



EUROPEAN CENTRAL BANK

EUROSYSTEM

# SIMULATING FINANCIAL INSTABILITY

## CONFERENCE ON STRESS TESTING AND FINANCIAL CRISIS SIMULATION EXERCISES

Frankfurt am Main  
12-13 July 2007

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## FOREWORD

This volume contains the proceedings of the conference on “Simulating Financial Instability”, held at the European Central Bank (ECB) on 12 and 13 July 2007, which gathered leading international academics and policy-makers with expertise in the areas of macro stress testing and financial crisis simulation exercises. This event, organised by the Directorate Financial Stability and Supervision of the ECB, proved to be a timely initiative since the financial market turmoil that erupted last summer provided a salutary reminder of the importance of the preparedness of pertinent authorities to address situations of financial stress. In this context, the conference provided a unique opportunity to exchange views and experiences in testing both the resilience of the financial system and the institutional arrangements for maintaining financial stability. Conference participants also identified and discussed the main challenges faced in the efforts to enhance the relevant testing methodologies. The conference provided a useful opportunity to become acquainted with the diversity and richness of the work being undertaken in this field. The results of this work are reflected in this volume. I am confident that it will provide an important contribution to the debate on the further enhancement of the institutional and analytical frameworks for safeguarding financial stability.

*Lucas Papademos,*  
Vice-President of the European Central Bank

Frankfurt, June 2008



# SIMULATING FINANCIAL INSTABILITY

OLLI CASTREN, GIACOMO CAVIGLIA AND PEDRO GUSTAVO TEIXEIRA<sup>1</sup>

## INTRODUCTION

Testing the resilience of the financial system to a situation of stress as well as the effectiveness and robustness of the financial stability arrangements should be a priority task for the authorities responsible for safeguarding financial stability. This is also so, because developments in financial integration and financial innovation potentially make the management of a financial crisis more complex, as the recent financial market turmoil has shown. Against this background, authorities are conscious of the need to devise methodologies enhancing their understanding of the development of risks in the financial system and of their potential impact on financial stability, as well as their preparedness to manage a financial crisis, both domestically and on a cross-border basis.

In that respect, the conference organised by the ECB on “Simulating financial instability” in July 2007 provided a forum to share experiences from central banks, supervisory institutions and international institutions regarding the use of two elements of the toolkit for financial stability, namely macro stress testing of the financial system and the organisation of financial crisis simulation exercises.

Macro stress testing represents a tool for assessing the vulnerability of a financial system to potential macroeconomic shocks. In particular, it involves the quantitative definition of a hypothetical shock, such as for instance a sharp fall in asset prices, in order to assess its likely impact on financial institutions’ balance sheets. This makes it possible to gauge the relative importance of risks to the stability of the financial system. The use of this tool has been fostered in particular by the IMF and the World Bank as one of the components of the Financial Sector Assessment Programs (FSAP) which are used worldwide. In the EU and the euro area, this tool is widely used by central banks for the performance of their respective financial stability tasks within their domestic financial sectors. The Eurosystem is currently working towards a framework that explores the frontiers of the cross-border dimension of macro stress testing.

Financial crisis simulation exercises, on the other hand, involve the real-life replication of the unfolding of a financial crisis in order to test – and help enhance – the institutional framework for managing crises, which encompasses the procedures for detecting disturbances to the financial system, assessing their nature and deploying the appropriate policy tools. Simulation exercises may test the procedures within a single authority, between authorities within a country, or the cross-border interaction between authorities. The Eurosystem has, thus far, organised two simulation exercises – in 2005 and 2006 – which tested its

<sup>1</sup> Conference organisers, Directorate Financial Stability and Supervision, European Central Bank.

preparedness and ability to effectively address a financial crisis with the potential for systemic implications across several countries in the euro area.

The focus of the ECB conference on these two subjects was innovative in demonstrating the potential interlinkages and synergies between macro stress testing and financial crisis simulation exercises which, thus far, have often been treated separately. Furthermore, the conference contributed to highlighting many of the challenges faced by macro stress testing and simulation exercises. These include issues such as coping with the pace of financial innovation, the availability of micro/supervisory data, accounting for contagion in cross-border stress testing and simulation exercises, and the specific European and euro area context.

Finally, this conference provided the opportunity to reach a common understanding on the joint use of macro stress testing and simulation exercises as financial stability tools. This may support further cooperation among authorities with a view to enhancing the effectiveness of these two instruments.

## MAIN CONCLUSIONS - KEYNOTE SPEECHES AND POLICY PANEL

The main conclusions from the conference may be drawn from the two keynote speeches delivered on that occasion and the concluding policy panel.

In his speech on current practices and future challenges for stress testing, **Jaime Caruana** considered that a sensible approach to integrate finance into macro surveillance should contain at least three elements: continuous analysis of high-frequency data; assessment of the efficiency and robustness of the financial sector; and the use of stress tests to provide a more comprehensive picture of the interaction between underlying variables and shocks. The main challenges in the stress testing work include, apart from modelling challenges, the measurement of risk exposures (given the increasing prominence of leveraged instruments for risk transfer), adequate interpretation of the results and aggregation of them across institutions and sectors. Intensified cooperation is needed between macro modellers and financial stability experts, given the comparative advantage of public sector institutions in these areas, and continuing efforts to improve data collection. Also, Mr Caruana called for enhanced cooperation between public and private sector risk managers, quoting the positive feedback received from the IMF's FSAP exercises as an example of well-functioning interaction.

In his speech, **Lucas Papademos** considered that both macro stress testing and simulation exercises crucially support the coupling of the macro and the micro-prudential approaches to financial stability and contribute to enhancing risk assessment and crisis prevention, as well as the preparedness of authorities for addressing a financial crisis. In this context, useful synergies can be achieved between the two tools. For example, synergies may be obtained in the design process through the use of model-based crisis scenarios and the mapping of the potential systemic interlinkages that may spread the propagation of shocks and increase the severity of the crisis. Moreover, the combination of the outcomes of stress testing and simulation exercises can provide policy-makers with a broader and more realistic picture of the degree of resilience of the financial system and

of the effectiveness of institutional arrangements in crisis situations. Looking forward, fundamental changes in the financial system (financial integration, innovation and consolidation) posed challenges for the financial stability framework and imply that stress testing and simulation exercises should be further enhanced.

The policy panel (chaired by the **ECB President, Jean-Claude Trichet** and comprising **Malcolm Knight, Donald Kohn, Lars Nyberg, Peter Praet** and **Kenzo Yamamoto**) focused on possible measures for enhancing financial stability, and monitoring and improving the level of preparedness of authorities for addressing financial crises. In terms of challenges, it was highlighted that financial integration is a process deserving particular attention from a crisis management perspective, especially by those countries with a high degree of foreign ownership of the banking system. This attention also involves addressing the more sensitive issues, such as transferability of assets across jurisdictions and burden-sharing. It was also recalled that the dynamic nature of financial markets renders it increasingly difficult to predict system-wide outcomes. Retrieving and interpreting the required information for assessing potential financial system vulnerabilities has become increasingly complex. As a result, both macro stress testing and simulation exercises have become very challenging, as it is very hard to understand the process of the transmission of financial disturbances *ex ante*. In this context, high quality research is essential for coping with the growing pace of innovation and the increased complexity of the financial system. The policy panellists devoted particular attention to the close interdependence between micro and macro-prudential monitoring. For instance, aggregate information on key developments in the banking sector, such as the rapid growth of banks' balance sheets, can only be properly understood and assessed when considering banks' activities in sufficient detail. This requires a close dialogue not only among central banks and supervisors, but also with market participants. Finally, the importance of an adequate level of preparedness of authorities for crisis situations was reiterated. This may include elements such as a framework for assessing the systemic nature of a crisis, a clear demarcation of responsibilities among competent authorities, and mechanisms to develop trust among all parties on an ongoing basis to facilitate effective coordination during crisis situations. Crisis simulation exercises can be particularly useful in this respect.

**Jean-Claude Trichet** concluded the panel discussion by highlighting that a high level of shared experience, mutual trust and well-developed ongoing interaction among the responsible authorities and market players is crucial for ensuring an effective and rapid response during crisis situations. As in the design of monetary policy, devising an appropriate course of action in the face of a complex crisis situation needs to build on the collegial experience and wisdom of the policy-makers involved. In this context, both macro stress testing and financial crisis simulation exercises are fundamental tools for safeguarding financial stability, which should be further developed in light of the challenges identified by the participants in the conference.

## OVERVIEW OF THE SESSIONS

The speakers at the conference comprised policy-makers and practitioners with leading international expertise in these areas, and the audience consisted, for the most part, of central banking and supervisory executives, with some also from outside Europe (Australia, Japan, Russia and the United States).

The interventions were organised in three parts: (i) experiences and methodologies of macro stress testing; (ii) organisation of domestic and cross-border financial crisis simulation exercises; and (iii) European and euro area challenges in both areas.

The first part consisted of presentations reporting on the current state-of-the-art in macro stress testing as part of the central bank's toolkit for financial stability analysis. In particular, three specific experiences on macro stress testing were reported: the importance of stress testing for the IMF as a key quantitative instrument of the Financial Sector Assessment Programmes (FSAPs); the Bank of England's new approach to top-down systemic stress testing; and the Banco de España's experience with stress testing exercises, including an analysis undertaken during Spain's FSAP. In addition, speakers working on the research frontier reported on particular methodological challenges, including the consideration of: (i) the rapid expansion of risk transfer activities within the financial system implying that the key data for a meaningful analysis and stress testing is on (net) risk profiles of players; (ii) the non-linear reactions and second-round effects of a crisis on the financial system. In that context, it was also stressed that traditional correlation analysis is not an adequate method for the estimation of system-wide measures of default dependence and that, in such cases, copulas should be used; and (iii) the contagion and systemic risk, through the presentation of a model which is able to generate system aggregate loss distribution for hypothetical scenarios.

In the second part, the speakers highlighted the use of simulation exercises in: (i) evaluating the effectiveness of authorities' contingency plans and practices for managing and resolving crises including large and complex banks; (ii) testing institutional coordination between authorities at the domestic and regional levels in areas such as the provision of emergency liquidity assistance or burden-sharing; and (iii) further enhancing existing financial stability arrangements, particularly by identifying weaknesses and increasing the level of understanding of the processes and procedures in place for crisis management in the home country and, more importantly, in other countries. In addition, the speakers also made a number of suggestions on areas which could be usefully tested in the future, including systemically important non-banks or conglomerates, financial infrastructures and possibly cooperation between the authorities of the major international financial centres.

In the third part, speakers focused on the methodological and institutional issues in the European and euro area contexts. Some of the challenges highlighted for macro stress testing include the modelling of contagion through the combination of micro and macro information, the legal barriers to the sharing of micro data on banks and also on large value payment systems, as well as the need to

address the shift towards a more market-based financial system. On the side of simulation exercises, the main challenges concern the design of realistic financial crisis scenarios, which in particular are able to replicate the range of institutional incentives either facilitating or hindering cross-border cooperation between authorities.

## **ACKNOWLEDGEMENTS**

A number of people have contributed to making the ECB conference “Simulating Financial Instability” a success and to completing this volume. Their organisation and preparation have demanded substantial efforts from all parties involved. All authors have invested significant efforts in the reviewing and updating of the manuscripts for their publication. All conference participants (the list of whom is provided at the end of this volume) have contributed to the success. We would like to thank especially our colleagues at the ECB, Ricarda Maresch and Pia Reiter, for their key contribution on a wide range of issues relating to the organisation of the conference, Jan Malinowski, for his effective processing, cross-checking and harmonisation of the manuscripts included in this volume, and Werner Breun for his efficient technical support provided for the production of this book.

We hope that this book will be useful in providing interesting information about macro stress-testing and financial crisis simulation exercises and in highlighting some of the policy and technical issues involved in the management of these two elements of the toolkit for financial stability.





# PROCEEDINGS OF THE CONFERENCE

## WELCOMING REMARKS

*Jean-Claude Trichet*

## MACRO-PRUDENTIAL STRESS-TESTING: REFLECTIONS ON CURRENT PRACTICES AND FUTURE CHALLENGES

*Keynote address by Jaime Caruana*

## SIMULATING AND DEALING WITH FINANCIAL INSTABILITY: CHALLENGES FOR CENTRAL BANKS

*Keynote address by Lucas Papademos*

## INTERVENTIONS AT THE POLICY PANEL

*Malcolm Knight, Lars Nyberg, Peter Praet and Kenzo Yamamoto*



## WELCOMING REMARKS

### JEAN-CLAUDE TRICHET<sup>1</sup>

Ladies and gentlemen,

It is with great pleasure that I welcome you all to this ECB conference on simulating financial instability. The theme of the event – stress testing and financial crisis simulation exercises – is highly relevant both at the national and area-wide level for all those authorities contributing to safeguarding financial stability.

The organisers have prepared an impressive conference programme and I trust that we will all benefit from such an extensive and frank exchange of views. This should also be supported by the wide range of knowledge and experience of all the different participants.

Only a few years ago, the analysis of tools capable of testing the resilience of the financial sector to shocks, as well as the ability of institutional arrangements to mitigate the detrimental effects of these shocks to financial stability, was considered an issue of relevance only for a few.

Since then, a lot of progress has been made with the increasing involvement of public authorities at the national and international level. Today, this conference is part of a number of initiatives around the world aiming to enhance the understanding of the roles and functions of the authorities responsible for assessing financial stability and developing adequate financial stability arrangements.

The increasing attention paid to this topic at the international level is expression of the importance of developing a common set of tools at disposal of the authorities responsible for financial stability which is able to contain the effects of the main characteristic of a financial crisis, its unpredictability. We have to be prepared whenever it comes. Nobody knows neither the day nor the hour.... We live in a world full of opportunities, but because it delivers prosperity it has also a great level of risks.

In this context, the organisation of a forum like today's conference is rather the expression of a broader consensus among authorities that, in the event of a financial crisis, the latter could be very complex to manage.

This means that the authorities responsible for crisis prevention, management and resolution need to deal with the challenge of considerably enhancing their understanding of the development of risks in the financial system and their potential impact on financial stability, as well as their preparedness to manage a real crisis.

<sup>1</sup> President of the European Central Bank.

With this in mind, I should like to turn to the substance of today's conference "Simulating financial instability". The emphasis is given to macro-level stress testing and financial crisis simulation exercises.

On the stress-testing side, the focus will be on reviewing current practices both at the country and cross-border level and on recent methodological advances. On the crisis simulation side, the conference aims to review experiences at the domestic, regional and EU levels in organising these kinds of exercises.

The general aim of the conference is to learn more about these two pillars of simulating episodes of financial instability, as well as about their relationships. With regard to the latter aspect, I should like to draw your attention to two broad issues:

- first, the activities of macro stress testing and crisis simulation exercises should be seen as an expression of a common conceptual framework;
- second, macro stress testing and crisis simulation exercises should be regarded as complementary tools for promoting financial stability.

