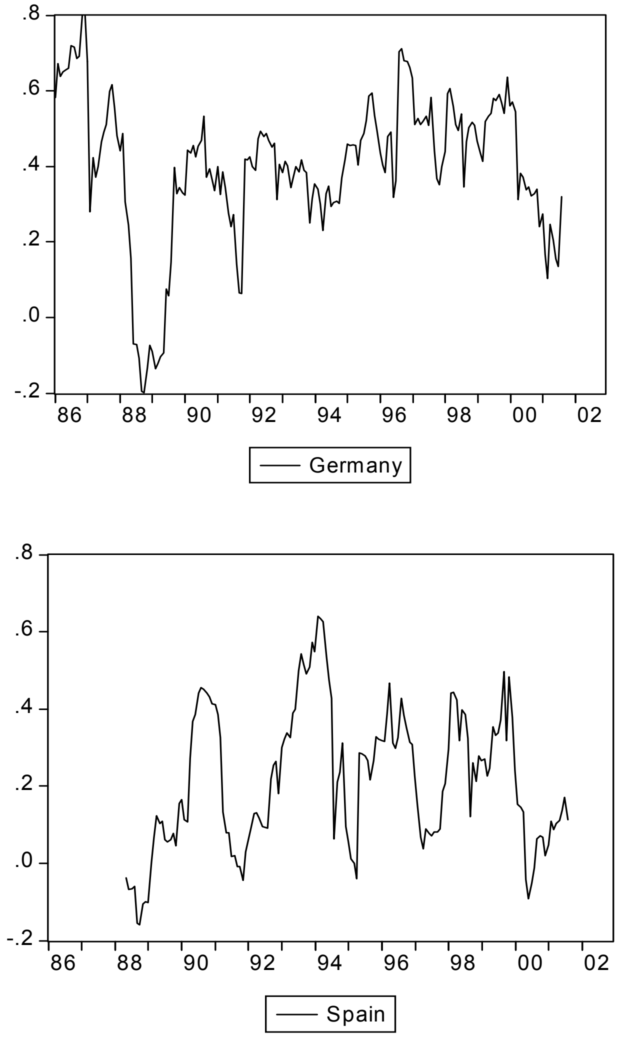
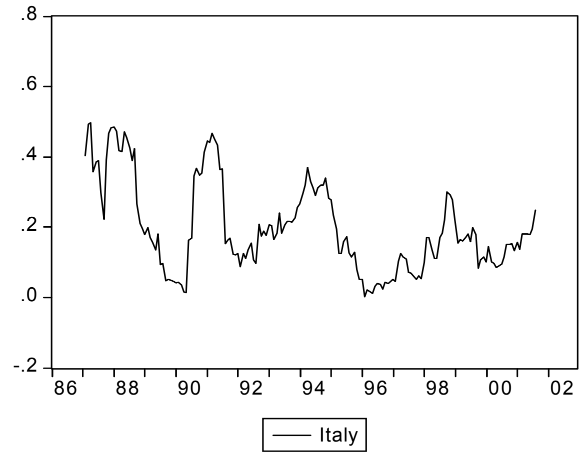
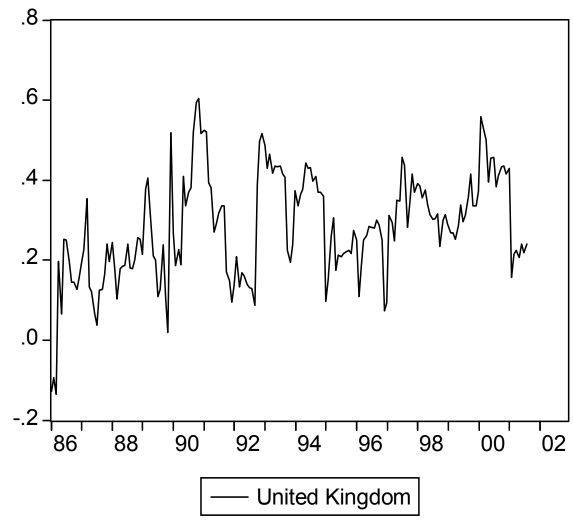


Figure 2 (cont.)—Mean 12-Month Rolling-Window Correlations of European Bank Stock Returns–National Samples





internal banking market in the EU. Thus, the potential of systemic risk in banking has increased at the European level.

