Endogenous financial risk : The seventh international conference of the NBB

H. Dewachter
G. de Walque
M. Emiris
P. Ilbas
J. Mitchell
R. Wouters

Introduction and motivation

Systemic risk has been an important topic of research and discussion among economists since the outbreak of the crisis. It arises when seemingly rational behaviour by individual agents can lead to system-wide imbalances building up over time and eventually causing a break-down of the whole system leading to significant levels of instability and costs at the macro-level. In the context of developed economies, the financial system and practices constitute an important source of systemic risk ; endogenous risk-taking behaviour by financial institutions affects other – interconnected – institutions. Given the close connection between the financial system and the real economy, these externalities in turn spill over to the rest of the economy causing large decreases in output, employment and welfare throughout the globe, as we have been experiencing since mid-2007.

With the current crisis, regulatory authorities have come to realise that endogenous risk-taking behaviour by financial institutions causes a market failure that can imply huge costs to society. Such costs were insufficiently taken into account in the pre-crisis regulatory and supervision framework for financial institutions, such as Basel II, which was primarily focused on the micro-level. That is why policy proposals now aim to internalise the costs caused by such systemic externalities. These proposals, as set out in the Basel III regulation, for example, aim to regulate financial institutions at the broader macro-level. This new regulatory framework for macro-prudential policy comes with new challenges for policymakers. By organising its seventh biennial conference around the theme "Endogenous financial risk", held in Brussels on October 11 and 12, 2012, the Bank's aim was to contribute to the discussions and progress in facing these challenges.

The first challenge that policymakers face concerns the operationalisation and implementation of the regulatory framework. In particular, the operational aspect of the macro-prudential regulation involves detecting potential risks to future systemic instability. This requires knowledge about the nature of systemic risk and how to best measure it. Although a reasonable set of indicators for detecting risks to systemic stability have already been proposed, there is limited practical experience with them and further empirical testing is needed in order to gain more confidence in the reliability of the alternative measures. The first session, with the keynote speech by G. Bekaert, and two papers from the second session of the conference deal particularly with this concern regarding measurement of systemic risk.

However, even if the workings of the complex interconnected financial system are well understood, we need to gain insight into the effectiveness of the tools used to address it. What are the appropriate prudential instruments and how will they affect the financial system and the real economy ? Some of these tools are capital-based, such as countercyclical buffers and dynamic provisions, others are liquidity-based and will adjust liquidity requirements countercyclically, while a third group of instruments such

as loan-to-value and debt-to-income ratios are asset-based. Use of these instruments is a complex issue. Let's take the example of capital-based tools. When the capital position of the bank becomes an important determinant of the amount of funds that a bank can raise from investors (such as depositors and other banks), a bank capital channel arises that operates on the supply side of credit. This channel can arise endogenously due to asymmetric information between banks and investors, in which case banks are required to invest part of their own capital in addition to obtained funds in issuing loans, or by the introduction of explicit exogenous regulatory requirements, which affect the total amount available for lending. Capital regulation can then be regarded as a tool of macroprudential policy interacting with the endogenous bank capital channel. It therefore remains a challenge to understand this interaction, and how countercyclical capital buffers affect the market-determined implications of endogenous changes in bank capital, in order to develop an appropriate set of policy tools for intervention without causing too much disruption in the efficiency of the credit markets and the financial system as a whole. The paper on the Spanish dynamic provisioning experiments presented in the second session deals with this aspect of macroprudential policy in more detail.

The next challenge is of an analytical nature. The economic models currently used for policy analysis do not necessarily capture all relevant dimensions of systemic risk. In the period prior to the crisis, the majority of the models attributed only a minor role to financial frictions, making it a very difficult task to foresee or even understand the impact on and the transmission to the macroeconomy of the recent financial crisis. Although significant progress has been made since then in developing suitable models for macroprudential analysis and macro-stress testing, most models still fall short of capturing the interactions between all relevant actors in credit markets and the interlinkage between financial stability and the real economy. In addition, standard macroeconomic models are often linearised, while risks to systemic stability involve non-linearities which cannot be assumed away if we need a credible representation of the workings of the financial sector. The keynote speeches by Frank Smets and Yuliy Sannikov and the papers presented in the third session of the conference address some aspects of these modelling challenges.

A final challenge faced by policymakers concerns the desirability and the degree of coordination between macroprudential supervision and other areas in public policy, such as monetary and fiscal policy. Regarding the implications for monetary policy, some advocate significant modifications to the standard inflation targeting framework in order to assign an active role to monetary policy to safeguard financial stability. Others argue that the inflation targeting framework as such should be subjected to minor changes and that the financial stability goal should be addressed with separate prudential policies, using separate tools. The tendency to have central banks more involved in financial stability issues and supervision implies that the outcome of this discussion also has implications for the internal organisation of central banks and how they cope with these two tasks. An additional question in the euro area set-up is at what level macroprudential policy is best conducted. While the existence of common macro-financial factors argues in favour of setting macroprudential policy at area-wide level, conducting such policy at the national level could be seen as a means to cope with idiosyncratic developments at country level. A possible solution to this issue could lie in introducing two layers for setting macroprudential policy, something which should be feasible in view of the set-up of the proposed Single Supervisory Mechanism. As far as fiscal policy is concerned, the European sovereign debt crisis has taught us that there is a strong and complex interconnection between the stability of the financial system and sovereign debt. Macroprudential policy will therefore be affected by fiscal policies conducted in national economies, and vice versa. Setting up a framework that allows for the most effective degree of coordination is therefore crucial in order to restrict the social costs arising from possibly conflicting objectives of these different policies. The discussion during the panel session that closed the conference was based on some of these operational and institutional implications.