With regard to the first issue, it is worth recalling that the main challenge in simulating financial instability is the attempt to replicate reality, which, in the case of the financial system, is particularly complex and multi-dimensional. Therefore, the development of a conceptual framework for simulating financial instability would be of great benefit to both the macro stress testing and simulation exercises. I do hope that this conference provides the opportunity for the authorities involved to acknowledge the need to move towards more common approaches in these two domains.

As regards the second point, it is important to highlight that stress testing and simulation exercises are components of a sole toolkit for safeguarding financial stability. Stress testing allows for a better understanding of the possible effects on financial stability of the materialisation of identified risks, while simulation exercises promote the preparedness of authorities for addressing a financial crisis. The identification of potential synergies between the two strands of work would ensure a more efficient and effective result in using and developing these tools.

In this context, I should like to recall the ECB's interest in following the latest developments in these two areas. With regard to macro stress testing, this interest covers the development of tools for testing the shock-absorbing capacity of the euro area's "large and complex banking groups" in the context of the regular financial stability assessment in the euro area, as reflected in the ECB's Financial Stability Review, as well as the development of methods to analyse the cross-border dimension in stress-testing models. As for crisis simulation exercises, systematic attention is paid by the Eurosystem to testing the ability of the system to address effectively a financial crisis with the potential for systemic implications across several countries in the euro area. To that end, periodic simulation exercises are conducted, the most recent of which took place in May 2006.

Let me conclude by outlining the programme of the conference. This morning, the first two sessions will focus on macro stress testing, analysing the most recent experiences and the methodological challenges. In the afternoon, the third and fourth sessions will deal with the experiences of crisis simulation exercises, at the domestic and cross-border level. Tomorrow morning, the fifth session will present the specific challenges for the EU and the euro area in both domains. Finally, the conference will be closed by a policy panel – which I will have the honour to chair – focusing on the scope for enhancing the monitoring of financial stability and the possibilities for improving the level of preparedness of authorities to address a financial crisis in the light of past experiences and ongoing developments in the financial system.

We look forward to a stimulating debate. I trust that you will also benefit from this and take away new ideas and approaches. I wish you all the best in these endeavours, both during this conference and beyond.

# MACRO-PRUDENTIAL STRESS TESTING: REFLECTIONS ON CURRENT PRACTICES AND FUTURE CHALLENGES

## KEYNOTE ADDRESS BY JAIME CARUANA <sup>1</sup>

As the title of this conference implies, in order to develop good policies that preserve financial stability we need to be able to plausibly simulate financial instability, and to do that we need to understand the links between macroeconomic policies and developments in financial markets. This analysis is not easy because of the numerous and complex linkages between the financial system and the real economy due, in part, to innovations in risk transfer, new instruments, new players, increased cross-border capital flows, and the globalisation of financial institutions. These developments all broaden financial activities beyond the major, or “core” financial centres. This increased complexity also implies that the disequilibrium dynamics in the aftermath of a shock are probably more important for financial stability than the final equilibrium. The costs could be severe for misunderstanding such market developments, and failing to react appropriately. Therefore, it is important to avoid failures in policy coordination by improving our analytical tools, diagnostic processes and frameworks for cooperation and dialogue.

In this global setting with ever-widening networks of interconnected balance sheet and off-balance sheets risk exposures among key institutions, the two-way dynamic relationships between financial markets and the real economy are becoming more non-linear and difficult to map. The techniques to model specific links exist, but they are not fully integrated. There is indeed extensive literature on how to model the relationships: from general equilibrium frameworks that include financial variables, to the structural macroeconometric literature that estimates relationships between financial and real sector variables.

In reviewing this literature, it is clear that any practical work on the linkages between financial markets and the real economy calls for a variety of approaches rather than relying on one generally applicable standard model. Given the complexity of balance sheet and off-balance sheet linkages, there is no single widely accepted methodology for assessing financial sector stability. In practice, there is, however, broad consensus that financial stability assessments need to cover a wide range of topics, and to take a holistic view of the financial system beyond the confines of national boundaries and major financial centres.

These are some of the issues a task force created at the IMF considered last year to improve the integration of financial issues in our surveillance work. To make a long story short, the task force concluded that any sensible approach to integrate finance into macro surveillance should be eclectic, and should contain at least

<sup>1</sup> Financial Counsellor and Director, Monetary and Capital Markets Department, International and Monetary Fund (IMF)

three elements: First, we must extract relevant information from continuous analysis of high-frequency financial data; a second element is to assess the efficacy and the robustness of the financial sector: institutions, infrastructure and practices, including, i.e. Standards and Codes; and the third element is to use stress tests and scenario analysis to provide a more comprehensive picture of the interaction between underlying vulnerabilities and possible shocks. Although still under development, the Contingent Claims Approach may be a promising way to incorporate balance sheet and market data into our macro risk analysis.

The experiences of the 1990s made us all aware of the need to avoid traps such as “silo risk management” — treating the various components of risk separately without accounting for their interactions and potentially mutual amplification. Indeed, we learned that to be useful, strategic risk-assessments must help decision-makers to understand better the factors affecting risk exposures, especially the linkages between the micro frames of reference for firm executives, and the macro environments of public policy-makers.

## CHALLENGES

There are, however, challenges and limitations in designing, implementing, and interpreting stress tests that need to be recognised. Macro stress tests are particularly demanding. We must first identify and accurately calibrate numerous transmission channels affecting firms in the system. Then we also have to model how, and to what extent, the macro shocks generate sufficient strains at the firm level to cause systemic concerns. A full assessment requires that we estimate the likelihood of a shock, the size of losses for a given shock or series of shocks, whether the shocks may be correlated, and whether such losses may spread and amplify throughout the system.

Furthermore, any practical analytical framework will almost certainly have to struggle with many imponderables, such as significant data deficiencies, non-linearities, and an, as yet, insufficiently fleshed-out analytical framework encompassing incomplete markets, non-traded loan portfolios, market frictions, the effects of potential regulatory or institutional distortions, and the implications of changes in expectations and risk tolerance.

Our tools and methodologies for combining and ensuring consistency between shocks from the macroeconomic environment and their impact at the micro-level need further development. For example, most macro models are equilibrium-based, and may not be well suited for insights when extreme shocks and states of disequilibrium dominate. As you all know, one of the most difficult tasks in designing macro stress scenarios is to translate a set of macro shocks into stresses on relevant income and balance sheet items for firms with very different balance sheet and income compositions.

Another challenge arises in accurately measuring risk exposures, particularly in the presence of complex instruments. These instruments contribute greatly to financial stability by dispersing risks more broadly. However, leverage and risk exposures

may be hidden or blurred by some of these new instruments (such as seen recently among CDO-related instruments involving sub-prime mortgages). The lack of market liquidity, and the complexity of some of these instruments, has led to “marking-to-model” practices that greatly complicate our ability to estimate the size of the potential losses. Moreover, the opaqueness of the securitisation/risk transfer process makes it difficult to identify the ultimate holders of these risks or even whether the incentives to maintain sound credit underwriting standards are weakened through the process.

A crucial, but different set of challenges arises from interpreting stress tests and drawing policy conclusions. The term “stress test” conveys a sense of precision that may overstate what is actually delivered. Indeed, we may be victims of our own success. Policy-makers, and even some risk-management professionals, may be sometimes lulled into a false sense of security because of a belief that stress tests are an “all-in-one” tool for discovering a wide range of important risk exposures.

It is equally important to remember that techniques for risk aggregation across heterogeneous firms (banks and non-banks) and activities are still in their infancy. Research in this area remains very active — even leading some to propose “one number” risk measures (such as an aggregate “distance-to-distress” measure). However, there are currently no definitive answers on how to construct risk measures for an entire financial system.

## THE WAY FORWARD

Looking ahead, I see a busy, work programme for improving the analytical usefulness of macro stress testing in developing policy advice. From a production standpoint, we must continue to work at bridging the cultural divide between macroeconomists on the one side, and risk practitioners on the other side.

These groups perceive and analyse risks from very different perspectives. *Macroeconomic modellers* work to make more precise the range of expected outcomes for key macro variables. By contrast, *financial risk modellers* tend to focus on events at the extreme “tails” of the distribution of outcomes. In other words, macro modellers live mainly in the “first and second moments” of the distribution of outcomes, while financial risk managers inhabit the “third and fourth moments”. Successful macro-scenario stress testing requires combining the right blend of expertise: *macro modelling* for scenario design; *risk management expertise* to map the risks; and *quantitative skills* to measure the shocks.

It is important to marry these perspectives when designing a credible and informative stress scenario that includes realistic global shocks and transmission channels. Of course, this implies that macro stress testing is often resource intensive, and cost considerations may limit their frequency and scope.

On top of that, we know that the set of adverse risks and vulnerabilities are constantly changing. We are all familiar with the factors behind this dynamism: financial innovations, changing financial practices, regulatory changes, globalisation, and structural economic and financial changes. These changes can wreak havoc with historical regularities and correlation structures that are critical for both macroeconomists and financial risk managers to estimate their models and calibrate other quantitative tools. Moreover, the “good times” experienced by the global financial system over the past five years may be distorting recent efforts to improve data collection. Data depicting such low volatility, and risk premiums may limit our freedom when designing historically plausible stress scenarios.

We do not know when or how the next crisis will occur. Markets have a keen ability to surprise everybody. As financial institutions are becoming more global and markets become increasingly interconnected, I suspect that the unfolding of the next crisis will likely involve more countries, institutions, and markets beyond the core financial centres; more asset classes will become highly correlated; the gap between perceived market liquidity and actual liquidity will become more evident and new intermediaries will play more influential roles in the transmission, and perhaps in the mitigation, of shocks.

In this context, it will be crucial to manage expectations and avoid coordination problems if a crisis occurs. This will not be an easy task. The cross-border linkages, the rapid diffusion of financial innovations and relevance of new players (such as hedge funds) in global markets potentially broadens the range of locations of future “flashpoints,” and may magnify the impact of global shocks. To try to defuse the build-up of incipient risks and adverse market dynamics, we will need relevant and timely information and an inclusive multilateral framework that facilitates dialogue and consultation among relevant stakeholders. And relevant stakeholders, given the new role of many emerging markets, will most likely include more countries and institutions — not only those in the “core” financial centres.

I think that stress scenarios analysis and crisis simulation exercises are also communication tools that can help coordination issues. Transnational exercises can help us to not only understand better the complex linkages across many countries, markets, and institutions, but also trace potential risk amplifiers from cross-country and cross-market spillovers. Most important of all, they can support an informed dialogue among all the relevant stakeholders.

To conclude, let me emphasise the importance that we in the public sector continue exploring ways to understand better how macro events may affect the distribution of financial risks. Appropriate responses will clearly require improving communications, cooperation and promoting more joint research and information exchanges between public and private sector risk managers.

From our own IMF experience with stress testing in FSAPs, results are encouraging. The positive feedback from these exercises demonstrates the value of macro stress scenarios to both financial supervisors and private sector risk

managers. Nevertheless, we need to work harder to reduce the resource burden of macro stress tests, while adding value to the analyses that financial institutions already perform.

Notwithstanding the shortcomings about stress testing that I have noted, and the challenging agenda ahead, we must not let the perfect be the enemy of the good. Our current stress testing tools provide financial institutions as well as policy-makers with important and high-quality information and assessments about systemic risks and vulnerabilities. More importantly, they provide a framework for further analysis and discussion, at both the technical and policy levels. We must not underestimate the importance of this dialogue for advancing the frontiers, and that is why we, at the IMF, are pleased to be part of this discussion.



# SIMULATING AND DEALING WITH FINANCIAL INSTABILITY: CHALLENGES FOR CENTRAL BANKS

KEYNOTE ADDRESS BY LUCAS PAPADEMOS <sup>1</sup>

## I. INTRODUCTION

The topic of this conference “Simulating financial instability” may, at first sight, seem odd for a conference organised by a central bank whose tasks include contributing to the safeguarding of financial stability. But we have all come to realise that in order to achieve the objective of preserving financial stability, we must further enhance our understanding of the factors and processes that lead to financial instability. To this end, we must improve our analytical tools for monitoring and assessing financial imbalances and potential risks that can adversely affect the stability and efficiency of the financial system. We must also strengthen the institutional arrangements that can help prevent the emergence of financial instability and, if a crisis occurs, can help to manage it effectively and mitigate its impact on the financial sector and the real economy.

To achieve these aims, it is useful – indeed necessary – to further develop analytical tools for modelling key processes, components and the functioning of the financial system and for stress testing its resilience to shocks. Moreover, it is also essential to conduct crisis simulation exercises to test the response and preparedness of institutional arrangements to a hypothetical but plausible “virtual reality” situation of financial instability. These are the two, seemingly rather technical, but very practical and policy-relevant topics that we are trying to address in this conference in the light of past experience and ongoing developments in the financial system.

In my remarks, I will focus on three pertinent issues. First, I will elaborate on the role and significance of stress-testing and simulation exercises within the framework for safeguarding financial stability, with special emphasis on the tasks and responsibilities of central banks for preserving financial stability. And I will also explore how we could achieve synergies between these two areas of work.

Second, I will highlight some of the changes that are taking place in the financial system and the macro-financial environment and assess their implications for the analytical, operational and practical aspects of the financial stability framework, and specifically for the two tools we have been discussing today, stress-testing and crisis simulation exercises.

Third, I will point to some broader policy issues concerning the effectiveness of the institutional arrangements for financial stability.

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## II. THE FRAMEWORK FOR SAFEGUARDING FINANCIAL STABILITY: THE ROLE OF STRESS-TESTING AND CRISIS SIMULATION EXERCISES

Let me start with some observations on the current “state of play” with regard to the framework for safeguarding financial stability. This framework has analytical, operational and institutional components. Since the early 1990s, significant progress has been made towards enhancing the precision and rigour of analysis and the effectiveness and efficiency of institutional arrangements. This progress reflects the increasing importance of financial stability issues as a result of the remarkable development, growth and integration of financial markets as well as the episodes of market turbulence experienced over this period.<sup>2</sup>

Nevertheless, despite the progress made, it is fair to say that the financial stability framework has not yet reached a steady-state, but is still evolving. There are several reasons for this. First, the quantification of the objective of financial stability is not straightforward. Second, the analytical component of the framework (involving appropriate indicators, models and methodologies) for monitoring and assessing the dynamics of the financial system and of the factors and potential risks that can affect its stability is inherently more challenging than is the case for the monetary policy framework. Third, the continuous and striking transformation of the financial system poses additional challenges for the analytical and institutional components of the financial stability framework.<sup>3</sup>

What are the roles of stress-testing and simulation exercises in the framework for safeguarding financial stability? And can these tools help address some of the implications for financial stability arising from the ongoing transformation of the financial landscape?

