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Interdependences among European Banks Via the Market Model

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Abstract

Based on the works elaborated by De Nicolo and Kwast (2002), Schüler (2003), Schüler and Schröder (2003), Gropp and Vesala (2003) and Aglietta et al (2000), this article aims at to study the systemic risk within the European Union. Indeed, the correlation between market model residues have been applied for the purpose of highlighting advancing the interdependence among the European banks domestically as well as at across border levels.

The method applied is to capture residue from several regressions and calculate the average correlations. Actually, as for as our study sample it has been demonstrated that both domestic as well as cross border interdependences do exist among concerned institutions (i.e. banks). Assuming the propagation of a negative externality, we concluded a possible systemic risk within the European banking

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industry appears prevalent and plausible in conformity with criteria set by De Nicolo and Kwast (2002), Schüler (2003), Schüler and Schröder (2003).

JEL Classification: G12, G14
Keywords: Banks, Interdependences, Domestic, Cross border, Market model, Systemic risk

1 Introduction

Numerous potential risks might seriously engender negative impacts likely to threaten the area of macroeconomics. Actually, such risks affect financial institutions belonging to a single economy's monosystem in as much as they can affect institutions based in various countries, thus benefiting from and taking part in different financial systems. Noteworthy, systemic risk is the most-often feared risk by the banking system supervising authorities or overseers. Indeed, according to Frydl (1999), the cost of a systemic banking crisis is estimated at about 8% of GDP in terms of lost output and crisis relief cost. As for Hoggarth et al. (2001), they have estimated an annual loss rate of bank output of about 15 to 20% of GDP during the crisis period. Thus, the impact of systemic banking crises affecting on economic growth have given reason to explain the establishment and implementation of regulators and supervisors able to intervene ahead of crises, hardship or even downturn.

Based on studies achieved by De Nicolo and Kwast (2002), Schüler (2003), Schüler and Schröder (2003), Gropp and Vesala (2003) as well as Aglietta et al (2000), the present research aims at studying the systemic risk within the European Union. Indeed, applying market data, these authors have established the difference between domestic contagion and cross-border one. Although domestic contagion is more significant with respect to the cross-border one, the authors argue that the

cross border aspect of contagion among European banks remains still significant, especially after the introduction of the single currency. The supranational dimension in systemic risk management has also been discussed in their works. Regulating Schüler and Schröder (2003) they have relied on the works elaborated by De Nicolo and Kwast (2002) to discuss the systemic risk within the European banking industry. Indeed, conforming to, and retracing the steps made by, De Nicolo and Kwast (2002) regarding the U.S. banking industry, Schüler and Schröder (2003) have applied the correlation among the market model residus in order to put forward the greater interdependence among European banks on both the domestic level as well as the cross-borders one.

In this respect, this article's subject matter focuses on the issue of systemic risk with regard to the European banking industries. Accordingly, we present the methodology pursued to perform our empirical study in our discussion of the interdependences within the European banking industry.

2 Methodology

2.1 Presentation of the interdependence study

The present study addresses the question of the existence of some kind of interdependence among some of the banks across the European countries. For this purpose, a sample of 58 banks has been selected on the basis of certain norms. The first criterion is the bank size measured by total assets. Some large banks have been selected according a wide range of products and services they offer both domestically and internationally, and an extensive participation in the payment systems and settlement of high value. The second criterion of choice is the listing of these institutions on the stock market. This criterion implies that only banks listed on the respective markets of fifteen countries have been selected due to the nature of

our approach based on a market model. Actually, these fifteen countries' ten largest banks have been chosen in respect of their assets. Eventually the combination of both criteria (large size and listing) has allowed us to select a set of 58 banks. Our choice also consists in selecting only banks located in at least two EU member countries and originating from a member country of the union. These institutions establishments are implanted in some European countries either as participants in bank capitals of different nationalities or through the setting up of subsidiaries or branches.