In the following sections, a general overview of the main conclusions and findings resulting from the presentations and the discussions during the conference is provided.

1. Systemic risk : Measurement, dynamics and interaction with monetary policy

The key challenges for the macroprudential authorities turn out to be how to identify the systemically important financial institutions and how to measure interconnectedness in the absence of sufficiently granular data on financial exposure and interconnectedness at the individual bank level. Two papers presented at the conference analyse ways of circumventing this lack of information by relying on the public information conveyed by stock market prices in order to build indicators and tools, helpful for the regulators. The contributions of Boudt, Daníelsson, Koopman and Lucas (2012) and Castro and Ferrari (2012) focus both on the empirical question of how to measure systemic/endogenous risk using stock market data from individual financial institutions. They evaluate to what

extent correlation and volatility among these individual stock prices can serve as useful instruments in measuring and assessing systemic risk.

The Boudt et al. (2012) contribution points out that a good statistical model is necessary to understand and identify the joint dynamics of the banking stock prices. They especially emphasise that the volatility in the financial market series is not only time-varying but also subject to regime switches. Even though this is supported by ample theoretical and empirical evidence, standard non-switching volatility models, of the GARCH[1] type, are still widely used in practice. Therefore such models are likely to be misleading when an accurate volatility forecast is of the most importance, i.e. at the time of a transition from a low risk to a high risk regime. The ambition of the project is to propose an econometric model allowing for regime switches in volatility and correlation in order to improve the prediction regarding these two essential features of financial assets. For this, the model needs first to assess correctly volatility and correlation within a regime, and second to forecast changes in regime.

The assumptions regarding the form of the distribution are essential for the volatility dynamics. Indeed, extreme (positive/negative) returns are a stronger signal of a volatility increase under the normal distribution than under a fat-tailed distribution. In order to take this into account, the authors consider that the within–regime dynamics in volatility and correlation are driven by the score of the conditional density function, as in Haas et al. (2004). As a result, the volatility/correlation impact of extreme returns is downweighted under a fat-tailed distribution. In order to model and forecast regime switching probabilities, they make use of macro-financial state variables like the VIX, the TED spread or the St. Louis Financial Stability Index.

The model is applied to weekly stock returns of the major US deposit bank holding companies from 1994 to 2011. The best model identified is a two-regime equicorrelation model with switching probabilities driven by the VIX and a negligible time-varying correlation in the low correlation regime. Interestingly, while state variables have generally not been found useful in forecasting volatility, they do significantly predict regime switching probabilities. However, in the discussion following the presentation, it was pointed that it would be helpful for the reader to obtain more details on the econometric estimation on this point of the study. Indeed, the relationship between the probability of being in the high correlation regime and the financial stress indicators is not graphically obvious when looking at Figures 5 and 6 in their paper.

(1) Generalized autoregressive conditional heteroskedasticity.

The approach of Castro and Ferrari (2012) is rather different, even though using the same primary information, i.e. banks' stock market returns. Their goal is to identify, in a statistically precise manner, which banks should be considered as systemically important financial institutions. The systemic importance of a financial institution can be determined using co-risk measures that consider the increase in the risk of the financial system when a given financial institution faces distress. The paper focuses more particularly on the ΔCoVaR measure, developed in a pioneering paper by Adrian and Brunnermeier (2011). This co-risk measure is computed as the difference between conditional and unconditional value-at-risk (VaR). The unconditional VaR is computed from the distribution of stock returns of either a financial index (if assessing systemic importance) or a specific financial institution (if assessing bilateral risk transmission). The conditional VaR is computed as the VaR for the same distribution of stock returns as considered for the unconditional VaR, but now conditional on the stock return of the financial institution assessed as systemically important and beingin distress (i.e. at its VaR level).

The ΔCoVaR method has already been extensively applied as a tool for identifying/ranking systemically important institutions and assessing interconnections between institutions. However, the paper argues that there is still a need to develop testing methods which would allow assessing the absolute and relative significance of this measure. The authors make a useful contribution in this direction by establishing a methodology to compute :

– a test of significance, based on estimated risk contribution, that helps determine whether or not a financial institution is systemic ;
– a dominance test, allowing an ordinal ranking of financial institutions according to their systemic importance as measured by their ΔCoVaR.

After deriving the statistical tests the authors run Monte-Carlo experiments which indicate that the tests developed perform moderately well for the number of observations usually available for financial daily data. The authors then apply their testing procedures to a sample of 26 European banks, using daily data from October 1993 to March 2012. The banks' returns are regressed on a set of common factors (STOXX Europe 600 Basic Material index and Industrial index, together with the VIX index). Residuals from these estimations are then used to estimate ΔCoVaRs in a second stage. A first set of outcomes is displayed in Table 1 below. When ranked according to their ΔCoVaR measure, nine of the banks in the first half of the ranking have a statistically significant systemic risk contribution, compared to only three in the second half. This shows that a higher ΔCoVaR does not necessarily imply significant systemic risk contribution, and that point estimates are misleading. Furthermore,

