IV SPECIAL FEATURES

A CROSS-BORDER BANK CONTAGION RISK IN EUROPE

INTRODUCTION AND BACKGROUND

Contagion across banks is widely perceived to be an important element in banking crises and thus a major systemic stability concern. For example, the private sector rescue operation of Long Term Capital Management (LTCM), which was coordinated by the Federal Reserve Bank of New York, was justified on the grounds of the risk of contagion to banks. Similarly, contagion risks transmitted through the interbank market played a major role in the decisions of the Bank of Japan to react to the failures of major Japanese securities houses in the early 1990s. Generally, however, evidence of the significance of contagion is fairly limited.

This special feature analyses the risk of cross-border contagion for large European banks. Given the innovative nature of the empirical approach, the results presented in the article should be interpreted with a high degree of caution. The main objective of the article is to draw attention to a potentially highly relevant financial stability issue, which so far may have been under-explored. The term "contagion risk" in this article refers to the transmission of an idiosyncratic shock affecting a bank or possibly a set of banks, and its transmission to other banks. The latter could take place through the interbank market, payment systems, contagious bank runs or asset markets.[1] Defined in this way, contagion is a subset of a broader concept of systemic crisis. Analytically, therefore, the identification of contagion crucially depends upon empirically distinguishing between a common shock that affects more than one bank, and contagion per se. From a policy perspective, the difference is very important as the policy reaction to the failure of a single large bank requires a rapid assessment of its systemic importance.

More specifically, the analysis focuses on the spillover effects of very large shocks among EU banks in the absence of a large-scale systemic crisis.[2] The approach identifies contagion among banks using large shocks to banks' distance-to-default. The distance-to-default represents the number of asset value standard deviations away from the default point. The default point is defined as the point at which the value of the bank is precisely equal to the value of its liabilities (i.e. its equity is zero). It has been shown that the distance-to-default is a complete and unbiased predictor of bank fragility and seems to align well with the objectives of supervisors.[3] The advantage of using a market-based indicator to measure contagion is that there is no need to take a specific view on the channel of contagion.

A large shock is defined as a shock putting the bank in question in the lower 95th percentile of the distribution of the weekly first differenced distance-to-default. This is somewhat arbitrary but it reflects a compromise between focusing on large shocks and maintaining sufficient sample sizes to conduct empirical estimation. In the next step, the number of banks that were simultaneously in the tail is counted. This is labelled "coexceedances" in the literature.[4] The

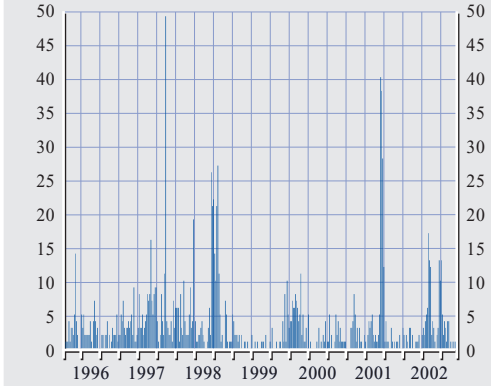
1 Contagion among banks via the interbank market may arise from unforeseen liquidity shocks (see, for instance, Allen, F. and D. Gale (2000), *"Financial Contagion"*, Journal of Political Economy 108 (1), pp. 1-33; Freixas, X., B. Parigi and J. C. Rochet (2000), *"Systemic Risk, Interbank Relations and Liquidity Provision by the Central Bank"*, Journal of Money, Credit, and Banking 32 (3/2), pp. 611-40) or from credit risk in the interbank market, namely deposits at other banks not being repaid (see, for instance, Furfine, C. H. (2003), *"Interbank Exposures: Quantifying the Risk of Contagion"*, Journal of Money, Credit and Banking 35 (1), pp. 111-28, Upper, C. and A. Worms (2002), *"Estimating Bilateral Exposures in the German Interbank Market: Is There a Danger of Contagion?"*, Deutsche Bundesbank Discussion Paper No 9; Degryse, H. and G. Nguyen (2004), *"Interbank exposures: An Empirical Estimation of Systemic Risk in the Belgian Banking Sector"*, paper presented at the ECB/CFS Symposium on *"Capital Markets and Financial Integration in Europe"*, May).