As you know, the framework for financial stability includes the performance of various functions and can be usefully considered as comprising three main stages concerning crisis prevention, crisis management and crisis resolution. Crisis prevention consists of the performance of both micro-prudential supervision and central banking functions. The latter include financial stability monitoring and assessment, which rely on macro-prudential analysis. Crisis management comprises the set of tools and policy actions that public authorities may use if and when a financial crisis occurs in order to contain its impact. And crisis resolution relates to the arrangements for the orderly winding-up of a failing institution and the protection of the rights of creditors, notably depositors.<sup>4</sup>

Within the financial stability framework I have just described, both stress-testing and crisis simulation exercises can support the coupling of the macro and the micro-prudential perspectives to financial stability and the preparedness of authorities to address a financial crisis. Macro stress testing is one of the activities aimed at crisis prevention, while financial crisis simulation exercises

<sup>2</sup> See Houben, Kakes and Schinasi (2004).

<sup>3</sup> See Large (2005).

<sup>4</sup> See Houben, Kakes and Schinasi, *op. cit.*

are geared towards the testing and enhancement of crisis management and resolution procedures.

For central banks, key activities contributing to the performance of their financial stability tasks are (i) the identification and monitoring of sources of risk and vulnerability in the financial system and (ii) the analysis and assessment of internally generated imbalances and externally induced disequilibria due to shocks. Stress tests are particularly useful for risk monitoring and assessment as they make it possible to quantify the likely impact of shocks, which helps to rank risks by their importance and allows assessment and surveillance to be more focused. Moreover, stress tests can help provide early warning signals and thus contribute to the forward-looking dimension of financial stability monitoring and assessment.<sup>5</sup>

Crisis simulation exercises are also forward-looking instruments as they aim to predict how the crisis management and crisis resolution arrangements will function in practice on the basis of crisis scenarios. Moreover, simulation exercises of a cross-border financial crisis can demonstrate the challenges to achieving the appropriate degree of cooperation between national authorities in order to address the cross-border systemic implications of a crisis, to the benefit of all those affected.

Crisis simulation exercises may also be designed to test the overall effectiveness of financial stability arrangements, including the consistency of the principles and procedures underlying crisis prevention, management and resolution. In particular, some of the simulation exercises organised thus far have helped to bring to light the existence of legal, regulatory and other obstacles to smooth cooperation between authorities. Some of the implications of these obstacles cannot be fully anticipated *ex ante* but, if the factors underlying such obstacles are replicated in a simulation exercise, their potential impact on the overall effectiveness of crisis management and resolution processes can be demonstrated, and this can help enhance preparedness for handling a crisis.

A key question worth exploring is whether useful synergies between macro stress-testing and crisis simulation exercises can be identified and achieved. This is an important issue as work has generally been conducted separately in the two fields and the current juncture could provide a good opportunity to examine potential complementarities and synergies. Let me say a few words on two such types of synergy.

The first type of synergy which can be achieved between stress-testing and simulation exercises concerns what we may call the design process. On the one hand, crisis simulation exercises can benefit from stress-testing models, as the results obtained from such models can be used as input for the design of a crisis scenario to test institutional arrangements. Stress-testing models may be particularly useful in assessing whether a particular scenario will generate outcomes that are sufficiently severe as to have systemic implications. Of course, the use of model-

<sup>5</sup> See Jones, Hilbers and Slack (2004).

based scenarios to replicate a financial crisis is subject to limitations. Nevertheless, such scenarios – supported by the outcomes of stress tests – are useful to the extent that they allow policy-makers to consider the propagation of shocks and the evolution of a crisis and thus identify ex ante alternative channels of shock transmission and appropriate policy responses.

Conversely, stress-testing models can also benefit from simulation exercises as the design of a simulation exercise involves a mapping of the potential systemic linkages that may spread the propagation of a crisis and increase its severity. These linkages may include the relationships between vulnerabilities embedded in a bank's balance sheet, the links to the liquidity needs of that bank and of the banking system as a whole, as well as the repercussions for payment systems. The thought processes underlying the design of a simulation exercise can provide valuable input for stress-testing models through the identification of additional indicators and factors which may be usefully considered.<sup>6</sup>

The second type of synergy which can be achieved relates to the information provided by macro stress-testing and simulation exercises for policy-makers. While macro stress testing certainly helps to quantify the effects of various shocks on the macro-financial environment and to model their transmission to the financial system using internally consistent scenarios, it is based on some simplifying assumptions. One such assumption is that it usually does not incorporate the responses of either financial market participants and financial institutions or of central banks and supervisors. Crisis simulation exercises can provide useful information on the effectiveness – as well as the potential limitations – of the institutional arrangements intended to safeguard financial stability when faced with a severe crisis scenario. Combining the outcomes of stress-testing and simulation exercises allows policy-makers to obtain a broader and more realistic picture of the degree of resilience of the financial system and of the effectiveness of institutional arrangements with respect to crisis scenarios.

### **III. THE CHANGING FINANCIAL SYSTEM AND MACRO-FINANCIAL ENVIRONMENT: ANALYTICAL ISSUES AND POLICY CHALLENGES FOR FINANCIAL STABILITY**

Thus far, I have spoken at some length about analytical tools, simulation exercises and crisis scenarios. But there is one scenario which does not involve a crisis, namely the future development of our own efforts to better understand the changes that are taking place in the financial system and the macro-financial environment; to discern what they mean for financial stability and for the financial stability framework; and to assess their potential impact on the substance of our central banking task of safeguarding financial stability, as well as on the two specific tools of stress-testing and simulation exercises.

<sup>6</sup> See Sorge (2004).

## THE CHANGING FINANCIAL SYSTEM

We have all been witness to fundamental and far-reaching changes in the financial system. I would like to highlight three and point to their policy implications. The first is the rapidly increasing financial integration in Europe and globally, both across borders and across financial sectors. This is leading to a blurring of the boundaries of markets and of the separation between the activities of financial institutions. This, in turn, implies that a comprehensive financial stability assessment must take into account, monitor and analyse the cross-sectoral links and internationalisation of financial systems. Moreover, detecting and assessing risks and vulnerabilities, containing threats and managing a potential crisis in an increasingly integrated financial environment require appropriate sharing of information and effective cooperation between central banks and other responsible authorities across jurisdictions.<sup>7</sup>

Second, financial innovation has engendered the emergence and rapid growth of new and complex financial instruments and the expansion of over-the-counter (OTC) derivatives markets and has fostered the growing presence of other, non-bank financial intermediaries that are very active in both traditional and OTC markets.<sup>8</sup> Many of these other financial institutions are highly leveraged and most are lightly regulated. These developments have facilitated the spreading and redistribution of risks across sectors and have contributed to the completeness and efficiency of financial markets. One important consequence of recent financial innovations, advances in risk management techniques and the associated phenomenal growth in the market for credit risk transfer (CRT) instruments is that they are altering the traditional roles and business models of different types of financial intermediaries. There are good arguments supporting the view that, on the whole, these developments strengthen the shock-absorption capacity of the financial system. But there are also concerns that under certain circumstances, and in response to sizeable – and possibly correlated – shocks, the financial system may face a real and challenging “stress test” of shock amplification. One thing is clear. The complexity of some of the new financial instruments, the cross-sectoral redistribution of risks and the opaqueness of the transactions of a growing number of non-bank financial institutions have made the modelling of the financial system as well as the monitoring and assessment of risks much more difficult.

The third, and final, feature of the financial market landscape I would like to highlight is a consequence of the previous two and their interaction with global macroeconomic factors and monetary conditions. Financial liberalisation and integration, innovation and consolidation combined with the global distribution of saving and investment, and global monetary conditions have contributed to a macro-financial environment characterised by low market volatility, low risk premia and abundant financial market liquidity. The potential links between, on the one hand, structural change and micro factors in the financial system and, on the other hand, macroeconomic factors and monetary conditions are not

<sup>7</sup> See ECB (2007).

<sup>8</sup> See Kohn (2007b).

sufficiently well understood and deserve further analysis. For example, although financial market liquidity and monetary liquidity are distinct concepts, there are links between the two which could have implications for the level of risk and term premia, the dynamics of asset prices and the conduct of central bank policy. These observations support the view – recently also stressed by Malcolm Knight and Jaime Caruana – that, in performing the task of safeguarding financial stability, the micro and macro-prudential approaches should be increasingly combined, in order to obtain a broad-based and robust assessment.

What are the other implications of these changes in the financial system and the trends in the macro-financial environment for the analytical, institutional and operational aspects of the financial stability framework, and, specifically, for stress-testing and crisis simulation exercises? And are there any broader implications for central bank policy? These are the questions I would like to briefly address next.

## **CHALLENGES FOR STRESS-TESTING AND CRISIS SIMULATION EXERCISES**

We have made impressive progress in the fields of both macro stress testing and crisis simulation but, in the light of the substantive changes in the financial system I mentioned before, I would like to raise three issues concerning: first, the limitations of model-based scenarios; second, the availability of data; and third, the design of crisis simulation exercises.

First, overcoming the limitations of model-based stress tests is an analytical challenge. Obviously, models can only provide a stylised and limited picture of reality. This limitation is especially acute in the case of a financial system which is evolving, becoming more complex and multi-dimensional. Stress tests often focus only on part of the financial system and fail to produce sufficiently “severe” results, because many of the typical characteristics of financial crises, such as contagion, non-linearities and second-round effects, are not accounted for. These characteristics are probably becoming more relevant as a result of the ongoing transformation of the financial system. Further advances in the modelling of the manifold linkages within the system are crucial in order to generate stress tests that simulate crises of systemic importance – for these are particularly relevant to us as central bankers. In addition to improved modelling of several interactions and contagion channels within a given financial system, we need a better understanding of the links between the financial system and the macroeconomic environment. We thus need to bring together both micro and macro aspects and incorporate them into stress-testing and simulation exercises.<sup>9</sup>

Second, a more practical but equally essential issue is the availability of data. Any model can only be as good as the data fed into it. And undoubtedly, model-based stress tests are demanding in terms of data. The challenges on that front are manifold. Sufficient historical data are often lacking, and even when relatively long time series are available, changes in the macroeconomic or regulatory

<sup>9</sup> See Haldane, Hall and Pezzini (2007).

environment may limit their usefulness. Cross-country analysis is especially complicated because data availability differs substantially across countries.

However, perhaps the most relevant data problem relates to confidentiality. I accept that in most cases there are very good, and indeed legal, reasons for preserving confidentiality, particularly when dealing with information on individual banks. But the scarcity of data seriously limits modelling efforts. The existing data difficulties are augmented by the growing importance of new financial instruments that are traded over the counter, and by the increasing activities of non-bank financial institutions. A key question is how we can obtain sufficient data to help improve our detection and understanding of risks and vulnerabilities without imposing restrictions and burdens which would unnecessarily hamper innovation and efficiency in financial markets.

I am not making this point to justify or rationalise the seemingly insatiable appetite of researchers and specialists for ever more data. I am making it because effective risk assessment and crisis prevention require a certain minimum degree of realism in the scenarios that are developed. Financial institutions, supervisors and central banks should explore ways to enhance disclosure of adequate and relevant information so that potential flash points in the financial system and the functioning of shock transmission mechanisms can be identified in a timely manner. That said, in calling for adequate and relevant information, we must bear in mind the risk that requests for more detailed disclosure could also result in undesirable outcomes.

Third, an operational aspect is the design of crisis simulation exercises. The crisis scenario should be sufficiently realistic, but also manageable for everyone involved. At the same time, it should serve to effectively evaluate the institutional arrangements. As anyone who has designed or participated in a simulation exercise can testify, combining these three objectives is not easy. And there are inevitably limitations. This is particularly important when evaluating such exercises *ex post*. After all, the evolutionary biologist Thomas Huxley reminds us that “what you get out depends on what you put in; and the grandest mill in the world will not extract wheat flour from peascods”.

## **POLICY IMPLICATIONS FOR FINANCIAL STABILITY INSTITUTIONAL ARRANGEMENTS**

Finally, what are the broader policy issues and challenges stemming from the rapidly evolving and integrating financial system for the institutional component of the framework for safeguarding financial stability? And how can we effectively address them?

These questions do not have short and straightforward answers, but I would like to briefly stress a few points. First, increasing financial integration clearly requires enhanced cooperation between authorities across countries, not only in supervision and crisis prevention, but also in crisis management and resolution. Second, and in order to achieve that objective in an effective and efficient manner, the arrangements for crisis management and resolution should be consistent with the arrangements for crisis

prevention, including financial stability monitoring and assessment. This entails a need to explore thoroughly how to strengthen cooperative arrangements for financial stability especially, but not exclusively, in the increasingly integrated European financial system which, however, is characterised by institutional arrangements in which authorities have an essentially national responsibility and accountability. Third, institutional arrangements should be such as to minimise moral hazard and preserve constructive ambiguity about the terms and timing of a possible public intervention. This is essential for reinforcing market discipline and fostering appropriate incentives. Fourth, it is important to address various legal and technical issues, for example the removal of legal obstacles limiting the transferability of assets across borders, which can facilitate the management of a potential crisis affecting cross-border banking groups. In this context, I am pleased to say that much has been learned from crisis simulation exercises in the Eurosystem on how to address some of these issues and on the importance of removing obstacles that can hinder the effective performance of our financial stability tasks. Finally, strengthening the links and achieving synergies between the micro and macro-prudential approaches to financial stability is becoming increasingly important for a more robust assessment of risks to financial and macroeconomic stability.<sup>10</sup>

It could be observed that a number of the issues I have just raised are direct, rather obvious, implications of the ongoing changes in our financial system and macroeconomic environment. I would consider it very positive if agreement could be reached on the above points. But the design and implementation of the appropriate institutional arrangements for financial stability are less straightforward. Fortunately, a lot of pertinent work has been undertaken by authorities and other fora in order to enhance the effectiveness of the financial stability framework of the European Union (EU). Interestingly, some of that work started as a follow-up to an EU-wide simulation exercise of financial instability.

#### **IV. CONCLUDING REMARKS**

After this rather dense presentation of various analytical and policy issues related to our topic “Simulating financial instability”, let me conclude by sharing with you an interesting observation on this very theme. Originally, simulation had rather negative connotations. In the dictionary of the English language of 1775 it is noted that “a Deceiving by Words, is commonly called a Lye, and a Deceiving by Actions, Gestures, or Behaviour, is called Simulation”. But, even with such associations surrounding the word, Francis Bacon, the English philosopher, could still see some utility in simulation when he mused about “a good shrewd proverb of the Spaniard, ‘Tell a lie and find a truth’. As if there were no way of discovery, but by simulation”. This brings us back to our discussion today, for we seek, through simulating financial instability, to discover the “truth” or at least enhance our understanding about the underlying factors and processes that may lead to instability in today’s complex financial system, and about the most effective institutional arrangements and policies to prevent and deal with financial instability.

Thank you very much for your attention.

<sup>10</sup> See Kapstein (2006).