TABLE 1 RANKING OF BANKS IN TERMS OF THEIR IMPACT ON THE MARKET

	Bank	$\Delta CoVaR$	Dom
1	ING Groep	6.25*	13
2	Banco Santander	5.83*	1
3	Credit Suisse Groupe	5.64*	2
4	Société Générale	5.54	1
5	HSBC Holding	5.51*	1
6	Deutsche Bank	5.46*	1
7	BBVA	5.35*	1
8	BNP Paribas	5.24*	1
9	Unicredit	4.99	1
10	UBS	4.97*	2
11	KBC Groep	4.85*	0
12	Intesa Sanpaolo	4.75	0
13	Commerzbank	4.61	1
14	Standard Chartered	4.21	0
15	Banco Popular Español	4.14	0
16	Danske Bank	4.06	0
17	Bank of Ireland	3.89	0
18	Svenska Handelsbanken	3.84	0
19	RBS Group	3.79*	1
20	National Bank of Greece	3.63*	0
21	Barclays	3.53*	1
22	Natixis	3.46	0
23	BCP-Millenium	3.23	0
24	Landesbank Berlin-LBB	2.79	0
25	Allied Irish Banks	2.55	0
26	Banco Español de Credito	2.40	0

Sources: Castro and Ferrari (2012).

Notes: $\Delta CoVaR$ is the impact of the bank in question on the market index, as measured by $\Delta CoVaR^{index\ i}(\tau)$ with $\tau = 0.95$ and $\tau_{}i = 0.99$. The values of $\Delta CoVaR$ of the banks for which the systemic risk contribution is statistically significant for $\tau = [0.90, 0.99]$ are marked with an asterisk. The columns with header "dom" indicate the number of other banks in the sample whose systemic risk contribution is stochastically dominated by the one of the banks in question for $\tau = [0.90, 0.99]$.

size is a poor proxy as some relatively small banks are ultimately found to be systemically important while other large ones are not. Note that the last feature seems to be inherent to co-risk measures based on market prices.

After this "absolute" ranking, authors investigate whether the systemic risk contribution of the financial institutions with a ΔCoVaR significantly different from zero is indeed larger than that of the institutions for which it is not. For this, they apply their dominance test to all the pairs of banks in the sample. The result is displayed in Table 1 (columns "dom") and 2:

- one bank is shown to statistically dominate thirteen others, and twelve other banks only statistically dominate one or two other banks (Table 1);
- out of 325 pairs of banks (i.e. $\sum_{i=1}^{26-1} i$), there are 55 where both banks have a significant systemic risk contribution and 105 where neither of the banks has a significant contribution;
- for only 27 pairs of banks out of the 325, one bank's systemic risk contribution is found to statistically dominate the other. Among these, 20 are banks with a significant systemic risk contribution dominating banks with an insignificant systemic risk contribution; in 4 cases, both banks have a significant systemic risk contribution and in the 3 remaining cases, neither has a significant systemic risk contribution.

Noticeably in this application, it never happens that a bank with an insignificant systemic risk contribution dominates another with a significant systemic risk contribution. From this observation, one could argue in favour of stronger control of all the banks with a significant systemic risk contribution. However, among the 165 pairs involving a bank with a significant systemic contribution and a bank with a non-significant systemic contribution, there is only a very small minority (20) of pairs in which a bank with a significant systemic contribution actually statistically dominates a bank with an insignificant systemic risk contribution. This raises the importance of taking into account pairwise dominance tests, which would allow restricting the number of institutions under particular supervision. However, very few banks can be ranked according to their ΔCoVaR, and the potential inability of this measure to rank financial institutions according to their systemic risk contributions could be viewed as a major limitation of the usefulness of this co-risk measure for macro prudential policy purposes. A key message raised during the discussion following the presentation is that the regulator should consider estimation errors as an additional source of risk, and take a conservative stance in order not to underestimate the systemic importance of a financial

TABLE 2 DOMINANCE TEST RESULTS

Variable	Bank pairs with dominance	Total bank pairs
Total	**27**	**325**
significant dominates significant	4	55
significant dominates insignificant	20	165
insignificant dominates significant	0	
insignificant dominates insignificant	3	105

Sources: Castro and Ferrari (2012).

Notes: The reference to "(in)significant" in the first column refers to banks for which the systemic risk contribution in Table 1 is statistically (not) significant for $\tau = [0.90, 0.99]$

institution. It was also suggested that the ΔCoVaR measures and tests related to ING and KBC could be biased by the fact that these institutions have a large insurance activity.

Finally, the paper proposes a mapping of the banks' interconnections, computing the ΔCoVaR not for the financial market anymore, but for each of the particular financial institutions with respect to each of the others: out of the 650 possible linkages (i.e. $2.\sum_{i=1}^{26-1} i$), only 150 are statistically relevant. This allows to substantially narrow down the linkages that have to be analysed in greater detail. Therefore, testing for the significance of estimated ΔCoVaR affects the picture of the bank network by greatly simplifying it.

In a somewhat different philosophy, Bekaert, Hoereva and Lo Duca (2012) focus on the VIX "fear index" as a way to measure the perception of risk by the market and try to see how monetary policy authorities and the real economy interact with this perception of risk. The study starts with the observation that the VIX index closely parallels the monetary policy stance. Bekaert et al. (2012) decompose the implied volatility of the VIX into risk aversion on the one hand and uncertainty on the other hand. These two variables are then introduced into a structural VAR analysis together with business cycle data, prices and monetary policy.

Increases in uncertainty affect industrial production in a negative way. The same finding applies to increases in risk aversion, but here the effect is not significant. The converse is not true and real supply shocks affect neither the degree of uncertainty nor the risk aversion as extracted from the VIX index. This confirms previous results obtained by Bloom et al. (2009) but seems at odds with the result obtained by Popescu and Smets (2010) for Germany, that risk aversion is more important than uncertainty in driving business cycles. Finally, the authors find that risk aversion is a good predictor of uncertainty.