Noteworthy, our study covers the period ranging from 1995 to 2004. The Datastream database has been applied to extract the bank's weekly share courses subject of our sample and to extract the chronicles of stock market indexes of fifteen stock markets in our sample. The average slippery correlation method has been applied, which consist in capturing residues of several regressions and calculating the average correlations. Therefore, this method has been chosen with respect to the results derived from the stability test of coefficients (Chow test). Before administering the Chow test, here is a definition of our applied model.

2.2 Model presentation

In this study, we regress the individual banks' stock returns in their respective markets' stock returns. We calculate for each bank the average of correlations between its residues and those of regressions' yields of the other banks in the sample. This average has to be regressed on a trend and a constant to analyze its evolutionary tendencies over time. Initially, this process has been applied to all banks in the sample for the sake of obtaining the evolution of the average correlations among the residues of the EU-15. The targeted objective lies in

depicting how all banks' interdependences have progressed among themselves regardless of the domestic or transboundary specifities.

We are mainly interested in correlations between the estimates residues as we assume that European effects on stock returns of banks in our sample are latent and contained in these residues. Actually, this consists in taking account of non-national factors, above all the European factors, likely to foster interdependence among European banks. Noteworthy, however, the present study does not seek to highlight nor explain any eventual dependence, but is rather restricted to just prove their existence. Our applied model is a single index market model:

$$R_{i,t} = \alpha + \beta RM_{t,p} + \varepsilon_{i,t} \quad (1)$$

with:

$R_{i,t}$: Stock returns of bank i in week t (i = 1, 2, 3 ,..., 58);

$RM_{t,p}$: The national market return of country p (p = 1, 2, 3 ... ..., 15) in week t;

$\varepsilon_{i,t}$: A random shock with E ($\varepsilon_{i,t}$)= 0; = Constant and Cov ($\varepsilon_{i,t}$, $\varepsilon_{j,t}$) = 0.

To note, all market and banking sector indexes used in this study are constructed by means of DataStream.

2.3 Estimated Model and Chow test

Prior to dealing with the regressions procedure, we reckon to perform a stability test of regression coefficients (Chow test). The objective behind this initiative is to ensure the coefficients' stability over the entire period. Thus, regarding each of the 58 banks in the sample, a Chow coefficient-stability test is to be undergone. Hence, for each bank, there are as many values for the test statistics as there are rupture points. Among all these values, only the strongest one is to be retained and we calculate the minimum risk of first rate. It must then be retained to conclude with the rejection of the null hypothesis, namely, that of stability

coefficients. This test is performed by means of a latent program encompassed within the Eviews software whose results are presented in Table 1 below.

Table 1: Results of the Chow test

Bank	Chow Statistics	Rejection Probability (%)	Breaking Point (F max)
AT_INVB	24.25133	7.84E-09	06/12/2003
AT_OBEB	5.456564	0.449533	15/08/1998
BE_FORT	5.023875	0.687489	19/07/1997
BE_KBCG	3.745040	2.422139	07/01/1995
DE_BANS	3.412525	3.363627	10/05/2003
DE_BAYH	5.855730	0.303946	20/05/1995
DE_COMB	11.67179	0.001078	21/09/2002
DE_DEPFA	1.860708	15.65111	
DE_DETB	5.396368	0.476884	12/07/1997
DE_EURH	2.532535	8.035588	
DK_AMAB	4.847418	0.817690	29/04/1995
DK_DANB	5.917945	0.285974	14/01/1995
DK_FIOB	3.429013	3.309275	05/04/2003
DK_FOBK	4.677136	0.966761	19/08/1995
DK_JYSB	4.515950	1.132934	26/09/1998
DK_SPNB	3.245728	3.966489	10/04/1999
DK_SYDB	8.931240	0.015172	15/05/1999
ES_BINR	8.665528	0.019633	22/04/1995
ES_BPOP	10.77942	0.002543	07/01/1995
ES_BSAN	5.626617	0.380473	21/09/2002
ES_BVAR	7.236482	0.078827	14/11/1998
FI_ALAB	4.333435	1.355975	15/02/2003
FI_NORT	6.894161	0.110085	21/10/1995
FI_OKOB	7.073223	0.092434	13/01/1996