2 The article is largely based on results reported in Gropp, R. and G. Moermann (2004), *"Measurement of Contagion in Bank Equity Prices"*, Journal of International Money and Finance 23, pp. 405-59; and Gropp, R. and J. Vesala (2004), *"Bank Contagion in Europe"*, paper presented at the ECB/CFS Symposium on *"Capital Markets and Financial Integration in Europe"*, May.

3 See Gropp, R., J. Vesala and G. Vulpes (2004), *"Equity and Bond Market Signals as Leading Indicators of Bank Fragility"*, forthcoming: Journal of Money, Credit and Banking; and Gropp, R., J. Vesala and G. Vulpes (2004), *"Market Indicators, Bank Fragility and Indirect Market Discipline"*, Policy Review 10 (2), Federal Reserve Bank of New York, September, pp. 53-62.

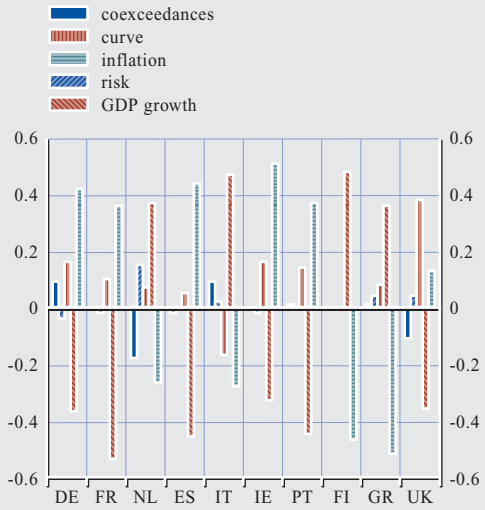
4 See Gropp and Moerman (2004), op. cit.

Chart A.1 Weekly number of coexceedances (banks in the 95th percentile)



Source: ECB.

Chart A.2 Correlation of the underlying variables with common factors (factor loadings), domestic factor 1



Source: ECB.

sample consists of 67 major European banks, of which 51 are from euro area countries.

The number of coexceedances can be interpreted as a simple measure of the degree of systemic risk during a given week (see Chart A.1).[5] Two spikes stand out: one during the first two weeks of October 1998 (Russia's default/the LTCM crisis) and the second during the week of September 11 (the day of the terror attacks on the US). Both reflected common disturbances in the financial system, rather than contagion. The chart highlights the fact that the number of coexceedances can be interpreted as an indicator of the degree of systemic risk; it also underlines the need to control for common factors to properly identify contagion.

IDENTIFYING SOURCES OF COMMON SHOCKS

A large number of variables could potentially be related to measuring common shocks across banks. Faced with this problem (and the need to be parsimonious in the estimations), a factor model was constructed to extract common components between the number of coexceedances in a country, industry sector shocks that could affect the credit portfolios of more than one bank, and standard macroeconomic variables (see Box A.1). In all, two domestic and one euro area factor were used in the estimation. This procedure provides explanatory variables which should capture the correlation of the coexceedances with common shocks and thus ultimately allow for the identification of banks' tail events that are due to contagion.

Charts A.2-A.4 show the correlations of the underlying variables with the common factors (factor loadings). The first factor seems to represent overall macroeconomic conditions, as there is a high correlation of this factor with GDP growth and inflation, and a rather high correlation with the steepness of the yield curve. Conversely, correlations between the industry risk measure and coexceedances is typically

5 Data in Chart A.1 correspond closely to the idea of "assets at risk" as a financial fragility indicator, as sketched in Gropp, R. (2004), *"Bank Market Discipline and Indicators of Banking System Risk: The European Evidence"*, in: Borio et al., Market Discipline across Countries and Industries, MIT Press, Cambridge, pp. 101-17. However, it should be noted that there the measure was the share of assets at or below a certain level of the distance-to-default.