Finally and more importantly, Bekaert et al. (2012) provide an empirical validation of the Rajan (2006) conjecture that a lax monetary policy leads to a decrease in risk aversion, leading to risky, correlated investments. Uncertainty reacts in the same direction but in a weaker manner. Conversely, high degrees of risk aversion and uncertainty seem to lead to a laxer monetary policy in the short term, but this reaction is not statistically significant. This result challenges Bernanke's view (Bernanke and Kuttner, 2005) that monetary policy would not have a sufficiently strong effect on stock markets to inflate a bubble. On the other hand it also shows that in periods of crisis, monetary policy can influence risk aversion and uncertainty on the markets, and through this bias affect the real economy.

2. Financial intermediation and endogenous risk

The papers in the second session built an empirical characterisation of excessive correlations in different segments of the international financial markets during the crisis. Baele, Bekaert and Inghelbrecht (2012) focused on strong negative stock bond-return correlations or "flight-to-safety" episodes and showed that flight-to-safety periods have also been accompanied by significant macroeconomic effects. De Bruyckere, Gerhardt-Schepens and Vander Vennet (2012) documented bank-sovereign spill-overs in the premia of credit default swaps (CDS) and showed that, to a large extent, the bank-sovereign spill-over in bond markets could be explained on the basis of both bank- and country-specific fundamentals. Finally, Jimenez, Ongena, Peydro and Saurina (2012) take profit of the spanish experimentation regarding dynamic provisioning to assess its effects on credit supply to firms.

Baele, Bekaert and Inghelbrecht (2012) used daily data on stock (total market indices in local currency) and bond (10-year benchmark government bonds) returns over the period 1980-2012 to construct different measures of flight-to-safety (FTS): a set of individual FTS indicators, which takes the value of 1 on days with both an extreme negative stock return and an extreme positive bond return; an ordinal FTS index built from the individual FTS indicators; and a univariate regime-switching FTS model for the difference between bond and stock returns. In this last model, there are three regimes, one high volatility regime, one low volatility regime and one FTS regime, defined as the regime which has the highest (positive) mean of the three. The regime variable follows a Markov Chain with constant transition probabilities.

These measures showed that all well-known global crises, such as the October 1987 crash, the 1997 Asian crisis, the Russian crisis, and LTCM debacle in 1998, and more recently, the Lehman Brothers collapse and several spells during the European sovereign debt crisis were also FTS episodes. During these episodes, bond returns exceeded equity returns by 2 to 3 percent on average.

Furthermore, Baele et.al (2012) showed that, during this period (1980-2012), FTS episodes were not very frequent, comprising less than 5 % of the sample, while FTS episodes remained mainly country-specific. Large developed countries such as the US, the UK and Germany featured a relatively low proportion of global spells, suggesting they were more subject to idiosyncratic flights-to-safety.

TABLE 3 COMOVEMENT OF FLIGHT-TO-SAFETY WITH FINANCIAL/ECONOMIC VARIABLES

	United States	Germany	United Kingdom	Sign
VIX	2.881***	1.704***	1.482***	22
Michigan consumer sentiment	–0.038***	–0.045***	–0.037***	8
IFO Business Climate	–0.026***	–0.028***	–0.022***	22
OECD consumer confidence	–0.004***	–0.003***	–0.002***	19
Swiss Franc	0.044	0.167***	0.213***	19
Japanese Yen	0.169***	0.298***	0.386***	21
S&P GSCI benchmark commodity index, Industrial Metals	–0.813***	–0.934***	–0.876***	23
S&P GSCI commodity sub-index, Crude Oil	–1.038***	–0.851***	–0.902***	23
S&P GSCI commodity sub-index, Gold	0.119***	0.042	–0.002	4
Inflation	–1.270***	–0.908***	–0.801***	19
GDP growth	–2.038***	–2.781***	–1.364***	20
OECD leading indicator	–0.944***	–0.714***	–0.351***	17

Sources: Baele, Bekaert, Inghelbrecht and Wei (2012).

Note: The table reports regression coefficients from a regression of the variables in the first column on the average FTS indicator. For more details, we refer the reader to Tables 9, 12 and 13 in Baele, Bekaert, Inghelbrecht and Wei (2012). A (***) represents statistical significance at the 1 % level. The last column shows the number of countries for which the parameter estimates are significant at the 5 % level.

Having shown the presence of flight-to-safety in bond and stock markets, Baele et al. (2012) explored the nature and the drivers of the flight-to-safety episodes by establishing links between the FTS measures and a set of macroeconomic variables: risk aversion, uncertainty, stock and bond portfolio returns, commodity prices, exchange rates, economic real variables, such as inflation and GDP growth. Some of the results are summarised in Table 3 below which reports regression coefficients from a regression of these variables on the average FTS indicator.

The main findings indicate that FTS episodes coincided with increases in market uncertainty and investors' risk aversion as well as decreases in consumer sentiment indicators in the US, Germany and the OECD. FTS episodes were also associated with an appreciation of the yen and the Swiss franc, a decrease in most commodity prices (such as oil and copper) and a slight increase in the gold price. Both economic growth and inflation declined right after, and up to a year following, an FTS spell.

Two other market segments that have been increasingly interconnected since the beginning of the crisis are credit default swaps (CDS) for banks and sovereigns, signalling spillovers between sovereign and credit default risk. The second contribution in this session (De Bruyckere, Gerhardt-Schepens and Vander Vennet, 2012) examined the drivers of contagion between CDS spreads for banks and sovereigns and shed some light on the different sovereign/credit risk transmission channels. The empirical application used data from 15 countries and 50 banks for the period 2006 to 2011.