FI_SAMP	7.112945	0.088921	20/05/2000
FR_BNPP	6.449419	0.169996	07/01/1995
FR_NXBP	9.437725	0.009290	14/01/1995
FR_SOCG	6.366182	0.184411	07/01/1995
GR_ALPH	6.212170	0.214399	07/01/1995
GR_BPIR	12.24786	0.000620	27/06/1998
GR_EFGE	3.431136	3.302341	13/04/1996
GR_EGNB	3.826818	2.234349	01/04/1995
GR_EMPB	11.30937	0.001527	07/01/1995
GR_GENH	10.79339	0.002509	21/01/1995
GR_NATB	9.616770	0.007812	04/02/1995
IR_ALLI	8.774097	0.017670	24/06/1995
IR_ANGI	7.142341	0.086407	04/03/1995
IR_BANI	14.46776	7.44E-05	14/01/1995
IR_DEPFB	4.264984	1.450559	25/01/2003
IT_BINT	6.828021	0.117429	26/07/1997
IT_CAPT	7.197699	0.081866	28/09/2002
IT_SANP	3.401640	3.400003	21/03/1998
IT_UNIT	9.314009	0.010471	11/03/1995
LX_ESFI	1.686569	18.60811	
LX_KREB	11.48275	0.001293	11/03/1995
NL_ABNA	5.456331	0.449635	12/07/1997
NL_INGG	3.988044	1.905828	12/07/1997
NL_KASB	5.101460	0.637033	03/10/1998
PT_BANF	3.285749	3.812619	28/03/1998
PT_BBPI	17.20161	5.59E-06	14/01/1995
PT_BCPR	11.13554	0.001805	07/01/1995
PT_BESS	10.15781	0.004631	21/03/1998
SD_SEBA	9.159039	0.012167	21/01/1995
SD_SVEH	13.95285	0.000122	07/01/1995
UK_ABYN	2.223931	10.91258	

UK_BARC	2.198476	11.19173	
UK_HSBC	4.795659	0.860382	07/01/1995
UK_STCH	3.634329	2.701856	21/01/1995

It turns out, after this test completion, that in 53 cases out of 58, instability has been concluded with respect to the beta coefficients of the market model.

Table 2: Number of banks kept in the sample by country

Country	Number of banks retained
Austria	2
Belgium	2
Germany	6
Denmark	7
Spain	4
Finland	4
France	3
Greece	7
Ireland	4
Italy	4
Luxembourg	2
Netherlands	3
Portugal	4
Sweden	2
United Kingdom	4
EU-15	58

To remedy this state the market model residues have to be calculate by estimating this model over rolling skidding periods, which would allow us to take into consideration the instability attained by our model's coefficients. Thus, before calculating our model's rolling correlations' average, we calculate the market model residues by applying this model over rolling periods.

It is worthwhile noting that in some countries, the number of banks may be considered insufficient to achieve an econometric study that could lead to a through analysis of the performed regressions. Nevertheless, we consider that as far as the present study is concerned, this situation does not constitute an obstacle impeding the achievement of interesting results. Table 2 lists the number of banks retained in the sample by country.

3 Analysis of the interdependence results between banking institutions

For the purpose of checking whether any interdependence do exist among the various banks subject of the sample, we have made recourse to the method of corrected rolling correlations over the 1995-2004 period in a bid to calculate the correlation average between the different banks in the sample. Initially, we estimate the interdependences among the various banks constituting our sample. Then, we calculate, on the one hand, the existing rolling correlations between banks of different nationalities (cross-border interdependences) and those between banks of the same nationality (domestic interdependences) on the other hand. This approach allows us to highlight not only the interdependences between banks operating in one nation, but also the interdependences between European banks belonging to different countries. We assume that studying the possibility of the existence of systemic risk can be justified especially in the case of prevailing pan-European interdependence.