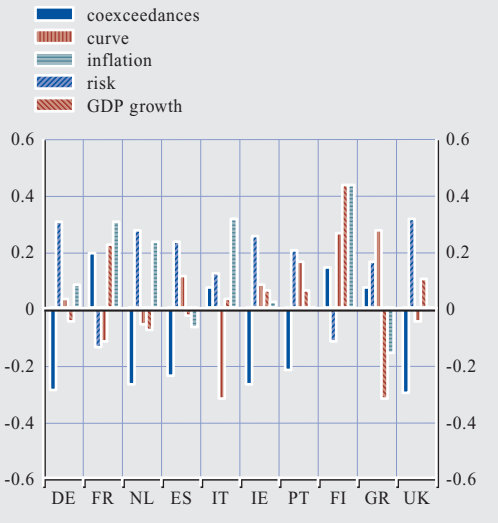
Box A.1 Methodology

The estimation procedure underlying the results reported in this special topic is detailed in Gropp and Vesala (2004 op. cit.). A two-step procedure was used. In the first stage, the common variance of coexceedances, sector risk, inflation rates, GDP growth rates and the steepness of the yield curve was extracted for each country, using standard factor models. Generally two factors were retained for each country, which tended to account for close to 100% of the common variance. The same approach was then used to extract the common variance between the (national) coexceedances, euro area GDP, euro area inflation rates, the euro area yield curve and euro area sectoral risk to obtain one euro area factor. In the second stage, given that the dependent variable is discrete, an ordered logit model was estimated. The model explains the number of banks in the tail simultaneously (i.e. the coexceedances) in one country, with the two domestic factors, the euro area factor, common factors for the corresponding other country, and the number of coexceedances lagged by one period in the other country. Furthermore, in order to ascertain the effect of being part of the common currency and sharing an interbank market, contagion variables were also split into pre and post-euro variables.

low. The second factor seems to represent the common credit risk components stemming from industry sector conditions and the co-movement in coexceedances. Only in a few countries does the second factor also correlate significantly with the macro variables. Finally, the euro area factor seems to capture the co-movement across all variables.

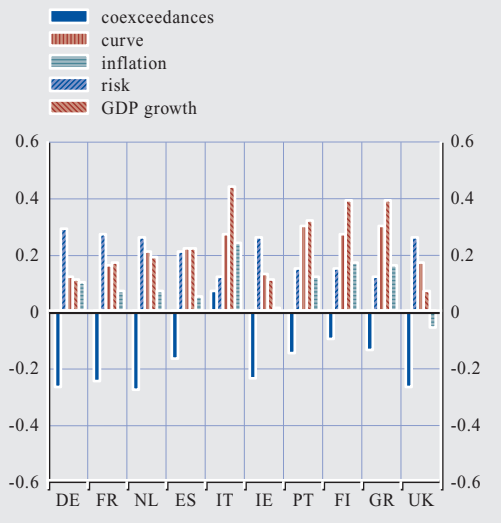
Given that common factors explaining banking fragility have been identified, the next step is to analyse whether the number of banks experiencing large shocks in another country adds explanatory power. Hence, in addition to the common factors, the number of coexceedances in one country (lagged by one period) were included. It should be noted that the direction of contagion can be identified, i.e. whether it is

Chart A.3 Correlation of the underlying variables with common factors (factor loadings), domestic factor 2



Source: ECB.

Chart A.4 Correlation of the underlying variables with common factors (factor loadings), euro area factor



Source: ECB.

stronger from country A to country B and vice versa, not just its presence.