From a theoretical perspective, the BIS (2012) has identified four channels for the transmission of sovereign risk to the credit risk of financial institutions. First, there is an asset holdings channel: sovereign risk is transmitted to the asset side of banks' balance sheets through their sovereign debt exposure. Banks' balance sheets may be weakened through losses on holdings of sovereign debt (Angeloni and Wolff, 2012). Second, there is a the collateral channel. Sovereign risk can spread to banks when the value of collateral that banks hold in sovereign debt is reduced (shocks in one market can affect collateral values or cash flows of securities in other markets, see Kiyotaki and Moore, 2005, and Kaminsky, Reinhart and Vegh, 2003). Third, there is the rating channel, as downgrades of sovereigns may impact the ratings of domestic banks and their funding costs. Finally, there is the guarantee channel (Demirguc-Kunt and Huizinga, 2011): market valuation may reflect the fear that a systemically important bank that is distressed may become "too-big-to-save" if its home country runs a large public deficit.

To define contagion between the spreads on credit default swaps for banks and sovereigns, the paper used

TABLE 4 EXCESS CORRELATIONS – IMPACT OF COUNTRY CHARACTERISTICS

Variables	(1)	(2)
Home Dummy	2.884***	–
Debt-to-GDP	1.144***	0.911***
Government Revenues	–0.159	1.422***
Bank Sector Size	–0.0174	0.442
Economic Sentiment	1.564***	0.962
EBA Exposure	–	0.0934***
Constant	17.13***	16.82***
R^2	0.668	0.563

Sources: De Bruyckere, Gerhardt-Schepens and Vander Vennet (2012).
Note: The table reports regression coefficients from a regression of excess correlations on a home dummy, a set of country specific characteristics and bank-time fixed effects. In column (2) the home country dummy is replaced with a variable that contains EBA exposure data. All variables are standardised so that the coefficients represent the impact of a one standard deviation change in the variable. For more details and other results, we refer the reader to Table 10 in De Bruyckere, Gerhardt-Schepens and Vander Vennet (2012). A (***) represents statistical significance at the 1 % level.

the notion of "excess correlation", that is the correlation between banks and sovereigns "over and above" what is explained by common factors, such as market-wide credit risk, business climate changes in the European Union (captured by the total stock market index for the EU), an investor fear indicator or market sentiment (captured by the VSTOXX volatility index), and market expectations about future conditions in the financial market (measured by the term spread, the difference between the 10-year government bond yield for each country and the 1-year Euribor rate).

The first step was to investigate the presence of a home country effect by regressing the excess correlations on a dummy variable which indicated whether a country is the home country of the bank. The results showed that contagion between a bank and its home country was indeed stronger than between a bank and any other sovereign.

The second step was to explore the factors that could lie behind this result, be it a strong home bias in financial institutions' bond holding portfolio, higher bailout risk, or fiscal consolidation leading to lower economic activity in the short term (Avdjiev and Caruana, 2012). The paper investigated the possible causes of the home bias by regressing the bank-country excess correlations on a home dummy, a set of country-specific characteristics such as the exposure of banks' portfolios to sovereigns (as disclosed by the European Banking Authority), the debt-to-GDP ratio, government revenues, the bank sector size and economic sentiment. Table 4 shows the results of this regression. Bank-country contagion is more pronounced for countries with a higher debt-to-GDP ratio: for every standard deviation change in the debt ratio, the excess correlation increases by 1.14 percentage points. Higher debt ratios reduce the probability of a bailout in the banking sector and also lead to higher bank-level credit risk through the bond portfolios of financial institutions, which explains this positive and significant effect. The second column of the table provides evidence that EBA exposure of banks' bond portfolios proxies for the home-country effect.

In a next step, the paper analysed the impact of bank characteristics on contagion. Table 5 shows the results from a regression of country-bank excess correlations on a set of bank-specific characteristics and a home country/foreign country – time fixed effect in order to effectively compare the excess correlation of bank i at time t with country j to the correlation of another bank k – located in the same country as bank i – with country j at time t. Thus, the part of the variation that is left in the bank-country correlation can only be explained by differences in bank-specific characteristics.

The results indicate that banks with a weak capital and/or funding position are particularly vulnerable to risk spillovers. In particular, bank size, capital adequacy levels and funding structure have had a significant impact on bank-country contagion. For example, a one standard deviation increase in the Tier 1 capital ratio (i.e. a rise in Tier 1 capital of about 2.2 percentage points) leads to a decrease in country-bank excess correlations of about 1.11 percentage points. For the average bank in the sample, this means a reduction in excess correlation of almost 7 percent.

TABLE 5 EXCESS CORRELATIONS AND BANK CHARACTERISTICS

Variables	(1)
Size	1.441**
Tier 1 Ratio	–1.110*
Loan-to-Assets Ratio	–0.527
Funding Risk	1.802***
Income Diversification	0.109
Constant	17.38***
R^2	0.788

Sources: De Bruyckere, Gerhardt-Schepens and Vander Vennet (2012).
Note: The table reports regression coefficients from a regression of excess correlations on a set of bank-specific characteristics and a home country/foreign country – time fixed effect. All variables are standardised so that the coefficients represent the impact of a one standard deviation change in the variable. For more details and other results, we refer the reader to Table 8 in De Bruyckere, Gerhardt-Schepens and Vander Vennet (2012). (*), (***) represent statistical significance at the 10 and 1 % level.