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# INTERVENTIONS AT THE POLICY PANEL

**MALCOLM KNIGHT<sup>1</sup>**

This has been a fascinating conference because it has brought together key officials from central banks, supervisory institutions and international organisations to discuss recent experiences, methodological issues and policy challenges related to macro-level stress testing of the financial system and financial crisis simulation exercises. The aim has been to “provide a forum to learn more about how synergies between the two areas could be better exploited in order to bridge the gap between the analytical and the institutional arrangements for financial stability”. I have learned a great deal from the discussions yesterday and this morning. In my remarks I would like to share some of the lessons I have learned, and then make a few comments on how to enhance monitoring and preparedness for dealing with financial crises.

## I SOME LESSONS FROM THE DISCUSSIONS

As the discussions in this conference have made clear, our thinking on a number of key issues (monitoring financial stability, crisis prevention, crisis management, and the resolution of problem institutions) is evolving rapidly. The presentations yesterday and today are testimony to the substantial effort that is going into developing model-based macro stress test methods for assessing systemic financial risks, as well as into major simulation exercises for financial crisis management. These efforts will no doubt pay significant dividends over time. In particular, macro stress testing can help us understand how shocks could be transmitted through the financial system and how they might impact financial stability. These stress tests can also tell us something about the shock absorption capacity of the financial system, and hence about systemic robustness and resilience. Similarly, crisis simulation exercises help policymakers – both central bankers and financial supervisors – check the relevance and robustness of crisis management arrangements. These two types of analysis – stress testing and crisis management simulations – are thus highly complementary.

At the same time, the results of these exercises so far have significant limitations. As regards macro stress testing models, the work is currently limited to studying the impact effects of a crisis on regulated banking institutions. Given that banks have reported comfortable capital levels, these stress tests generally suggest the benign result that even a large increase in credit risk would have relatively small adverse effects. However, the current type of stress tests do not model well either the cumulative effects on markets of decisions taken by large regulated institutions, or the actions of important new non-bank players in the financial system, nor the multiple channels of financial flows via institutions and markets. Thus they cannot show the process of contagion that is likely to occur as shocks reverberate through the financial system, impacting on both market and funding liquidity, and increasing the volatility of asset prices. This is one reason for the “disconnect” between the general perception that there are substantial risks in our

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globalised financial system and the small cost estimates of financial instability that are produced by the empirical stress testing models. It is important to avoid getting a false sense of security from these apparently benign results. I will return to this point in a moment.

“War games” that are played in crisis simulation exercises are at a preliminary stage. I have been particularly impressed by the high resource costs of these exercises, in terms of the amount of work that goes into designing the scenarios that trigger the crises and the key problems to be solved; the amount of time and effort of senior policymakers required to play the game; and the difficulties of taking account of the strategic reactions of the various players, particularly in the private sector, after the initial shock. Because these costs are high, such crisis simulation exercises are likely to be undertaken only infrequently. Given the rate of innovation in the financial system, this raises the concern that policymakers may be out of date when a crisis actually occurs. One possible way of addressing this problem would be to develop further the methodology that was proposed in the report of the Task Force on the Winding Down of Large and Complex Financial Institutions, produced in 2001. Rather than trying to determine the sorts of scenarios that could lead to a financial crisis, this report stressed the need for the policymakers who would manage a crisis to have detailed up-to-date information on the structure and key business activities of the major financial institutions in their jurisdictions. Thus one way to keep senior policymakers continuously up to speed in the period between infrequent crisis simulation exercises would be to provide them with relatively frequent briefings on the latest key information that the Task Force report concluded was most important for managing institutions under stress. Such a regular exercise would inform policymakers in quantitative terms of the current activities of financial institutions, and of developments in markets.

## **2 ENHANCED MONITORING OF FINANCIAL STABILITY**

Even in normal times, when the macroeconomy and financial system are functioning smoothly, the task of monitoring financial stability and identifying key risks and vulnerabilities is highly complex. This complexity results from the fact that the rapid pace of innovation in the financial system causes market structures and practices to evolve in ways that are inherently difficult – or even impossible – to predict. This is another reason for the disconnect, mentioned above, between the general perception that complex financial systems pose considerable latent risks and the relatively small empirical cost estimates produced by the current generation of macro stress testing models.

Thus the challenge for central banks and supervisory authorities is to develop systems of oversight that allow rapid financial innovation to take place while still ensuring that the system remains robust to shocks. Such a supervisory process needs to have three key elements: (a) it must be principles-based; (b) it must be applied consistently across financial sectors and institutions (in the sense that the same types of risks are mitigated in much the same way no matter where they are held); and (c) it must also be applied as consistently as possible across national jurisdictions. A more general question is how regulators take into account the

risks that non-regulated entities, which sometimes conduct activities very similar to those of regulated firms, can create in the financial system.

When a shock occurs, a key question concerns the conditions under which the financial system is likely to magnify the shock rather than absorb it. In recent years the global financial system has absorbed significant real macro shocks (such as the rise in oil prices) as well as financial shocks (such as the convexity hedging in mid-2004). But over the past decade, globalisation and goods and capital market integration, as well as effective implementation of monetary policies by the world's key central banks, have combined to hold down global inflation. In these conditions, financial integration, innovation and high global savings rates (relative to intended investment) have generated a steady secular decline in market-determined long-term real interest rates since the late 1990s, even though central bank policy interest rates have been on a rising trend in recent years. Since the real interest rate is the cost of leverage, this period has also generated a remarkable increase in indebtedness, leverage and asset prices. Furthermore, financial innovation (including making previously illiquid asset markets, such as residential equity or energy futures, liquid) has given a major added impetus to this process. Given these developments, it is certainly a relevant question whether the global financial system will continue to absorb negative shocks as easily when these favourable background conditions erode. Furthermore, although the system has proven resilient to changes in financial asset prices where there are liquid markets, it may well be less able to handle changes in the values of real assets, such as housing, business fixed capital, etc, where disequilibria can exist for a long time.

In order to make the current stress testing models more useful and realistic in these conditions, they need to be expanded to take account of three elements:

- Heterogeneity of players
- Second-round effects
- Strategic behaviour subsequent to the initial shock

This will be difficult to do, and I will not attempt to outline all the needed work. Let me just describe three particular challenges that need to be confronted in order to build stress testing models that take account of the complexity of the globalised and continuously evolving international financial environment.

### **1. New financial system players from outside the regulated banking sector.**

These, of course, include such institutions as hedge funds, private equity firms, insurance companies and pension funds. Along with the rise of these new players, the channels of financial intermediation have become “marketised”. On the one hand, this means that there are more channels for financial intermediation, which certainly improves the robustness of the system to modest shocks. But these new, unregulated institutions now generate a very large proportion of trading, not only in derivatives markets but also in the cash markets for fixed income instruments and equities. As a consequence, these institutions are now key providers of liquidity to core financial markets. They also tend to be relatively highly leveraged. As we learned from the episodes of market turbulence in May–June 2006 and February–March 2007, this can cause prices in markets that are uncorrelated or negatively correlated

in normal times to exhibit high positive correlations in stressed conditions. But, simultaneously, banks and other regulated financial institutions have come to depend more and more heavily on deep and liquid markets to manage their own risk profiles. This means that since the current generation of stress test models do not take account of the way the new, unregulated players that provide liquidity to markets are likely to behave in stressed conditions, they cannot tell us much about overall financial system risks or vulnerabilities.

**2. Understanding the distribution of risk.** New financial instruments, particularly derivative products, help distribute risk better. But there currently is very little information available to market participants, central banks and financial supervisory authorities about how these risk exposures are distributed throughout the financial system. In turn, this inhibits effective market discipline. How the system will behave under stress depends on the distribution of risk among the individual players, and how well those holding risk exposures are able to absorb losses. Standard accounting conventions and, more broadly, financial disclosure provide little useful information on these risk exposures. This is why the risk accounting measures used by portfolio managers to assess their risk exposures and economic capital need to be developed further. In particular, it would be a breakthrough if, somehow, broad risk measures could be aggregated at the sectoral level.

**3. Systemic interlinkages across borders.** A challenging task for financial stability monitoring is understanding the systemic interdependencies between the functioning of financial markets, the health of major financial institutions and the continuity of key wholesale payment systems and other financial infrastructure; namely, the intermediation of financial savings, liquidity provision, asset pricing and transaction settlement. The fact that markets, institutions and systems are increasingly interlinked across borders means that the implications of bad decisions or weak underpinnings can spread globally at a rapid pace.

Market failures, including coordination problems among market participants, could exacerbate these effects. My sense is that we need to do more work to understand the sources of systemic interdependencies among markets, financial infrastructures and large complex financial institutions. We also have to try to look at this from an international perspective. For example, work is under way in the Basel-based Committee on Payment and Settlement Systems that aims to map international interdependencies among payment and settlement systems.

### 3 HOW TO ENHANCE PREPAREDNESS FOR DEALING WITH A CRISIS

One implication of these developments is that there is a need for close international cooperation among central banks and supervisors in assessing developments, and in thinking about how to respond to them. In recent years, a lot of effort has been devoted to enhancing preparedness for dealing with cross-border banking problems in several regions. This has been particularly true among the countries of the European Union (EU), where significant progress has been made, including – as we heard yesterday – the work done by EU

member states to get their national crisis management arrangements in order, the signing of various memoranda of understanding to define agreed principles of international cooperation among relevant authorities, and the implementation of crisis simulation games. Further work is under way in the Economic and Financial Committee to consolidate this progress. Similarly, much attention has also been given to arrangements for resolving cross-border banking problems in the Nordic countries and in Australia/New Zealand. But elsewhere there has been less visible effort to grapple with the cross-border crisis management issues.

What is the scope for continuing to make improvements in this area internationally? I would just make two simple points:

First, I think there is still considerable scope for central banks and national supervisors in small groups of countries that have particularly close financial system interlinkages to meet to review national practices and potential cross-border challenges in specific institutions or markets. This could enhance preparedness in a number of key financial centres, and strengthen the efforts under way in the Financial Stability Forum to share information on national crisis management arrangements.

Second, central banks also need to think further about how they can effectively provide liquidity support in a world where institutions and markets operate in multiple currencies. Liquidity support in the early phase of a crisis can be crucial for maintaining a degree of freedom in subsequent crisis management. But what I have heard over the last two days suggests to me that since financial intermediation has become so much more “marketised” than 15 years ago, it may be that in a crisis it is best if liquidity is provided to certain key markets rather than specific private sector financial institutions. If this sounds a bit like going back to “Bagehot’s rule” it is no coincidence. Because I believe that this approach of providing liquidity to markets has two advantages. First, it acknowledges that financial intermediation is now market-based, rather than bank intermediation-based. Thus it is markets that will need liquidity in a crisis. Second, I think that providing liquidity to financial markets, rather than institutions, creates fewer moral hazard problems. Of course, making a market liquid makes some holders’ assets more valuable and others’ less valuable than they otherwise would have been. But the fundamental objective of feeding liquidity into key financial markets is limited – its goal is simply to restore enough confidence for market-makers to be willing to quote two-way prices again, so the system can continue to function. It seems to me that this is far easier than determining whether a key institution is just illiquid or insolvent. Furthermore, market liquidity can be withdrawn reasonably easily once the system stabilises – unlike the case where extended liquidity support is provided to a large financial sector institution that is experiencing difficulties. In fact, this sort of general liquidity support for markets has been provided successfully in a number of instances. I think, in particular, of the liquidity that the Fed injected into the US financial markets in the immediate aftermath of the stock market crash of 1987 or the LTCM crisis of 1998. And the Hong Kong Monetary Authority intervened successfully to stabilise the local equity market in late 1997. But even if this approach is simple and sensible, how is it to be accomplished across borders in our globalised financial system, particularly when the demand for liquidity is likely to be concentrated in a few key currencies?



## CONCLUSION

Let me thank the ECB for organising this fascinating meeting. It has given all of us, I think, a clearer vision of the challenges of financial instability and the ways of confronting it. But I should also end with a note of caution. The current state of our knowledge of financial stability monitoring and crisis management remains severely limited. Much additional work needs to be done. We are just starting to address the problems that could be thrown up by a system that is undergoing rapid and unpredictable structural changes as financial innovation unfolds before our eyes. Determining how to limit the “fallout” from this system if it is subjected to a major shock will take hard-headed modelling, intuition, decisiveness, and courage. Meetings like this one – taking place at times of relative calm – can help to prepare central banks, financial supervisors and governments to act in sensible ways if and when the global financial system starts to magnify shocks, rather than absorb them.

## INTERVENTIONS AT THE POLICY PANEL

LARS NYBERG<sup>1</sup>

Today, most supervisors and central bankers seem to agree on the importance of being prepared for a financial crisis – even though the views on what it means to be prepared differ widely between countries.

First, a few words on moral hazard. The traditional view is still that if you are well-prepared for a crisis and the financial sector is aware of this, moral hazard will increase. I do not share this view. On the contrary, if you are not well prepared, you are – in my experience – more likely to increase moral hazard and spend taxpayers' money. Let me give you a few examples.

When, in the early 1990s, we experienced our big banking crisis in Sweden, we were certainly not well-prepared. We did not see the crisis coming, in spite of all the flashing red lights. Asset prices, in particular property prices, were completely out of line. Banks in Norway were in a very bad condition, but we thought we were immune to any crisis. No doubt, lack of preparation increased moral hazard in the initial phases of the crisis.

The supervisors were not prepared. When the crisis started to hit a number of small institutions, the supervisors got heavily involved in trying to establish various private sector solutions, creating expectations of state support and saving institutions that should have been left to fail. Eventually, the head of the FSA left office.

The government was not prepared. When the savings banks got into trouble, they were saved by taxpayers' money in a way that made it impossible to reclaim the money when, after the crisis, bank capital had again been restored. The owners were bailed out and so was management. If the government had been reasonably prepared, its position in the negotiations would have been much stronger.

These examples of how the lack of preparation may increase moral hazard can be backed up by the experience of the IMF with many crises throughout the world.

Being prepared includes, for instance, letting the financial sector understand that even if institutions sometimes may be saved, shareholders and management never will. This is a good start when it comes to avoiding unwanted visits in the central bank or the ministry of finance. And, of course, constructive ambiguity can be kept, since the timing of and conditions for state interventions should not be communicated. But constructive ambiguity is sometimes taken to mean a complete absence of preparedness and communication with the financial sector. This, in my view, is very dangerous. There have been many crises where, in the end, there has been just ambiguity left, no constructiveness.

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What have we learnt over the past ten years when it comes to preparing for a crisis? I think two things stand out as being particularly important:

Financial stability reports are now being produced by a number of countries and also by the ECB and the IMF. In Sweden, we have just celebrated the tenth anniversary of our Financial Stability Report. Stability reports are important because when writing them, a number of well-educated and experienced people focus attention on current risks in the payment system and in the banking system. And these people are forced to put their assessment in print. Admittedly, this may be difficult in certain situations. But doing it gives a structure to the stability analysis which we did not have before and which is of great value. It also facilitates and sharpens the dialogue with banks and other institutions. If we had had a stability report in Sweden in the late 1980s, I am convinced that some of the worst and most obvious excesses might have been avoided. Banks saw their own balance sheets, but nobody showed them the whole picture and discussed the possible consequences. A good stability report would have done just that.