3.1 Interdependence among the set of banks in the sample

As mentioned earlier, our first step consist in calculating the residues' average rolling correlations among all the banks' set in the sample to check whether there does exist (or not) any interdependences within the EU-15 different banks in the sample over the period 1995 to 2004. Thus, we are entitled to obtain the mean of the rolling average correlations for the whole EU-15 without having to distinguish between domestic and cross-border interdependences. Afterwards, we turn to regress this obtained average on a constant and a trend to deduce the evolution throughout the whole period.

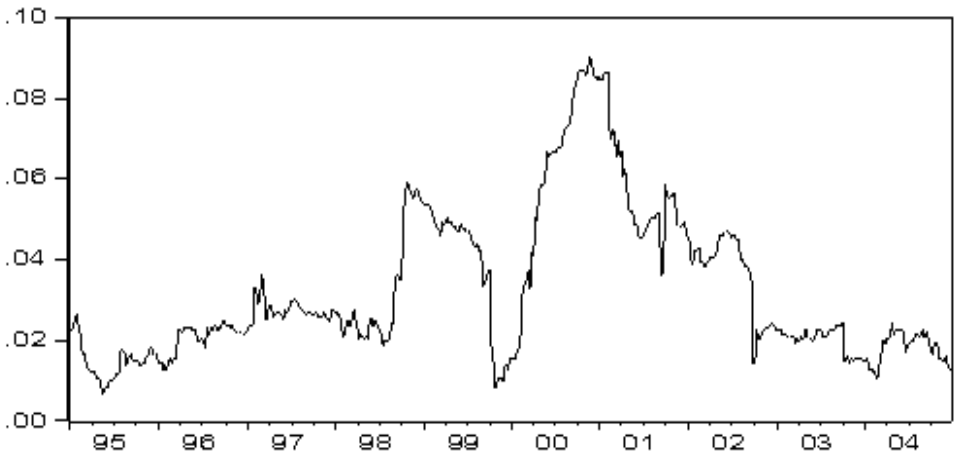


Figure 1: Mean of the EU-15 rolling average correlations

According to the obtained result, it can be concluded that, by means of application, there does exist a significantly increasing interdependence among banks subject of our sample between 1995 and 2004. Indeed, the coefficient related to the trend (t) is significantly superior to zero, which demonstrates a positive increase in interdependence. Chart 2 depicts the statistics relevant to the residues' mean of the rolling average correlations.

Table 3: Statistics of the average correlations' mean between residues

	Average	Minimum	Max.	Standard deviation
Model (1)	0.0327	0.0066	0.0905	0.0190

Regarding these results, it appears that the assumption of ascendant interdependence between banks subject of our sample is plausible. Indeed, and in consistency with our intuition, the various banks in our sample are increasingly interdependent in terms of the market model residues' correlations. Yet at this stage of study, it cannot be concluded whether this interdependence is due to domestic interdependences (among banks belonging to a single nation) or cross border ones (i.e. between banks of different countries but belonging to the EU-15 set).

In the following section, we propose a two-stage assumption regarding the means of the correlations' skidding averages between the 58 banks. In the first stage, we exclusively consider possible interdependences among domestic banks. As for the second stage, it allows us to deduce whether there does exist (or not) any interdependences among banks of different nationalities.

3.2 Domestic banks' interdependence

As mentioned above, it seems essential to understand whether the rising interdependence between the different banks subject of the sample is affected by domestic and / or cross border interdependences. Deciphering this influence is important insofar as it would allow us to better understand and, subsequently, better analyze the existence or not of any eventual systemic risk within the European banking industry.