Similarly, banks with a higher proportion of short-term debt in their total funding exhibit higher bank-country excess correlations. This confirms that banks with potentially volatile funding are more exposed to shocks in the quality of their assets, confirming the presence of the collateral channel. These findings stress the importance of adequate bank capital buffers for bank stability. Whereas previous studies showed a strong effect of bank capital on bank-specific risk indicators (see, e.g. Wheelock and Wilson (2000) and Altunbas, Manganelli, and Marques-Ibanez, 2011) the findings by De Bruyckere et al. (2012) suggest that adequate capital levels are also an important buffer against contagion. Similarly, where Demirguc-Kunt and Huizinga (2010) find that banks increase most of their short-term funding at cost of enhanced bank fragility, their findings point to the importance of stable funding as a feature in mitigating contagion.

The paper presented by Ongena (joint work with Jiménez, Peydró and Saurina) evaluates the impact of the Spanish dynamic provisioning system on the supply of credit to firms. Dynamic provisions are forward-looking provisions that oblige banks to build up buffers of own funds from retained earnings before individual credit losses are identified on specific loans. The introduction of this system in Spain in 2000:Q3, the modification in 2005:Q1 and the lowering of the floor of dynamic provision funds in 2008:Q4 provide three policy experiments that are very informative for analysing the impact of a countercyclical bank capital buffer system.

Countercyclical capital buffers are part of the new Basel III macroprudential regulatory framework. The objective of this instrument is twofold: first, boosting capital requirements in booms provides additional buffers in a downturn that help mitigate credit crunches, and second, higher requirements on own funds can limit credit-led booms because banks will internalise more of the potential social costs of credit defaults or charge higher loan rates due to the higher cost of bank capital. Countercyclical bank capital could therefore lessen the excessive procyclicality of credit.

The paper identifies the effect on the credit supply of banks by exploiting and combining information from various Spanish data sources: the credit register that comprises loan level data on outstanding business loan contracts, loan applications for non-current borrowers, and balance sheets of all banks collected by the supervisor. The impact on committed credit volumes (in terms of intensive and extensive margin), credit drawn, collateral and costs is considered, By combining this information with firms' balance sheets, they can also assess the impact on firm-level total assets, employment and survival. Depending on their credit portfolio, banks were affected differently by the three policy shocks, and together with firm-specific effects to control for demand effects, the paper can identify the impact of bank-specific balance-sheet shocks on credit availability.

The paper identifies significant effects of dynamic provisioning on credit supply. Banks that have to form relatively larger provisions make bigger cuts in committed credit to the same firm after the introduction of the system than before. These banks seem to tighten credit standards in general, as similar trends are observed for credit drawn, loan continuation, loan maturity and collateralisation. These effects on the behaviour of the individual banks are quantitatively important. However, when these additional provisions are introduced in times of good macroeconomic conditions, there are only short-run effects on the credit taken up by firms and there are no negative implications for firms' financing or performance. Under these macro conditions, firms do not seem to be hampered by the dynamic provisioning as they can switch between banks or towards other forms of credit. These results suggest that dynamic provisioning introduced at the right time can be a potent countercyclical bank capital tool with a minimal costs in terms of firms' performance. In contrast, relaxing the provisioning requirements in crisis times not only has a substantial impact on the supply of bank credit but also has severe effects on firms' access to credit, as switching from banks with low capital buffers to banks with large buffers may be difficult in such situations. Therefore, dynamic provisioning may yield strong positive real effects by mitigating the procyclicality of the credit cycle.

3. Endogenous risk and macroeconomic dynamics

Four theoretical contributions concerned macroeconomic models of endogenous risk and the specific role of financial intermediaries in generating this risk.

A common feature of all the models presented is that the bank capital ratio and the interbank exposure are important sources of endogenous risk. Being determinants of endogenous risk, these variables also become relevant from a macroeconomic perspective. Two general remarks can be made with respect to this type of models. First, there seems to be some convergence on the type of variables and mechanisms that need to be included in the future generation of dynamic macromodels. Second, the precise features that these models should embed, however, are not yet clear or robust, and owing to this lack of consensus, it is not possible at this stage to derive strong policy conclusions from these models.

Frank Smets presented a model featuring a non-trivial banking sector. Banks are heterogeneous with respect to their intermediation skills, and that gives rise to an interbank market. Moral hazard and asymmetric information on this market may generate sudden interbank market freezes, systemic banking crises, credit crunches and, ultimately, severe recessions. Simulations of a calibrated version of the model indicate that typical systemic banking crises break out in the midst of a credit boom generated by a sequence of positive supply shocks, rather than being the outcome of a big negative wealth shock. The model is able to link the procyclical credit cycle with a growing risk of systemic crisis because the balance sheet and credit growth increase the potential debt overhang risk when the economy starts to cool down. This work is supportive of the BIS view on the importance of credit cycles as a useful early warning signal and therefore also as an important variable for macro-prudential regulation. This BIS view was further elaborated by Claudio Borio during the panel discussion.

Robert Kollmann (and co-authors from the European Commission) studied the macroeconomic consequences of bank support programmes in the euro area using an estimated New Keynesian model with a banking sector. The model is used to analyse the effects of bank asset losses, government support for banks, and other fiscal stimulus measures. The findings suggest that support for banks had a stabilising effect on euro area output, consumption and investment. Increased government purchases helped to stabilise output, but crowded out consumption. Higher transfers to households had a positive impact on private consumption, but a negligible effect on output and investment. Banking shocks and increased government spending explain half of the rise in the public debt/GDP ratio since the onset of the crisis. During the discussion, one of the questions concerned the possibility of a key missing link that the paper might not have addressed: government support for the banks worsens the fiscal position, which leads to an increase in sovereign spreads that in turn affect lending rates, as in the case of Ireland and Spain. Hence, the two-way interaction between banking problems and sovereign debt problems might require additional attention in this framework.