Crisis management exercises are becoming a commonly used tool in many countries. They are important, not to show that everything works well, but to highlight situations where it does not. Exercises are run within institutions, but nowadays also to test the cooperation between supervisors, central banks and finance ministries. I think that everyone who has taken part in any of these exercises will have had some experiences that made them happy this was all a game and not for real. Exchanging relevant information is not easy and cooperation may be really difficult, even within a single country. Often simple things like a shared framework for assessing the crisis, a “common language”, are missing. And if people assess the problem in different ways, the road to a common solution may be long and cumbersome. Good crisis management exercises help us get better prepared for a financial crisis and also help to train new pilots to take us through it.

Finally, let me touch upon the important challenge to crisis preparation that has appeared during the last decade, namely the cross-border dimension. The Nordic banking crisis of the early 1990s was not a cross-border crisis. Admittedly, several of the Nordic countries experienced financial crises more or less simultaneously, but it was clearly not a cross-border banking crisis. It was a number of domestic crises, resolved domestically. A crisis today would be different. A crisis in any of the Nordic countries would most likely spread to all the others. This situation is not specific to the Nordic countries. We share it with many other European countries.

Is Europe ready to cope with a major cross-border financial crisis? I think we all feel a little uneasy about this question. Certainly we talk about the issue today, which is more than we did five years ago. Supervisory cooperation has developed. We have signed a number of MoUs where we promise to share information and cooperate in general terms. This, again, is a step forward. But is it sufficient for managing a crisis? I do not believe so. All the cross-border simulation exercises that we have conducted in Europe show that serious obstacles remain.

Even if we manage to exchange relevant information between authorities, which indeed may be difficult enough, the need to cooperate remains a powerful challenge. The interdependencies are such that a measure taken by a supervisor or a central bank in one country may have severe or even devastating effects for the financial system in a neighbouring country. These interdependencies have to be understood, acknowledged and respected if a cross-border crisis is to be handled in a manner acceptable to all.

Furthermore, assuming that all problems of information sharing and cooperation can be solved, severe conflicts of interest still remain. Some countries are forced by law to ring-fence a subsidiary (or even a branch) when a bank runs into trouble. This may under very reasonable circumstances deepen the crisis and later lead to repercussions on the ring-fencing country itself. Differences in the deposit insurance set-up may also complicate crisis management, e.g. affecting the possibility of engineering private sector solutions. Variations in the legal structure for public administration of banks in trouble may also create problems. Differences in insolvency laws will create problems even before an entity enters into bankruptcy proceedings due to the expectations and uncertainty about what these proceedings will lead to. All these issues relating to conflicts of interest must be brought up for discussion during normal times. When a crisis occurs, it is likely to be too late.

Probably the most important and most difficult of all conflicts of interest is the burden-sharing problem. If a bank has important operations in several countries, and in a crisis it turns out that saving the bank is a lot less costly to society than letting it fail, who should pay? Can burdens be shared in an equitable manner? And, if so, what is equitable?

I do not believe that we can find or agree on a formula that would stipulate ex ante how to share the burden of a failure of a given bank or banking group. All crises are different and where a crisis starts and how it develops may well affect any burden-sharing discussion. But I do believe that some procedures must be in place ex ante between the countries sharing the problem. Such procedures may contain agreements on how to organize the cross-border cooperation in a crisis, when to involve the different authorities, how to deal with conflicts of interest, including that of burden sharing, etc. An agreement may take the form of a MoU, which is not legally binding, but it must in my view be more precise than the MoUs we currently have. Do not read this to mean they should be overly prescriptive. But in all the exercises that I have seen, our present MoUs have been too vague to be of much practical help.

To conclude, I know that problems of burden sharing may seem theoretical and even dangerous to many European countries. To us in the Nordic countries they are very real. If a serious cross-border crisis occurred in a Nordic bank and the costs were not believed by the public to be shared in an equitable manner (e.g. if the taxpayers of one country had to carry the full burden of saving the financial system of another country), this would be a major problem. Political relations between the countries might be affected for a long period. And if it

turned out that responsible authorities, including the ministries of finance, were unprepared for such a situation, I fear we would all face some trouble.

# INTERVENTION AT THE POLICY PANEL

PETER PRAET<sup>1</sup>

## I INTRODUCTION

Managing a banking crisis, domestic or cross-border, is a complex task for authorities. The need to act quickly and the difficulty of operating in an uncertain environment constitute two different sources of complexity that are inherent in crisis management.<sup>2</sup> Indeed, crisis management is often compared to a race against the clock. A bad situation can very quickly deteriorate, due to the high leverage of banks and the ability of retail and wholesale depositors to withdraw their deposits. Decisions must be taken very rapidly to restore confidence and to avoid widespread bank runs and disruptions in the financial sector. In addition, a crisis situation is by its very nature uncertain. Although most crises share some common features, each crisis is essentially unique and presents contingencies that could not have been foreseen or dealt with *ex ante*.

Facing such complexity, authorities have the duty to prepare themselves to efficiently manage a crisis situation, particularly as insufficient preparation can seriously hinder crisis resolution. For instance, inadequate preparation can result in a lack of information that can slow down the ability to resolve a crisis. This is especially the case when banks operate in a complex environment. Conversely, adequate preparation makes it possible to identify operational shortcomings that would potentially constitute obstacles to efficient crisis resolution but that would otherwise not be visible in normal times. Techniques exist to minimise these two risks. The remainder of this presentation illustrates how Belgian authorities take advantage of stress-test exercises (Section 2) and crisis simulation exercises (Section 3) to minimise respectively the risk of inadequate information and the risk of operational shortcomings. A final section concludes.

## 2 INFORMATION AND STRESS-TEST EXERCISES

Stress tests constitute one channel through which information relating to potential risks is exchanged between a bank and its supervisor. The experience of the Belgian authorities with stress tests can not only be used to illustrate the sort of information that can be gained thanks to such exercises but also to identify areas where progress still needs to be made. Following on from the 2005 Financial Sector Assessment Program conducted in Belgium by the IMF, and similar to the experience of other countries, the National Bank of Belgium (NBB) and the Banking, Finance and Insurance Commission (CBFA) have jointly organised annual stress-test exercises to measure the respective importance of credit risk,

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<sup>2</sup> For an analysis of the different sources of complexity associated with both domestic and cross-border crisis management, see e.g. G. Nguyen and P. Praet (2006), “Cross-border Crisis Management: A Race against the Clock or a Hurdle Race?”, National Bank of Belgium Financial Stability Review, pp. 151-173.

market risk and insurance technical risk in the Belgian financial system. Both bottom-up and top-down stress-testing exercises have been staged to measure the sensitivity and resilience of individual institutions to a series of different very extreme shocks, including for instance:

- parallel upward (downward) shifts in the yield curve (+/- 100, 200 and 300 basis points) and steepening/flattening of the yield curve, i.e. decrease (increase) of short-term rates of 100 basis points associated with an increase (decrease) of long-term rates of 100 basis points;
- a general downgrade scenario triggered by an immediate increase in the probability of default (PD) of 30% from current levels, combined with defaults by counterparties that had an initial PD of at least 15%;
- a general default scenario triggered by the defaults of a certain number of counterparties within every rating class. This number of defaults is set at 30% of the average PD of each rating class (with a random selection of defaulting counterparties); and
- several insurance technical risks, including a worsening of the mortality rate, an exceptional natural disaster and an increase in the combined ratio.

The results of these mechanical stress tests are interesting but they only give a general idea of the risk that institutions face in the absence of any reaction and feedback effects. The informational content of this measure thus remains limited. Such stress tests may still be reasonably accurate in a context in which financial institutions do not actively trade risks, and in which their main risks are on balance. However, over the last decade, risk management techniques, together with the nature of information asymmetry, have changed tremendously.

In the past, the concept of informational asymmetry was mainly used to characterise the traditional lender-borrower relationship: since the lender can only imperfectly assess and monitor the quality of the borrower, the borrower has better information on its creditworthiness than the lender. This may possibly lead to a problem of adverse selection with regard to the borrower's quality and a problem of moral hazard incurred by the borrower. Logically, this problem of asymmetric information also affects supervisors trying to assess the actual credit risk taken by a financial institution. Mechanical stress tests can to some extent circumvent this source of informational asymmetry.

As a result of improvements in data processing combined with the development of quantitative techniques, progress in credit risk management techniques has allowed banks to narrow, to a certain extent, the informational gap that exists between them and their debtors. Thanks to a continuously expanding capacity to handle and exploit large databases, banks may have raised their standard informational requirements as well as their capacity to screen candidates for borrowing. At the same time, banks also become better able to assess the credit risk associated with a loan portfolio in balance, and to communicate this information to supervisors, investors, and the public at large.

The huge developments in credit risk measurement have contributed to the rapid expansion of techniques for credit risk transfer (CRT). Since banks were capable of assessing the credit risk of a portfolio of loans and also able to communicate information on the parameters influencing this risk to rating agencies and investors,<sup>3</sup> they were able to start to trade credit risk on the secondary market, developing a huge variety of instruments and techniques, from relatively simple single-name default swaps to more complex structured products. The traditional business model, in which a bank originates a loan to bear the risk associated with it, now coexists with a model in which a bank originates loans to redistribute them, directly or repackaged, potentially along with a slice of the associated credit risk, too.

This change of business model is generally considered to be positive. Indeed, banks can more easily hedge their credit risk and redistribute it to counterparties that want to bear it. A recourse to credit risk transfer techniques can consequently help banks to reduce or adapt their credit risk without jeopardising their relationships with their clients. In addition, it diversifies their sources of funding. Banks may also make use of these techniques to free up capital to provide additional lending. At the same time, these products are also attractive for investors who find in them an opportunity to diversify their portfolios or to increase their rate of return, especially in a low-yield environment.

Yet, this positive evolution also modifies the very nature of risks borne by banks and may have given rise to new forms of asymmetric information.<sup>4</sup> Firstly, at the microeconomic level, the introduction of credit risk transfer instruments may aggravate problems that already exist between the lender and the borrower and may create new problems of asymmetric information between the protection buyer and the protection seller. For instance, adverse selection with regard to the borrower's quality and moral hazard incurred by the borrower may worsen if incentives for the lender to efficiently screen and monitor borrowers decrease (e.g. if the credit risk protection offered by CRT markets makes the credit protection buyer less rigorous with regard to monitoring). However, these problems will not materialise or will remain limited if the protection seller can verify the quality of the underlying assets and check the intensity of monitoring, or if a contract can align incentives for both the lender and the protection seller.

Secondly, at the macro-prudential level, while credit risk is migrating off balance, it becomes harder for authorities and investors to identify who is ultimately bearing the risk. Consequently, the capacity of credit protection sellers to withstand the associated credit, market and liquidity risks also becomes more difficult to estimate. The latter problem, which may sometimes have been underestimated, may over time have become more important than the problems associated with the traditional form of asymmetric information between lender

<sup>3</sup> Although problems of data availability may have sometimes surfaced when long time series were required.

<sup>4</sup> For an extensive analysis of how credit risk transfer instruments introduce a new form of asymmetry of information, see e.g. J. Kiff, F.-L. Michaud and J. Mitchell (2002), "An Analytical Review of Credit Risk Transfer Instruments", National Bank of Belgium Financial Stability Review, pp. 125-150, or Committee on the Global Financial System (2003), "Credit Risk Transfer", Bank for International Settlements.



and borrower. In addition, this problem may be harder to solve with existing stress-testing tools, raising new challenges for the authorities.

Similarly, the nature of the main risks borne by credit institutions may have changed. While banks were previously mainly exposed to traditional forms of risks that can be reasonably well captured by mechanical stress tests, such as credit and interest rate risks, they are now increasingly exposed to funding and market risks. For instance, funding risks may arise from the potential difficulty to sell a financial asset quickly if secondary markets are illiquid. Market risk may result, for instance, from changes in the credit spreads of names represented in a portfolio of CRT instruments. In addition, the importance of concentration and counterparty risk may also have increased.

In order to partially assess the liquidity risks funding in an environment in which institutions can easily trade risks, it is essential to take into account the reaction to the shock of the affected institution, as well as the complex interactions between the different market players and any potential feedback effects. The Belgian authorities have carried out original liquidity stress tests in which some of these aspects could be reflected.<sup>5</sup> Indeed, the possibility of being able to take account of some behavioural assumptions was an explicit concern when conducting these tests. The four largest Belgian banks participated in the liquidity stress tests, conducted for the first time in 2006. Each banking group stressed its liquidity position according to several predefined scenarios over a three-month horizon. Specific attention was nevertheless paid to cash flow changes and the action taken by groups during the first few days of the crisis, as these early days are usually found to be most crucial for management of a liquidity crisis. Three broad scenarios were defined. The first scenario simulated an idiosyncratic three-notch downgrade. In the second scenario, the three-notch downgrade was combined with adverse market conditions. Finally, in the third scenario, banks were supposed to simulate the operational problem that would have put the greatest stress on liquidity positions. In addition, banks also reported the evolution of the liquidity position in a base case, i.e. in the absence of liquidity shocks.

The scenarios were only broadly defined, leaving participating credit institutions with considerable discretion. This made it harder to compare the quantitative results, but, on the other hand, it also gave the participating banking groups greater flexibility and reflected more closely the diversity in banking groups' liquidity management. For instance, credit institutions had to make assumptions about withdrawals of wholesale and retail deposits, with regard to the functioning of certain markets (including secured and unsecured interbank borrowing), the quality of collateral and the need for higher-quality collateral (rating triggers), the possibility to transfer collateral across borders and across the same group, the position in payment and securities settlement systems, etc. One of the main conclusions of this exercise was that banks fully used this discretion, as significant variations in the assumptions made by banking groups were observed. The differences basically concerned two types of assumption: first, the

<sup>5</sup> For more information on the liquidity stress tests conducted in Belgium, see J. Janssens, J. Lamoot and G. Nguyen (2007), "Liquidity Risk in the Banking Sector: the Belgian Perspective", National Bank of Belgium Financial Stability Review, pp. 123-133.

assumptions relating to the size of the shock and its impact on the behaviour of other economic agents, and second, the remedial action taken, if any. These stress tests, which were quantitative in nature, included a qualitative section as well, because banks also documented and justified the different assumptions made and the corrective actions that were postulated. Participating credit institutions also provided information on their contingency funding plans. This qualitative information was considered at least as important as the quantitative results. In order to complete the picture, a high-level meeting was held with each credit institution to discuss the interpretation of the stress tests and the plausibility of assumptions, scenarios and findings, and to provide feedback on the average results of the sector, as well as on the range of assumptions made.