This finding is endorsed when comparing the results for the European samples with the national samples, where only correlations between banks from the same country are used. Figure 2 shows mean rolling-window correlations for Germany, Spain, Italy, and the United Kingdom. Table 4 gives summary statistics, and Table 5 provides the results of a regression of the mean correlations on a constant and a time trend.

Table 4—Summary Statistics for Mean Monthly Rolling-Window Correlations–National Samples

Sample	Mean	St. Dev.	Min.	Max.
Germany	0.3983	0.1960	-0.1991	0.8110
Spain	0.2163	0.1814	-0.1588	0.6397
Italy	0.1970	0.1282	0.0010	0.4973
United Kingdom	0.2820	0.1325	-0.1361	0.6040

Sample period: 1986:01-2001:07

Table 5—Regressions of Mean Correlations on a Constant and a Time Trend–National Samples

Sample	Intercept	Time Trend
Germany	0.331216**	0.000403
	(7.205)	(1.534)
Spain	0.119294*	0.000537
	(2.075)	(1.741)
Italy	0.407671**	-0.001218**
	(13.409)	(-7.219)
United Kingdom	0.123167**	0.000954**
	(4.282)	(5.806)

Sample period: 1986:01-2001:07. t-statistics are indicated between parentheses. One (two) asterisk(s) indicate significance at the 0.05 (0.01) level

For most national samples a clear increase in mean rolling-window correlations is not observable. Only in the United Kingdom do sample mean correlations increase significantly over time. For Italy mean rolling-window correlation decreases significantly over time.

Striking is, however, that absolute mean correlations among stock returns of European banks from different countries are relatively low compared with correlations in the national samples. At the European level (Table 2), mean correlation for the *cross-border only* sample range from a low of -0.0707 to a high of 0.1873, with a mean of 0.0436. For the national samples (Table 4) mean monthly rolling-window correlations often reach values of up to 0.6 or even as high as 0.8 with means around 0.2/0.3. This may be taken as evidence that the threat of systemic risk is still higher at a national level than at the European level. The analysis above provides evidence that the potential of systemic risk in European banking has increased over the past 15 years. From this result one may conclude that there exists a significant Europe-wide threat of systemic risk without directly comparing this Europe-wide to the national threat.

Conclusions

The analysis in this paper attempts to answer the following question: Has the systemic risk potential in the European banking market increased over time? The integration process in the European Union (and particularly the development of the single market) and the introduction of the euro are directed toward an increase in the international business of European industrial companies and banks. An unintended negative consequence of this integration process might be a rise in the systemic risk in the European banking business.

Following De Nicolo and Kwast (2002), mean rolling-window correlations between stock returns of the largest European banks are used as a measure for the interdependencies among banks and, hence, for the systemic risk potential in Europe. In order to eliminate national influences from bank stock returns a return-generating model is estimated. Thereafter, rolling-window correlations are calculated using the adjusted bank stock returns.

We find evidence that interdependencies among European banks have increased over the last 15 years. Part of this increase is due to a jump in the time after the implementation of the second banking directive in 1993 that completed the internal banking market in the EU. This indicates that the systemic risk potential at the European level has increased. This compares to the national samples where mean correlations have mostly not increased over that period.

The evidence on the rise in the systemic risk potential found for Europe provides an argument in favor of Europe-wide banking regulation and supervision. Whether the existing forms of cooperation between the national authorities are 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 54 of 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

Note: Included are 54 of 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	-0.085	-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)**	
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 parentheses. 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