The contribution by Hans Dewachter and Raf Wouters presents a practical macroeconomic modelling approach based on capital-constrained financial intermediaries, which allows to integrate financial risk premiums, credit supply effects and financial intermediaries' capital positions in a standard macro model. The model allows for identification of an important risk channel arising from the risk aversion of constrained intermediaries; when the capital constraints are most stringent, financial intermediaries acting as marginal investors in the capital market apply substantially higher risk premiums in evaluating asset prices. These depressed asset prices reduce the investment incentives and aggravate further the macroeconomic context. The risk channel contributes significantly to the overall financial and macroeconomic volatility. According to the discussant, the model is able to feature appropriate cyclicality of leverage and asset prices where risk is endogenous and plays a role in allocations. The proposed framework allows to analyse traditional monetary policy concerns about inflation and the output gap together with financial stability concerns, such as volatility, risk and financial sector ratio's.

Yuliy Sannikov presented joint work with Markus Brunnermeier, based on a sophisticated model on how systemic risk appears naturally in an economy where the financial sector is a necessary intermediary to channel funds from lower to higher productive allocations. Asset price correlations are high in downturns. In an environment of low exogenous risk, experts assume higher leverage, making the system more prone to systemic volatility spikes. Securitisation and derivatives contracts lead to better sharing of exogenous risk but higher endogenous systemic risk. Financial experts may impose a negative externality on each other and the economy by not maintaining adequate capital cushions. Financial moderation (long periods of low volatility), financial regulation (controlling one sector or one type of intermediation) and financial innovations can therefore have unexpected consequences that in the long run can give rise to a stimulating rather than a dampening effect on systemic risk. The main conclusion based on this work therefore is that policy interventions can make crisis episodes less likely, although many seemingly reasonable policies can harm welfare. Policies for crisis episodes alone, such as those aimed at recapitalising the financial system, can increase risk-taking incentives. More surprisingly, simple restrictions on leverage may do more harm than good, as they only take effect in downturns and may have little impact on behaviour in booms. Policies that encourage financial institutions to retain earnings longer in booms appear to be most effective. It is of crucial importance that a careful and exhaustive analysis of all possible consequences of specific policy measures is carried out before they are put into practice.

4. Panel discussion

The panel discussion on "central banking after the crisis" was concentrated on the policy implications of systemic risk and in particular on the policy responses to the current crisis. André Sapir (ULB) focused his intervention

on the implications of the current crisis for central bank independence. Since the high inflation experience in the seventies and eighties, the general belief is that central bank independence is an important element for a credible and efficient inflation-oriented monetary policy. However, the financial crisis has illustrated that under specific circumstances, cooperation between the central bank and the fiscal authority might be useful and necessary. This applies in particular when the central bank, in order to safeguard financial stability, is obliged to take actions that have, at least potentially, important fiscal implications. In extreme crisis situations, central banks might be forced to act as lender of last resort to their own sovereign. In the euro area, the situation was more complicated as the central bank was not facing one fiscal authority but was confronted with 17 authorities which complicated any coordination. The central bank was experiencing what Sapir called a problem of "loneliness". He was optimistic about solving this problem after the adoption of the Outright Monetary Transactions (OMT) programme by the ECB, including a conditional LOLR action vis-a-vis solvent states, together with the approval of the ESM fund as political body with which the central bank can cooperate. On the other hand, he did not see much progress for the problem of the debt overhang in the euro area and the related cost-sharing mechanism.

Frank Smets (ECB) reviewed the monetary policy actions undertaken by the ECB over the last five years to fight the financial crisis and the resulting euro area crisis. He illustrated the effectiveness of the various standard and non-conventional measures undertaken by the ECB by their implications for the CISS-index of financial stress in the euro area (see D. Hollo et al., 2012). Apparently, the non-conventional actions, like the LTRO programme, the SMP programme and the more recent OMT programme, that were decided at periods with peak levels in the CISS-indicator, have been effective in reducing the financial stress in the euro area. However, monetary policy cannot solve the fundamental underlying problems alone, and should be clearly conditional in order to avoid moral hazard reactions from the other policy makers that try to postpone or avoid difficult but necessary decisions. From a longer term perspective, he also underlined that the financial crisis and the resulting long lasting and costly recession have clearly illustrated the need for preventive action by monetary and macroprudential policy. Financial markets have not been able to deliver sufficient regulation on their own, and policy intervention has been necessary. Macroprudential policies should be activated during good times in order to avoid the building up of imbalances. These policies need to be much more symmetrical and act in a countercyclical way in both good and bad times.

Claudio Borio (BIS) stressed the importance of the financial cycle for the evaluation of the broader economic stance and for adjusting policy accordingly. He argued that, in the environment that has prevailed for at least three decades, it is not possible to understand business fluctuations and the corresponding analytical and policy challenges without understanding the financial cycle. Financial cycles moreover operate on a different time scale than business cycles with cycles beyond 8 years. This calls for a rethinking of modelling strategies and for significant adjustments to macroeconomic policies. He highlighted the stylised empirical features of the financial cycle, conjectured on what it may take to model it satisfactorily, and considered its policy implications. In the discussion of the policy implications, he stressed the importance of preventive actions during boom periods but recognised the limitations of these policy measures as well. During bust periods, crisis management and crisis resolution were also crucial to restore confidence and to repair balance sheets. Important steps in this process were a recognition of the full loss before recapitalisation could be effective, shoring up private balance sheets by debt relief programmes and recognising the limits of monetary policy to avoid unintended effects or distorting incentives. Policy makers should think and act on the basis of the medium term.