As expected, this methodology allowed authorities to gather valuable quantitative and qualitative information on the risks borne by credit institutions. In particular, the methodology allowed (i) to better investigate complex relationships that would not have been observable in more mechanical stress tests and (ii) to discuss findings with high-level management. The stress tests conducted in June 2006, for instance, made it possible to highlight the liquidity risk associated with conduits and their functioning in the event of stress. The stress tests showed how these instruments may consume liquidity in stressful events such as a rating downgrade or a generalised market liquidity crisis. Liquidity needs resulting from the other committed facilities were also illustrated. The wide discretion left to banks allowed them to make a distinction between committed facilities with a high risk of being fully drawn and facilities for which this was less likely.

These stress tests also have their limits in the way they integrate complex interactions. Each institution tests its liquidity risk individually and no attempt is made to consolidate the results or to link them through some form of contagion channels in order to obtain an overview of the situation at a macro level. Similarly, credit institutions have to make assumptions on the behaviour of the other market participants. This behaviour is thus not endogenously determined. However, liquidity stress-testing exercises can be further developed to take account of these limitations or to include additional elements. For instance, introducing a reverse-engineered stress test in which each institution will have to specify a scenario to obtain a predetermined liquidity position may allow additional firm-specific vulnerabilities to be identified.

Finally, while liquidity stress tests reflect the liquidity risk associated with the development of the CRT market and the reaction of banks in a complex environment relatively well, they only imperfectly capture the greater vulnerability to market risk associated with the development of the CRT market. This obviously constitutes an important challenge for the development of future stress-test exercises in Belgium.

### **3 OPERATIONAL SHORTCOMINGS AND CRISIS SIMULATION EXERCISES**

Operational shortcomings constitute another form of obstacle to efficient crisis management. To the extent that crises are stressful events, things that may seem

easy in normal times may become more complicated or may not run smoothly, triggering additional difficulties that could be avoided with adequate preparation. Operational hitches may, for instance, include difficulties in identifying and reaching key people, difficulties in coordinating communication between authorities, with the ailing bank and to the public (including to markets and the press), problems getting access to accurate and updated information, in reaching the back-up facilities, etc. Important operational problems are more likely to surface when a banking crisis is caused by an external event that has a broader impact on the environment in general, such as a terrorist attack or a natural disaster, for instance, but they should not be overlooked in the management of a crisis limited to the banking sector.

Well-designed crisis simulation exercises can help prevent the occurrence of operational problems. These exercises can be more or less sophisticated. They can range from a mere communication test, in which organisers check whether they can easily contact some participants likely to be involved in settling a real crisis, to more sophisticated exercises aiming at testing contingency planning and/or involving the simulation of real liquidity or solvency problems in one or more credit institutions (that may be fictitious or inspired by existing banks).

The Belgian authorities are currently preparing a domestic crisis simulation exercise, leveraging the experience gained through participation in several cross-border exercises, either as organiser or participant. The objective of the simulation will be to test the functioning of the domestic arrangements between authorities, as well as the operational framework for crisis management. As the test has not yet been conducted, discussions on the Belgian experience will remain limited to the main motivations behind the organisation of such an exercise, and to the main limitations in interpreting the results.

The design of the scenario is essential for the success of such an exercise. The scenario should be based on a realistic but extreme event. It should be well documented and, to make it realistic, should foresee the dissemination of information that participants can expect to receive in real crisis times. For instance, in the context of the liquidity stress tests, Belgian authorities explained to credit institutions the kind of data they would expect to receive to assess the liquidity position of a bank in a crisis situation. Banks voluntarily presented the reports that they could currently provide should a crisis arise. Although the list of required information cannot be determined exhaustively *ex ante* as it will depend upon the nature of the crisis, it already gives an idea of basic reporting requirements that banks could expect to face in a crisis situation. In addition, these documents constitute a useful basis on which to construct a plausible scenario for a crisis simulation exercise. Using real templates in a simulation exercise can also give authorities a better understanding of the information that can be delivered in the event of a crisis, can help them to interpret submitted information in a short space of time, and enable them to understand limitations associated with the current reporting framework, and to formulate potential additional requirements if necessary.

Another incentive for conducting a crisis simulation exercise is that it could contribute to reinforcing mutual trust and knowledge and consequently strengthen networks of crisis management authorities. This advantage is obvious when a crisis is simulated in a cross-border context in which authorities operate in a less familiar environment, coordinating with counterparties with which they are not used to working. In a purely domestic context, in which participants are more likely to know each other fairly well, this advantage can be perceived to be less important. However, since crises are hopefully rare events, it is likely that participants have never worked together on crisis resolution, and the simulated crisis context can modify incentives and consequently behaviour and reactions of those involved. In addition, several agreements have recently been concluded between authorities in charge of crisis management, including the implementation of domestic standing groups. Testing these agreements is a necessary step to ensure their proper functioning.

Crisis simulation exercises have also some limitations. First, they are restricted in scope and time and therefore may not be fully realistic. In addition, participants act in a closed environment. They cannot test the reactions of financial markets and private sector participants which are necessarily simulated by the organisers. In such a context, it may be difficult to realistically test the implementation of a private sector solution. In addition, since participants know that the crisis is only a simulation, they may act more cooperatively than they would in reality. Since conclusions relating to conflicts of interest and to the behaviour of participants will remain limited, crisis simulation exercises should perhaps be more focused on findings relating to operational shortcomings. Finally, since each crisis is unique, a crisis management simulation exercise will never ensure that a crisis management framework is adequate in all circumstances. However, it can detect deficiencies, which, if resolved, will improve the way a crisis is handled.

#### **4 CONCLUDING REMARKS**

Crisis preparation is among the core tasks of authorities in charge of crisis management. Domestic authorities in European countries are to different extents and with different tools already preparing for crises. This preparation can take several forms and the experience in Belgium can be used to illustrate how the authorities have taken advantage of two exercises to improve their capacity to manage a crisis. First, well-devised stress-testing exercises help to improve the information available to authorities. Second, crisis simulation exercises help to oil crisis management mechanisms that are fortunately only rarely used.

Current stress-testing exercises are often too mechanical. In a complex environment, in which banks trade risks on secondary markets, operate in several countries, are active across sectors, and integrate and centralise some of their key functions, this mechanical approach may no longer be valid. Therefore, stress-test exercises need to take account of banks' specific features through behavioural assumptions. In addition, future stress-testing exercises will also have to take account of the regional dimension of cross-border institutions and authorities may want to cooperate to devise common stress tests. A better coordination of the

stress-test exercises would first benefit credit institutions that currently perform similar stress tests in several jurisdictions, which involves a duplication of effort. They would also benefit supervisory authorities and central banks which would have a better view of the group dimension. Similarly, this internationalisation context may also call for the organisation of cross-border crisis simulation exercises that would reflect the regional dimension of several credit institutions. The European Central Bank and the Economic and Finance Committee have already organised several international crisis simulation exercises. Authorities may now want to carry out exercises at a regional level and some have already done so.

The conclusions to emerge from cross-border stress tests and cross-border crisis simulation exercises may raise fundamental questions about the crisis management framework in Europe and may highlight a need for further improvements with regard to information sharing and the allocation of crisis management responsibilities. While some improvements may be further investigated, we need to bear in mind that the flexibility of the present crisis management framework needs to be ensured to maintain the capacity of crisis management authorities to adapt to a crisis environment, which, by definition, will remain uncertain.

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## INTERVENTIONS AT THE POLICY PANEL

### KENZO YAMAMOTO <sup>1</sup>

I would like to provide you with some thoughts based on our experiences in the trenches during the Japanese financial crisis.

We were a source of much concern to fellow central bank colleagues during that difficult period. I am pleased to say that the time has finally come where we can share with you our experiences and lessons which could be of value to you.

The first lesson is that determining whether a failure of an individual financial institution may cause systemic risk to materialize is very difficult. Commonly considered benchmarks of the failing financial institution such as "asset size", "magnitude of default" and "whether an entity is a bank or securities firm" may not necessarily be meaningful depending on the overall situation. In assessing the possibility of systemic shocks, other factors such as the condition of the real economy need to be sufficiently taken into consideration.

In November 1997, a mid-sized securities firm, Sanyo Securities, failed. It was the first case of a default in the interbank call market. Sanyo Securities was a securities firm with a limited amount of assets. Customer assets were segregated and protected. Furthermore, the defaulted amount in the call market was quite small.

However, the financial system as well as financial markets became very unstable. It was the first ever default in the interbank market and, also reflecting the weak economic environment, market liquidity tightened dramatically and other financial institutions rumoured to be in weak condition began to face difficulties in accessing funds.

As such, determining “the likelihood of systemic risk materializing” is a difficult task. Therefore, it is important to clearly establish beforehand the procedures to decide whether a case is systemic or not.

The second lesson is that, in preparing for a financial crisis, the basic functions of relevant authorities must be clearly established, based on a specific legal and structural framework. Unfortunately, initially, as the non-performing loan problem emerged in Japan, this demarcation of responsibilities was unclear.

Two weeks after Sanyo’s failure, one of the big four securities firms, Yamaichi Securities, failed. As I mentioned, the interbank market was in a very unstable state. Additionally, Yamaichi Securities owned several banking subsidiaries in Europe. Both the government and the Bank of Japan were strongly concerned about further instability in the domestic financial markets and the possible negative repercussions for the global financial markets, if Yamaichi Securities

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was allowed to simply fail. Under these conditions, the government, based on the assumption that Yamaichi Securities was still solvent, requested the Bank of Japan to provide funding on an uncollateralized basis.

There was fierce internal debate at the Bank of Japan whether to fulfil the government's request. Since Yamaichi Securities had hidden its losses, there remained uncertainty regarding whether Yamaichi Securities was actually solvent.

In the end, the Bank of Japan determined that the key priority was to prevent possible contagion in domestic and global financial markets. Based on the Minister of Finance's declaration to take sufficient measures to resolve the Yamaichi Securities problem, the Bank of Japan decided to provide special loans to Yamaichi Securities on an uncollateralized basis, fully supporting its liquidity needs.

What happened afterwards? Yamaichi Securities was dissolved. The process took seven years to complete. Yamaichi Securities turned out to be insolvent and the Bank of Japan eventually suffered losses. I still believe the decisions taken at the time were appropriate under the circumstances, although some went beyond the fundamental role of a central bank.

As further experience in resolving problems at financial institutions was gained, laws were revised or newly prepared and the safety net to deal with financial crisis was strengthened. Now the following functions have been clarified: (1) the central bank provides funds to solvent financial institutions, and (2) the government is responsible for overall resolution planning as well as the injection of public funds as capital and loss coverage. The Bank of Japan has published its four principles as the lender of last resort, continuing its efforts to enhance the understanding of the specific role of the central bank in a financial crisis:

- 1) there must be a strong likelihood that systemic risk may materialize;
- 2) there must be no alternative to the provision of central bank funds;
- 3) all responsible parties are required to take clear responsibility to avoid moral hazard; and
- 4) the financial soundness of the Bank of Japan should not be impaired.

The third lesson is the importance of developing a strong trust among relevant parties based on a face-to-face relationship. In a crisis, various events will continuously unfold in unexpected ways. Foreseeing beforehand all plausible crises is not practical. Thus, in order to be able to deal with unexpected crises in a flexible manner, it is important to develop a strong relationship among relevant authorities during normal times.

For example, when Long-Term Credit Bank of Japan failed in 1998, the government chose to temporarily nationalize the bank and prepared the necessary legislation. One difficult practical issue which we faced was whether this would trigger an event of default under derivatives contracts. Long-Term Credit Bank of Japan had substantial derivatives transactions on its books.

The measure of temporary nationalization was chosen in order to maintain the Long-Term Credit Bank of Japan's financial functions and to avoid disruption in the financial markets and the financial system. Thus, the government and the Bank of Japan had expected that even after the nationalization, all contracts would be fulfilled. If the counterparty, however, deemed that the temporary nationalization was an event of default, due to cross-default clauses included in the derivatives contracts, there was a risk that this could trigger widespread defaults, causing disruptions in a broad range of financial markets.

After obtaining information that some counterparties were considering it as an event of default, the Bank of Japan, the Financial Services Agency and the Ministry of Finance explained in detail, to financial market participants, industry groups such as International Swaps and Derivatives Association, Inc. (ISDA), and overseas authorities, the objective and framework of the temporary nationalization before it came into effect. Looking back, it was unclear which authority was responsible for handling such issues. Nonetheless, the three authorities considered it a joint responsibility and actively coordinated their efforts in promoting the new resolution measure. This was possible due to the trust developed through our day-to-day contacts.

Lastly, how did we handle cross-border issues during the period of financial instability? In practice, regardless of whether they were branches or subsidiaries, the Japanese authorities decided to provide support for all liquidity needs as well as all losses. This was due to (1) the fragile state of the Japanese financial system, and (2) the relatively small weight of the activities of overseas subsidiaries. The measures to deal with the cross-border issues were determined to cope specifically with the unique situation in Japan at the time. But I may say that the responses of the home authorities may differ, depending on the overall situation.

Thank you for your attention.





## **SESSION I**

### **MACRO STRESS TESTING – MOST RECENT EXPERIENCES**

#### **THE IMF'S EXPERIENCE WITH MACRO STRESS TESTING**

*Mark Swinburne*

#### **DEVELOPING A FRAMEWORK FOR STRESS TESTING OF FINANCIAL STABILITY RISKS**

*Nigel Jenkinson*

#### **STRESS TESTING: THE SPANISH EXPERIENCE**

*Jesus Saurina*

#### **MACRO STRESS TESTING – MOST RECENT EXPERIENCES**

Comments by *Gerhard Hofmann*

# THE IMF'S EXPERIENCE WITH MACRO STRESS TESTING<sup>1</sup>

MARK SWINBURNE<sup>2</sup>

## I INTRODUCTION

As most of you are I'm sure aware, one key component of the Financial Sector Assessment Program (FSAP), undertaken by the International Monetary Fund (IMF) and the World Bank, has been the use of stress tests to identify vulnerabilities across institutions that could undermine the stability of a country's financial system.

Since the Program began in 1999, FSAPs have been completed or are currently underway for over 120 countries — two-thirds of Fund membership. And the Program is increasingly moving into Update mode, with around 30 FSAP Updates already completed or underway. As you may also know, Europe has been very well represented in these numbers. In any event, some form of stress testing has been universal in these first round FSAPs and Updates, though admittedly in some cases the “stress testing” has, of necessity, been very simple.

Furthermore, as a reflection of the growing integration of financial sector work into the IMF's Article IV surveillance process, Article IV teams are starting to experiment with introducing stress-testing exercises as part of their regular consultations. It is very early days yet, and such exercises will probably be done on only a subset of countries, and will always be significantly more limited than what could be undertaken in an FSAP or Update. But the direction of movement over time seems clear. It is in turn facilitated by the rapid expansion of interest in, and capacity for macro stress testing amongst the authorities in an increasingly wide range of countries.

In this presentation, I will focus on our experience with the more comprehensive form of stress testing in FSAPs. The next section provides background on the nature of an FSAP and the role of macro stress testing within it; after that, I will describe how the methodology of stress testing in FSAPs has been evolving and what fairly common approaches are now being used, as least for more advanced economies; and then I will discuss the main challenges for future development of macro stress testing in FSAPs.