Firstly, we proceed by calculating the mean of the slipping residues' average correlations among a single nation's banks. Once these average correlations are calculated, we turn to regress them on a constant and a trend in order to observe how domestic interdependences evolve over the study period. To note the "beta" coefficients as well as and the corresponding t-statistics of equation (3) have been assembled in Table 3. This proceeding is likely to further clarify the evolution of domestic interdependences within every EU-member country between the years 1995 and 2004.

$$moy\_corr = \alpha'' + \beta''T + \varepsilon_{i,t} \qquad (3)$$

with:

moy_corr: Residues' average slippery correlations;

α'': A constant

β'' : Trend-related coefficient

$\varepsilon_{i,t}$: A random shock with E ($\varepsilon_{i,t}$) = 0; = Constant and Cov ($\varepsilon_{i,t}$, $\varepsilon_{j,t}$) = 0.

On analyzing the previous regressions' results, one might well notice a remarkably significant increase in domestic interdependences with respect to 8 among the 15 countries, while these interdependences are significantly decreasing in 5 other countries.

Table 4: Trend associated factors and the associated t-Student's statistics (mean of residues' domestic slippery average correlations 95-04)

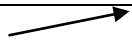
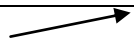
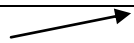
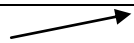
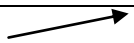
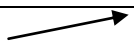
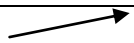
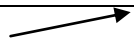
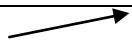
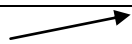
	Number	Coefficient	Student t	Trend	Average
AT	2	-0.000301	-11.51**	↘	0.452
BE	2	-0.000240	-11.44**	↘	0.487
DE	6	-0.000255	-15.55**	↘	0.359
DK	7	0.000020	1.13		0.295
ESP	4	-0.000138	-10.95**	↘	0.437
FI	4	0.000137	9.61**	↗	0.370
FR	3	0.000466	24.32**	↗	0.478
GR	7	0.000470	25.24**	↗	0.519
IR	4	0.000165	6.76**	↗	0.407
IT	4	-0.000069	-3.36*	↘	0.494
LX	2	0.000013	0.06		0.460
NL	3	0.000123	4.91*	↗	0.401
PT	4	0.000104	4.64*	↗	0.468
SD	2	0.000151	10.03**	↗	0.503
UK	4	0.000183	9.57**	↗	0.660

3.3 Cross-border banking interdependences

For the purpose of depicting and highlighting the existence of eventual cross-border interdependences among constituent banks of our sample, we estimate the slippery average cross border correlations among the model's issued out coming residues (1). Indeed, correlations among banks belonging to different countries are to be estimated. Thus, we tend to estimate the average slippery correlations of residues among a certain bank and others that do not belong to the same country as

that bank. Once these correlations have been determined for all the sample's banks, we turn to calculate the average. This average is then regressed on a trend and a constant. The coefficients associated with trends and constants corresponding to the equation 3 regressions are shown in Table 4. The objective of this approach consists in determining not only the trend according to which the various correlations evolve, but also their mean's values. These average means serve to help us compare them with the previously obtained ones reached while calculating domestic interdependences.

Table 5: Trend associated coefficients and the associated Student's t-statistics
(mean of the cross border slippery average correlations of residues 95-04)

	Number	Coefficient	Student t	Trend	Average
AT	2	-0.00023	-10.41**		0.070
BE	2	-0.00012	-7.13**		0.244
DE	6	0.000006	0.31		0.194
DK	7	0.000075	4.94**		0.148
ES	4	0.000241	14.62**		0.212
FI	4	0.000272	15.79**		0.191
FR	3	0.000548	26.10**		0.256
GR	7	0.000447	27.90**		0.174
IR	4	0.000127	6.02**		0.210
IT	4	0.000431	24.84**		0.204
LX	2	0.000203	10.26**		0.212
NL	3	0.000153	7.88**		0.212
PT	4	0.000303	15.34**		0.193
SD	2	0.000230	9.15**		0.209
UK	4	0.000378	20.61**		0.265

With respect to the results depicted in Table 4, one might well notice that cross-border interdependences among the banks subject of our sample had been growing between 1995 and 2004 with regards to 12 of the 15 countries. Actually, they had been decreasing with regards to two countries. Consequently, it turns out that banks belonging to different nations are increasingly interdependent.