Finally, A. Farkas (EBA) concentrated his intervention on the role of prudential instruments from a micro and a macro perspective. From a microprudential perspective, capital requirements as a typical policy tool were used as passive instruments. On the other hand, from a macro perspective, a more dynamic and active perspective is needed to exploit the instruments as a preventive tool. Avoiding inconsistency between the use of these instruments for the various goals is therefore important. The active countercyclical management of these instruments should limit discretion, as market and political pressure during both good times and bad times may complicate the implementation of necessary countercyclical adjustments. Farkas stressed that the macroeconomic perspective in the current redesign of the European prudential policy framework should not be forgotten.

Mathias Dewatripont summarised the various contributions presented at the conference and the panel discussion by observing that there is now a relatively broad consensus on the diagnosis and the policy actions necessary to resolve the current crisis and to manage the problem of systemic risk in general. However, the implementation of the necessary policy action was not always as efficient and effective as one could expect. He noted that this "political economy" dimension of the problem had not been discussed in the conference and remains an important challenge for future research.

Bibliography

Papers presented during the 7th National Bank of Belgium International Conference on "Endogenous Financial Risk"

Baele L., G. Bekaert, K. Inghelbrecht and M. Wei (2012), *Flights to safety*, NBB Working Paper 230.

Bekaert G., M. Hoerova and M. Lo Luca (2012), *Risk, uncertainty and monetary policy*, NBB Working Paper 229.

Boissay F., F. Collard and F. Smets (2012), *Booms and systemic banking crises*. mimeo.

Boudt K., J. Daníelsson, S.J. Koopman and A. Lucas (2012), *Regime switches in volatility and correlation of financial institutions*, NBB Working Paper 227.

Brunnermeier M.K. and Y. Sannikov (2012), *A macroeconomic model with a financial sector*, NBB Working Paper 236.

Castro C. and S. Ferrari (2012), *Measuring and testing for the sytemically important financial institutions*, NBB Working Paper 228.

De Bruyckere V., M. Gerhardt, G. Schepens and R. Vander Vennet (2012), *Bank/sovereign risk spillovers in the European debt crisis*, NBB Working Paper 232.

Dewachter H. and R. Wouters (2012), *Endogenous risk in a DSGE model with capital-constrained financial intermediaries*, NBB Working Paper 235.

Jiménez G., S. Ongena, J.-L. Peydró and J. Saurina (2012), *Macroprudential policy, countercyclical bank capital and credit supply: Evidence from the Spanish dynamic provisioning eExperiments*, NBB Working Paper 231.

Kollmann R., M. Ratto, W. Roeger and J. in 't Veld (2012), *Fiscal policy, banks and the financial crisis*, NBB Working Paper 234.

All papers and presentations of the conference are available on the web site: http://www.nbb.be

Other papers cited in this conference summary

Adrian T. and M. Brunnermeier (2011), *CoVaR,* NBER Working Papers 17454, October.

Altunbas Y., S. Manganelli and D. Marques-Ibanez (2011), *Bank risk during the financial crisis: Do business models matter?*, ECB Working Paper 1394.

Angeloni C. and G. Wolf (2012), *Are banks affected by their holdings of government debt?*, Bruegel Working Paper 07.

Avdjiev S. and J. Caruana (2012), "Sovereign creditworthiness and financial stability: an international perspective", *Banque de France, Financial Stability Review,* 16, 71–85, April.

Bernanke B. and K.N. Kuttner (2005), "What explains the stock market's reaction to Federal Reserve Policy?", *Journal of Finance* 60 (3), 1121–1257.

BIS (2011), *The impact of sovereign credit risk on bank funding conditions*, CGFS Papers 43, July.

Bloom N. et al. (2012), *Really uncertain business cycles*, NBER Working Paper 18245, July.

Borio C. (2012), *The financial cycle and macroeconomics: What have we learnt?*, BIS, mimeo.

Demirguc-Kunt A. and H. Huizinga (2011), *Do we need big banks? Evidence on performance, strategy and market*, World Bank Policy Research Working Paper 5576.

Haas M., S. Mittnik and M. Paolella (2004), "A new approach to Markov-switching GARCH models", *Journal of Financial Econometrics 2*, 493–530.

Holló D., M. Kremer and M. Lo Duca (2012), *CISS – A Composite indicator of systemic stress in the financial system*, ECB Working Paper 1426.

Kaminsky G., C. Reinhart and C. Vegh (2003), *The unholy trinity of financial contagion*, NBER Working Paper 10061.

Kiyotaki N. and J. Moore (2005), "Liquidity and asset prices", *International Economic Review*, 46 (2), 317–349, May.

Popescu A. and F. Smets (2010), "Uncertainty, risk-taking and the business cycle in Germany", *CESifo Economic Studies*, 56 (4), 596–626, November.

Rajan R. (2006), "Has finance made the world riskier?", *European Financial Management*, 12 (4), 499–533, September.

Wheelock D. and P. Wilson (2000), "Why do banks disappear? The determinants of US bank failures and acquisitions", *The Review of Economics and Statistics*, 82 (1), 127–138, February.