## 2 BACKGROUND: OVERVIEW OF THE FSAP

The broad objective of FSAPs is to help strengthen and deepen financial systems and enhance their resilience to potential financial crises. Specifically, they aim to

<sup>1</sup> I would like to thank, without implicating, IMF colleagues for helpful comments and suggestions, especially Martin Čihák and Alexander Tieman.

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make assessments of the main financial sector risks and vulnerabilities, and offer policy recommendations aimed at: (i) reducing the potential for systemic crises; (ii) limiting the severity of crises; and (iii) more generally, addressing structural weaknesses related to the financial sector.

A key feature of FSAPs and FSAP Updates — perhaps the defining feature — is that they endeavor to take a relatively broad, holistic view of system level risks and vulnerabilities. This means not only the main structural, institutional and market features and activities of the financial sector, but also the financial policy framework within which the financial sector operates — in particular the strengths and weaknesses of arrangements to prevent or manage financial sector crises, and how these in turn affect financial sector behaviour.

Similarly, it means applying a range of both quantitative and qualitative tools and methodologies to get at the important issues. Formal standards and codes assessments, for example, are one important tool on the qualitative side, but are not always the most suitable (or cost-efficient) way of addressing policy issues.

Likewise, stress testing is a key quantitative tool in FSAPs, but not the only one. A sort of CAMEL-style analysis of the financial system, summarized in Financial Soundness Indicators (FSIs) is also needed, along with aggregate balance sheet analysis (macro, sectoral) and, where feasible and available, analysis of market-based indicators and (supervisory or other) early warning systems.

### 3 STRESS TESTING IN FSAPS<sup>3</sup>

There is an important point of principle underlying this rather eclectic approach, under which — to reiterate — stress testing is a key tool in FSAPs, but one that is supplemented by both qualitative analysis and other forms of quantitative analysis. As stated succinctly by Bunn et al (2005):

“.....no single model is ever likely to capture fully the diverse channels through which shocks may affect the financial system. Stress testing models will, therefore, remain a complement to, rather than a substitute for broader macroprudential analysis of potential threats to financial stability.” (p.117)

Thus, FSAP stress testing is not interpreted by IMF staff as providing numerical estimates that are in themselves very precise. Rather, the benefit lies as much in the analytical process undertaken by the FSAP team and the authorities in constructing the stress testing as a means to explore potential vulnerabilities in the financial system. They are an instrument for a useful dialogue on these issues, and often a useful learning experience. I think it is also fair to say that the FSAP stress-testing process has quite often encouraged policymakers to further develop their own capacities in this area, as part of the broader process of building a more specific financial stability assessment function and capacity. (IEO, 2006)

<sup>3</sup> This section draws especially on Blaschke et al (2001), Jones et al (2004), and Čihák (2007).

FSAP stress tests are tailored substantially to country-specific circumstances, both as to the different types of potential vulnerabilities to be subjected to stress testing, and the exact nature, coverage and size of the shocks applied to the various risk factors. In combination with the ongoing evolution of stress-testing methodologies, this has therefore resulted in quite a wide range of practice.<sup>4</sup> Within this, some basic principles of “good practice” in FSAP stress testing have developed over time and are continuing to evolve.

## STRESS-TESTING APPROACHES

Stress tests in FSAPs come in four broad varieties, but all in the end are aimed at examining the potential vulnerabilities at the system level. On one dimension, they may be either in the form of a range of *sensitivity tests* addressing the impact of shocks to single risk factors in each test, possibly in a rather ad hoc and atheoretic fashion; or they may be tests focusing on *scenarios* in which multiple risk factors change in a fashion which is intended to be internally consistent within a defined broader, underlying scenario.

On a second dimension, and notwithstanding the ultimate focus on the system level, FSAP stress tests can be either *bottom up*, based on the portfolios of individual financial institutions, or *top down*, where the focus is on an aggregate system-wide model. Since other speakers will be discussing bottom-up and top-down methodologies, I will not discuss these variants in any detail here, but simply note three points that clarify what this distinction means, and does not mean, in the context of FSAP stress tests.

First, given the IMF’s normal focus and comparative advantage, it is perhaps not surprising that FSAP stress tests have increasingly emphasized the design of adverse macroeconomic scenarios, and the impact of these scenarios on the creditworthiness of financial institutions and the stability of the financial system as a whole. The construction of such macro scenarios — and more generally the identification of the macro-level risk factors to be shocked — is a critical exercise in the FSAP stress-testing process, whether these will be applied in a bottom-up exercise, or only in a top-down way.

Second, since FSAP stress tests are fundamentally intended to address the risks that arise from common shocks, the essence of FSAP stress testing is therefore that the same shocks are applied uniformly to all institutions, whether the methodology is top down or bottom up.<sup>5</sup>

And third, no careful analysis of system-level stability can afford to look only at the system-level aggregates and averages. Some attempt also needs to be made to understand the nature of the dispersion underneath the aggregates and averages, since concentrations of exposures and vulnerabilities that may be important at a system level can be hidden beneath more benign-looking aggregates.

<sup>4</sup> The Appendix to this paper summarizes the range of practices for FSAP stress testing in European countries.

<sup>5</sup> To be more precise, the same shocks are applied to a given set of institutions covered within a given stress test.

Some form of bottom-up testing is therefore critical in FSAPs, whether or not this is informed by well-integrated and internally consistent macro scenarios. Indeed, for FSAPs the merit of purely top-down tests lies mainly in providing supplementary analysis, especially — in the spirit of the principle of not relying too heavily on any one model — as a means of partially cross checking the results of bottom-up tests.

In terms of the calibration of the scenarios and shocks, the basic underlying principle for FSAP stress testing is that the shocks should be “extreme but plausible”. What that translates to in any particular case can vary quite widely, however, depending on circumstances.

## STRESS-TESTING EXPERIENCE

As already noted, stress-testing processes and methodologies in FSAPs have evolved quite significantly since the early days of the Program, and in a number of ways, as summarized in the table below. I would highlight the following main points.

- (a) Most FSAPs conduct single-factor sensitivity analysis, but these analyses have evolved from being quite central to being more supplementary, e.g. as a means of obtaining some sense of the partial derivatives that may be associated with a broader, multi-factor scenario.
- (b) In contrast, more recent FSAPs have increasingly involved explicit macroeconomic scenario analysis, of varying natures and degrees of complexity.
- (c) The testing increasingly involves the authorities’ direct involvement at all levels, from the design of the methodology and selection of scenarios and shocks in agreement with the FSAP team, to the implementation or coordination of the tests, and analysis of results.
- (d) It also increasingly involves financial institutions directly, at least in relatively advanced systems. Institution-by-institution implementation uses their own models, analyses and judgments about the impact of the given scenarios and shocks.
- (e) Interbank contagion is becoming more commonly integrated into the stress testing to examine further, indirect effects of the common shocks. Typically this has been based around a matrix of mutual exposures in the domestic interbank money market.
- (f) And finally, non-bank financial institutions are also increasingly covered in FSAP testing, mainly in the form of insurance companies and to a lesser degree pension funds. Most commonly, the non-bank sector(s) is tested separately from the banking sector, but in a number of cases, cross-sectoral conglomerates have been tested at the overall group level.

**Table 1 Evolution of FSAP stress testing methodology**

(% of all FSAPs initiated in the period)		
	2000–2002	2003–2005
Scenario analysis	64	95
Contagion analysis	11	38
Insurance sector stress testing	25	37

Source: Čihák (2007).

## RISKS ADDRESSED IN FSAP STRESS TESTS

FSAPs have addressed a range of different risks in stress tests, within the broad categories of credit risk, market risk (interest rate, exchange rate, volatility, and equity, real estate and other asset price risk), liquidity risk, and contagion risk.

*Credit risk* has been the most important risk addressed in FSAPs, reflecting the fact that it is in general the most important overall source of risk for financial systems, as typically reconfirmed by the stress tests themselves. At the same time, both in the FSAP context and more generally, it is also the risk area most in need of further development of assessment and management methodologies.

A fairly typical approach is to use single equation models for household and corporate sector creditworthiness, with credit quality as a function of various macroeconomic variables.<sup>6</sup> For example, the Hong Kong FSAP used single equation aggregate estimates as well as panel estimates using bank-by-bank data. And in the recent Denmark FSAP, a robust VaR was used to estimate economic capital over the business cycle in a data-restricted environment. This latter case reflected some of the newer modeling methodologies (see Segoviano and Padilla (2006)).

The credit risk scenarios used have depended significantly on the specific circumstances of the country (e.g. macroeconomic circumstances), as well as data availability. Measures of NPLs and loan provisioning have been tested in most countries, for example through NPL migration analysis and loan reclassification. Increasingly, this has also been undertaken through more sophisticated analyses of PDs and LGDs, including the effect on these of various macro factors. In addition, various other specific issues have been examined in some cases where they were particularly relevant, such as cross-border lending (e.g. for Austria), foreign currency lending (e.g. Jamaica), or loan concentrations (e.g. the Netherlands, Russia).

*Market risk* has tended to show smaller effects in FSAPs, partly due to the shorter horizon but also presumably reflecting the fact that it is an area generally better managed and addressed through prudential supervision, and often handled using internal models. Correlations of market and credit risk, however — especially

<sup>6</sup> In some cases where data permitted, it has been possible to further disaggregate the corporate sector and look at credit quality indicators by sub-sector.

through indirect credit risk — have often not been covered as well. Analysis of market risk has used a range of different approaches. For interest rate risk analysis, some FSAPs have looked at repricing and maturity gaps (e.g. Hungary), others have looked at duration (e.g. Czech Republic, Israel), and others at Value at Risk (e.g. Belgium, Italy). For exchange rate risk analysis, tests focused on net open positions in some cases (e.g. Bulgaria, Sweden), and on Value at Risk measures in other cases (e.g. France, Germany).

Market risk shocks have been built on ad hoc, hypothetical or historical interest rate increases, sometimes in the form of a parallel shift in the yield curve, in other cases with a steepening or flattening of the yield curve. Similarly, exchange rate changes, volatility shocks or asset price shocks have also been built around ad hoc, hypothetical or historical movements. Sometimes, the tests have been built explicitly around the Basel Committee amendment to the Capital Accord to incorporate market risk. *Equity and real estate price shocks*, for example, have very commonly been tested, including shocks to the global or local stock markets (e.g. Finland, South Africa), housing price shocks (e.g. Hong Kong, Ireland), and shocks that explicitly examine LTV ratios or mortgage PDs (e.g. Belgium, Australia).

*Liquidity risk* shocks have most often been in the form of changes to a liquidity ratio measure, either ad hoc (e.g. Austria, UAE), or based on historical data (e.g. France, Croatia).

A range of *other risks* have been tested on a more intermittent basis, including commodity prices (e.g. Finland, New Zealand); country exposure risk (e.g. Luxembourg); shocks to specific sectors (e.g. shocks to agriculture in Belarus and New Zealand, or the ICT sector in Finland); impact on interest margins of competition risk (Lithuania, Slovenia); and interbank contagion (although, as noted earlier, this is becoming more common). Stress testing *contagion risk* is a potentially important complement to the stress testing of individual institutions faced with common shocks in bottom-up FSAP tests. When undertaken, these tests typically examine domestic, uncollateralized interbank exposures (e.g. Belgium).

## 4 FSAP STRESS TESTING GOING FORWARD

As the FSAP continues, and is increasingly dominated by FSAP Updates, a range of issues arises on how the stress-testing aspects might or should evolve further. Some of these are narrower issues about how the underlying analytical methodologies could evolve, and some are broader issues more to do with the stress-testing process in FSAPs.

Looking at the analytical methodologies first, it seems clear that we, like other macro stress testers, will want to continue to work on the further development of credit risk modelling, including specific modeling of distributions of PDs and LGDs, as well as correlations between banks and between portfolios to better reflect credit risk at the system level. But there is also a range of other specific



areas for further development, or at least consideration in light of the challenges they may pose to stress testing. These include:

- (a) Examining the *correlations between credit risk, and market and liquidity risks*, at several levels. First, strengthening the joint analysis of indirect credit risk (banking book effects arising from changes in key market prices) alongside the associated market risk (trading book) effects. Second, considering wider-ranging scenarios that directly include funding or market liquidity stresses (a liquidity run) as well as the more normal macro effects (so that the shock scenarios represent more of a “perfect storm”).
- (b) Further developing *contagion stress tests*. One form that could be explored, in line with the analysis undertaken by some central banks, would be to examine mutual exposures in payment and settlement systems. Another would be to consider possible liquidity contagion, especially where there is experience from past runs. Yet another component that could be considered is the scope to use Extreme Value Theory to explore correlations between institutions as the basis for a contagion stress test.<sup>7</sup>
- (c) Cross-border transmission channels need more consistent coverage in FSAP stress testing, including cross-border contagion between financial institutions.
- (d) While stress testing of *insurance companies and financial conglomerates* will likely continue to become more common, an open question to be considered is how far FSAP stress tests should go towards including other NBFIs directly in the quantitative stress-testing analysis.
- (e) While monetary policy reaction functions are sometimes built into the formulation of macro stress testing, what should we do, if anything, about the *reaction functions of the financial institutions*. On the one hand, these may ameliorate the effects of shocks on individual institutions, but if they allow for common reactions, herding behavior, fire-sales and the like, the opposite may well be true at the system level.
- (f) How can *second-round feedback effects* (from the financial sector back to the macroeconomic environment) be better taken into account in the quantitative modeling? The modeling here typically gets complex quite quickly.
- (g) Can we deal better with potential *non-linearities and structural breaks* in behavioral relationships?<sup>8</sup> This issue arises in virtually all stress tests we do, but appreciating the potential implications is crucial. One quite common example in an FSAP context is modeling the impact of a major devaluation in a hard currency peg country. Past time series for such a country may be of very limited use given a lack of past exchange rate volatility. However, experience from other countries and expert judgment can often play a key role in calibrating such a test. Various authors have tried to model non-linearities more explicitly, though this is still largely uncharted territory.

<sup>7</sup> This would examine correlations between extreme negative movements in institutions’ distances to default, and result in an inter-institutional matrix that might be able to be used in a fashion analogous to an interbank exposures matrix. For a recent EVT analysis, though not linked to a stress test, see Chan-Lau et al (2007).

<sup>8</sup> See also CGFS (2000, 2005) and Sorge (2004) for further discussion on this and other challenges.

So there is a quite large and rich potential agenda at the methodological level. At the level of FSAP processes more generally, there are also a couple of important broader points. First, FSAPs need to further improve the integration of stress testing and other modes of quantitative analysis. This includes continuing to improve the availability of (the formal) FSIs—an ongoing medium-term work plan in the IMF building on the recent FSI “coordinated compilation exercise”. And relatedly, further “benchmarking” of FSIs — not in any mechanistic sense, but built around a growing understanding of how different countries’ FSIs need to be interpreted. Finally, it also means more widespread use of market-based indicators and analysis thereof, both as modes that are complementary to stress-test analysis and also, where feasible, actually reflected directly in the stress-test analysis.