The results of our various regressions have shown that both domestic as well as cross border correlations have a tendency to increase. In fact, an important point needs to be emphasised: European banks are becoming increasingly interlinked and intertwined. However, in general, domestic correlations are found to be higher and more frequent than cross border ones. An average discrepancy test of the domestic as well cross border correlations is shown in Table 5. Nevertheless, a significant increase in cross-border correlations could be noticeably witnessed.

Obviously, the fact that the domestic correlations are on average higher than the cross border ones is not a surprising result in so far as the national banking industry is more integrated than the cross border one. However, the pan-European banking industry has been discovered to construct potentially safe robust future as highlighted by several studies (Schüler and Heinemann (2002), Schüler (2002), Schüler (2003), Schüler and Schröder (2003) and Hartmann et al. (2005)). Most of these studies establish certain links between this pan-European industry's recent development and the systemic risk threatening it, which is also the case in our study. As highlighte earlier, we do not seek to highlight this accruing interdependence, but rather to demonstrate its existence. We have the intuition that these cross-border interdependences differ from one country to another. As shown by Gropp and Vesala (2003), the cross border contagion involves pairs of countries more than others therefore, our aims is to show that by applying our model, interdependence calculated by the residues average slippery correlations of the market model yields similar results. For this reason, we have proceeded, in Section 3 with an analysis of interdependences on the basis of country pairs.

Table 6: Mean discrepancy test between the domestic averages and transborder ones

Country	Degree of liberty	t statistic	Probability of t
Austria	1044	-65.75624	0.0000
Belgium	1044	-55.08887	0.0000
Germany	1044	-38.60164	0.0000
Denmark	1044	-40.39216	0.0000
Spain	1044	-61.87721	0.0000
Finland	1044	-45.59168	0.0000
France	1044	-34.70016	0.0000
Greece	1044	-60.81736	0.0000
Ireland	1044	-38.85035	0.0000
Italy	1044	-58.20954	0.0000
Luxembourg	1044	-55.84595	0.0000
Netherlands	1044	-38.30667	0.0000
Portugal	1044	-55.50366	0.0000
Sweden	1044	-61.50904	0.0000
United Kingdom	1044	-81.09161	0.0000

Apparently, it seems that the use of both models 1 and 2 lead to the same trends regarding both domestic and cross-border analyses. Yet the results achieved and emerging from estimates and from regressions greatly differ. Nevertheless, the performed average-discrepancy tests accomplished throughout the different stages of this study have shown that the null hypothesis (equality of means) has been retained.

4 Conclusion

The aim of this paper has been to determine whether any significant interdependence do exist and prevail among banks subject of our sample. The conclusion is affirmative, which corroborates the findings of the already-mentioned works. Indeed, we have attempted and managed to demonstrate the existence of such cross-border interdependences between the constituent banks of our simple. Assuming the propagation of a negative externality, we are led to reach the conclusion that an eventual systemic risk predominating within the European banking industry in conformity with the criteria set by De Nicolo and Kwast (2002), Schüler (2003) and Schüler and Schröder (2003). Regulators of national banking systems in the European Union have to reflect and consider this trend. The Union's banking industry is thus abiding more and more by its European character. Of course, these interdependences are not significant at both the domestic as well the across border levels with respect to all the EU countries. Indeed, as has been demonstrated, the Austrian and Belgian banks are not interdependent vis-à-vis all the other European banks constituting our sample.

The existence of a potential systemic risk leads to the assertion that a particular cross-border contagion is likely to prevail and reign over among the European banks. Hence, an analysis of the issue of contagion and its determinants would certainly provide us with more tools to address the systemic risk issue.

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