CONTAGION RISK AMONG MAJOR EU COUNTRY BANKING SYSTEMS

The results suggest that coexceedances (widespread bank fragility) result from common shocks and contagion. The domestic common factors and the euro area factor are generally very important in explaining banking fragility. It is found that quite often the foreign common factors are also important in explaining coexceedances and, hence, domestic banking fragility. One possible interpretation is that banks are directly exposed not only to domestic and European conditions, but also to specific conditions in other European countries, e.g. by way of subsidiaries or branches.

Even though the model using only common factors tends to explain a very high proportion of coexceedances (R^2 in excess of 0.5), the contagion variable also tends to be highly statistically significant among most large EU countries. For the entire sample period (1996-2003) there is evidence of strong contagion risk between the major EU countries. In contrast, when considering contagion to and from smaller countries of the EU, essentially no contagion risk was found. A number of interpretations for this finding are possible. First, as these countries are small, their banks may be simply not large enough to lead to contagion in other countries, although this explanation would suggest that there should be contagion from large countries to smaller countries, which is not the case. Second, the interbank exposure of banks in these countries may be much lower than in other banks in the EU. It seems likely that the finding is explained by a combination of both of these factors.

The patterns of contagion risk were examined also for the period before and after the introduction of the common currency. Some increase in contagion risk after the introduction of the euro was found. Contagion links across large countries in particular seemed to become stronger in the post-euro period, and the estimates for the entire sample period seem to be dominated by post-euro contagion risk. However, it would be premature to attribute the increase in contagion risk to the introduction of the common currency for two reasons. First, a complementary study using multivariate extreme value theory suggests that contagion risk may have increased well before the introduction of the euro (around 1995-97) and may have increased in the US banking system as well.[6] Second, contagion risk from the UK also increased in the post-euro period (but not contagion to the UK from euro area banking systems) and, hence, it is difficult to attribute the increase in contagion solely to the integration of euro area money markets.

All of these conclusions are based on conditional probabilities, meaning that the likelihood of this occurring is extremely low. Nevertheless, it can be concluded that, given a sizeable shock to the banking sector of a large EU country, the consequences may very well be felt in the in other EU countries. In addition, the non-linearity of the conditional probability curves suggests that the severity of contagion risk increases rapidly and disproportionally when the number of foreign banks experiencing simultaneous shocks increases.

Banks' exposures to each other in the interbank money market can be a major (although certainly not the only) channel for the spread of contagion. Overall there is significant correlation between the importance of the particular interbank asset or liability linkages by country pairs (according to ECB data) and the estimated contagion risk. However, the results far from exclude other reasons for the identified patterns of contagion, and it would be incorrect to conclude that interbank exposures are the only relevant source of contagion. For example, banks' exposure to financial centres (i.e. Frankfurt or London) and to financial markets more generally may be an

6 Hartmann, P., S. Straetmans and C. de Vries (2004), *"Banking System Stability: A Cross-Atlantic Perspective"*, paper prepared for the NBER conference on "Risks to Financial Institutions and to the Financial Sector", Woodstock, VT, 20-21 October.

additional important channel for the spread of shocks among banks.

CONCLUSION

In this special feature, cross-border contagion risk in Europe was analysed by modelling banks' default risk using the stock market-based distance-to-default, with large changes in this measure reflecting major shocks in banks' financial condition. It is argued that contagion risk can be identified when the incidence of such tail events is significantly influenced by a lagged measure of coexceedances of banks from another country. To distinguish between common shocks affecting more than one bank and contagion, a factor model was used to extract common factors between coexceedances, sector risk and macro variables.

Overall, the evidence supports the existence of some cross-border contagion risk among the large EU countries. Cross-border contagion was found to be a significant and economically relevant factor in explaining bank fragility, controlling for macroeconomic and other factors. Given the caveat that the results are based on a new empirical methodology and, hence, should be further scrutinised, they tend to suggest an important pan-European dimension in the monitoring of systemic risk.