Second, the rather wide range of practice to date raises a question: should FSAP stress testing be more standardized? More precisely, what is the appropriate balance between cross-country uniformity of stress tests, versus continuation of the case-by-case approach. The consensus amongst FSAP stress testers is that, while more uniformity would have its attractions, standardizing the shocks and their sizes across countries would not in fact achieve much real uniformity because of the different natures, activities and potential vulnerabilities of different countries’ systems. What might look like standardization could be quite misleading. That said, there may be scope to standardize FSAP stress testing more at the level of broader good practices, within a flexible overall framework. IMF-World Bank (2005) takes initial steps in this direction, and an adaptable “template” for smaller and less complex financial systems has been made publicly available (Čihák, 2007).

In seeing how much further to go in this direction, we also have to keep in mind that macro stress testing is still a new field which will continue to evolve. And in this context, there is a basic trade-off to be struck between the general desirability of greater analytical rigor and accuracy — including through the use of multiple approaches as consistency checks — and the non-negligible resource costs, computational burden and data availability issues.

Some of those costs are more in the nature of startup, rather than ongoing costs, and the trade-off has been eased as an increasingly wide fraternity of macro stress testers has invested time and effort in pushing out the boundaries of what is feasible. But the trade-off has not gone away and FSAP stress testers in particular will continue to face it. In managing this over time, we will want to continue to have close dialogue with stress-testing counterparts amongst policymakers and academics. Several recent initiatives to share information and methodologies are notable in this regard, including the internet-based platform for public sector stress testers recently organized by the Deutsche Bundesbank, following an expert forum on advanced stress-testing techniques at the IMF last year. And of course this conference itself is another example, and I look forward to hearing other macro stress testers’ thoughts today.

## APPENDIX

These tables are reproduced from Čihák (2007), Appendix III.

<b>Table 1 Who Did the Calculations in European FSAP Stress Tests? <sup>1)</sup></b>	
	<b>FSAP</b>
Supervisory agency/central bank	Austria, Belgium, Denmark, Estonia, France, Germany, Hungary, Ireland, Israel, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom
FSAP team	Belarus, Belgium, Bosnia and Herzegovina, Croatia, Czech Republic, Denmark, Estonia, Iceland, Ireland, Israel, Latvia, Lithuania, Macedonia, Moldova, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Serbia, Spain, Ukraine, United Kingdom
Financial institutions	Belgium, Denmark, Estonia, France, Germany, Ireland, Israel, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, United Kingdom

1) In some FSAPs, calculations were done by several parties, as indicated in the table.

<b>Table 2 Institutions Covered in European FSAP Stress Tests</b>	
<b>Institutions Covered</b>	<b>FSAP</b>
All banks (bank by bank)	Belarus, Belgium, Lithuania, Moldova, Ukraine
Large/systemically important banks (bank by bank)	Austria, Belgium, Bosnia and Herzegovina, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Iceland, Ireland, Israel, Latvia, Luxembourg, Malta, Netherlands, Norway, Poland, Romania, Russia, Slovakia, Slovenia, Serbia, Spain, Sweden, Switzerland, United Kingdom
Insurance companies	Belgium, Denmark, Finland, France, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom
Pension funds	Netherlands, United Kingdom

**Table 3 Approach to Credit Risk Modeling in European FSAP Stress Tests**

Approach to Credit Risk Modeling	FSAP
NPLs, provisions: historical or macro-regressions	Austria, Czech Republic, France, Iceland, Israel, Russia, Romania, Sweden
NPLs, provisions: ad hoc approaches	Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, France, Hungary, Israel, Latvia, Lithuania, Macedonia, Malta, Moldova, Poland, Serbia, Slovakia, Slovenia, Switzerland, Ukraine
Shocks to probabilities of default based on historical observations or regressions	Austria, Belgium, Denmark, Luxembourg, Russia, Spain
Shocks to probabilities of default (ad hoc)	Germany, Netherlands, Norway, United Kingdom
Explicit analysis of cross-border lending	Austria, Spain
Explicit analysis of foreign exchange lending	Austria, Croatia
Explicit analysis of loan concentration	Malta, Netherlands, Russia, Serbia

**Table 4 Interest Rate Shocks in European FSAP Stress Tests**

Interest Rate Scenarios Used	Examples of Shock Sizes
<ul style="list-style-type: none"> <li>• Ad hoc or hypothetical interest rate increase</li> <li>• Parallel shift in yield curve</li> <li>• Historical interest rate increase</li> <li>• Basel Committee Amendment to Capital Accord to incorporate market risk</li> </ul>	<ul style="list-style-type: none"> <li>• 3 standard deviations of 3-month changes</li> <li>• 50%-100% increase</li> <li>• three-fold increase in nominal rate</li> <li>• 100 basis point shock to interest rates</li> <li>• 100 basis point shock to dollar interest rates and a concomitant 300 basis point shock to local currency interest rates</li> <li>• 300 basis point increase</li> </ul>

**Table 5 Approaches to Interest Rate Modeling in European FSAP Stress Tests**

Approach to Interest Rate Risk Modeling	FSAP
Repricing or maturity gap analysis	Austria, Belarus, Belgium, Croatia, Czech Republic, Hungary, Lithuania, Macedonia, Malta, Moldova, Poland, Russia, Romania, Serbia, Ukraine
Duration	Belgium, Iceland, Israel, Latvia, Norway, Slovakia, Switzerland
Value at Risk	France, Denmark, Germany, Israel, Netherlands, United Kingdom
Others (e.g., $\Delta$ NPV of balance sheet, $\Delta$ market value of bank capital, regressions, simulations)	Norway, Sweden

**Table 6 Exchange Rate Shocks in European FSAP Stress Tests**

Exchange Rate Scenarios Used	Examples of Shock Sizes
• Ad hoc or hypothetical devaluation	• 20%-50% devaluation
• Historical large exchange rate changes	• 30% devaluation
	• 10% depreciation
	• 20% depreciation/appreciation
	• 40% depreciation/appreciation of Euro/Dollar exchange rate

**Table 7 Approaches to Exchange Rate Modeling in European FSAP Stress Tests**

Approach to Exchange Rate Risk Modeling	FSAP
Sensitivity analysis on the net open position	Austria, Belarus, Belgium, Bulgaria, Croatia, Czech Republic, Hungary, Iceland, Latvia, Lithuania, Macedonia, Malta, Moldavia, Norway, Poland, Russia, Romania, Serbia, Slovakia, Slovenia, Sweden, Switzerland, Ukraine
Value at Risk	France, Germany, Israel, Netherlands, United Kingdom

**Table 8 Approaches to Modeling Other Risks in European FSAP Stress Tests**

Other Risk Modeling Approaches	FSAP
Liquidity risk (ad-hoc decline in liquidity)	Austria, Belarus, Belgium, Bosnia and Herzegovina, Germany, Lithuania, Netherlands, Russia, Spain, Ukraine, United Kingdom
Liquidity risk (historical shock)	Croatia, France
Shock to main stock market index	Austria, Belgium, Finland, France, Germany, Israel, Latvia, Lithuania, Malta, Netherlands, Norway, Slovakia, United Kingdom
Housing price shock	Netherlands, Norway, United Kingdom, Ukraine
LTV ratios, mortgage PDs	Croatia, Sweden
Commodity price	Finland
Interbank contagion	Austria, Belgium, Luxembourg, Netherlands, Romania, United Kingdom
Slowdown in credit growth	Bosnia and Herzegovina
Country risk	Luxembourg
Competition risk (i.r. margin)	Lithuania, Slovenia
Shock to specific sector(s)	Belarus Finland

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# DEVELOPING A FRAMEWORK FOR STRESS TESTING OF FINANCIAL STABILITY RISKS<sup>1</sup>

NIGEL JENKINSON<sup>2</sup>

## I INTRODUCTION

Developing a rigorous, coherent and robust framework to analyse the resilience of the financial system to withstand strain presents many well-known and formidable challenges. Financial system behaviour is very difficult to model, particularly under stressed conditions when strategic interactions between participants and risks of spillover and contagion come to the fore. And, thankfully, episodes of stress are rare, so history offers only limited assistance.

We are currently witnessing a period of major change in financial markets. The global financial system is evolving at a tremendous pace, fuelled by rapid innovation and cross-border integration, and supported by lower macroeconomic volatility. Innovation and integration may have a profound impact on the behaviour of the financial system under pressure. In particular, risks may have been dispersed more broadly through credit risk transfer and increased participation in capital markets. The resulting reduction in credit risk concentration may have strengthened the robustness of the financial system to withstand small to medium shocks. But equally, greater market integration has strengthened the ties between financial firms within and across borders, both through direct exposures and through common exposures to asset markets. If a shock is sufficiently large, the financial network may consequently act as a conduit for transmitting rather than absorbing risk. So the flip side of greater integration is that it may have lowered the frequency but increased the magnitude of potential financial crises.<sup>3</sup>

## 2 TOOLKIT FOR FINANCIAL STABILITY ANALYSIS

Improving the toolkit for financial stability analysis is consequently a very high priority for public authorities and for major financial institutions. Enhancing the capability to model the financial system under stress is the key challenge.

In recent years, many central banks and supervisory agencies, charged with the public policy goal of supporting the maintenance of financial stability, have sought to develop a so-called “top-down” or “macro” stress-testing capability. Utilising information on balance sheet exposures, the authorities draw on

<sup>1</sup> I am very grateful to Adrian Penalver, Prasanna Gai, Geoff Coppins and Piergiorgio Alessandri for input and helpful comments.

<sup>2</sup> Executive Director of the Financial Stability Area at the Bank of England.

<sup>3</sup> *Systemic risk in modern financial systems: analytics and policy design* by Prasanna Gai, Nigel Jenkinson and Sujit Kapadia, Journal of Risk Finance, Vol 8, No 2, 2007. *Financial System Risks in the UK – Issues and Challenges*, speech by John Gieve, July 2006 ([www.bankofengland.co.uk/publications/speeches/2006/speech280.pdf](http://www.bankofengland.co.uk/publications/speeches/2006/speech280.pdf)).

macroeconomic and financial models to try to assess the impact of adverse shocks on the financial system. Several inter-related high-level objectives can perhaps be set for an “ideal” stress test:

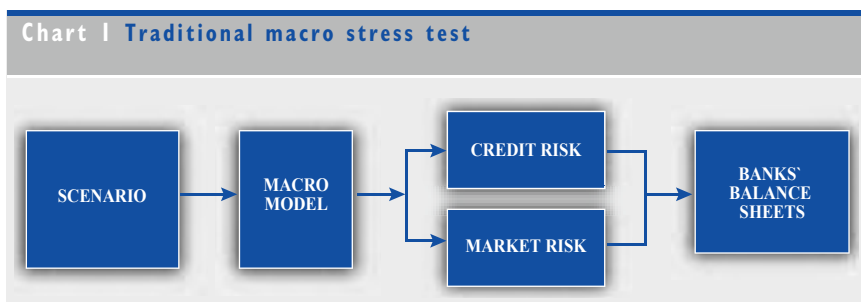
- to assess the vulnerability of the financial system to extreme but plausible shocks;
- to improve the understanding of the transmission of shocks through the financial system (and, in a worst case, the potential propagation of financial crises); and
- to identify “weak spots” in the financial system, to guide risk reduction priorities and crisis management planning.

To meet these objectives effectively, the aim is also to use a rigorous and consistent analytical framework, which integrates behavioural responses, interactions and feedback effects, to ensure that the system-wide implications are fully captured.

## 2.1. TRADITIONAL MACRO STRESS TEST

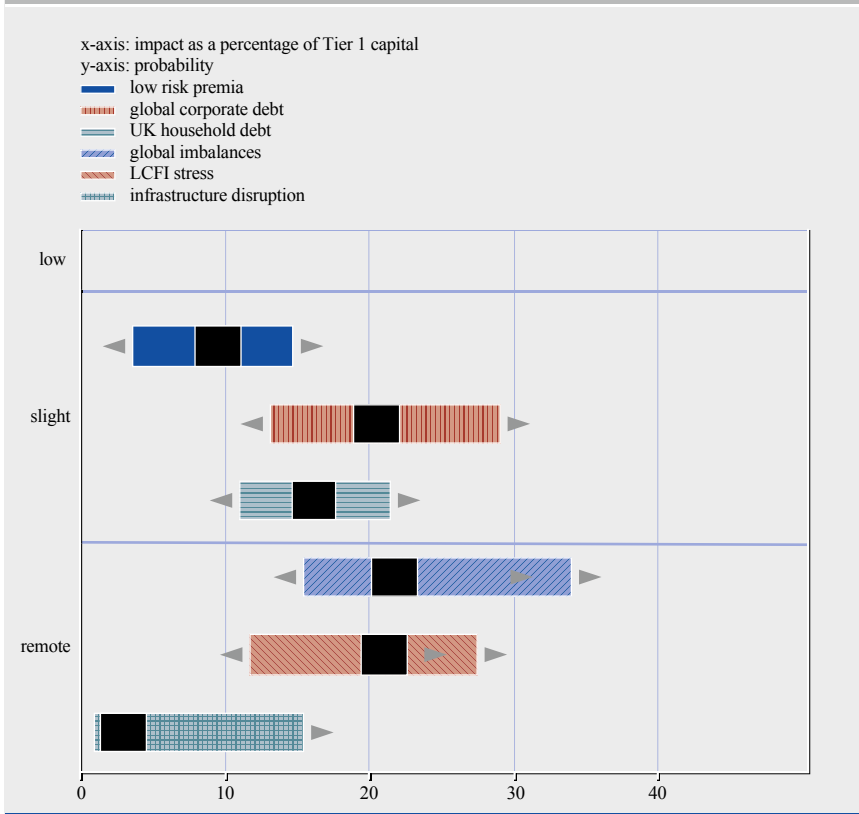
A typical or *traditional “macro” stress test* has the stylised form set out in Chart 1. The first stage is to put together a coherent stress scenario, typically using a macro-econometric model (which may include some assumed endogenous policy response). By mapping important propagation channels, an estimate of likely financial sector credit losses is produced, e.g. by modelling the impact of the macro stress on corporate and household balance sheets and gauging the consequent impact on the probability of default and likely recovery rate on banks’ credit exposures. Market losses are estimated by judging the impact of the macro stress on different asset classes. Total bank losses are calculated by aggregating credit and market losses, perhaps including an additional allowance for the impact of the stress scenario on net interest income and on funding costs. Expected losses are then compared to the buffers of profits and capital (perhaps with an adjustment for whether the scenario is likely to be “slow burn” wherein potential future profits might absorb some of the loss, or “fast burn” where pressure falls more immediately on capital) to guide the judgement on the overall impact of the stress scenario on the banking system (and/or on the financial system more broadly).

We have utilised this *broad approach* within the Bank of England to assess the risks to the major UK banks from sources of potential major vulnerability – both





**Chart 2 Severe stress scenarios**



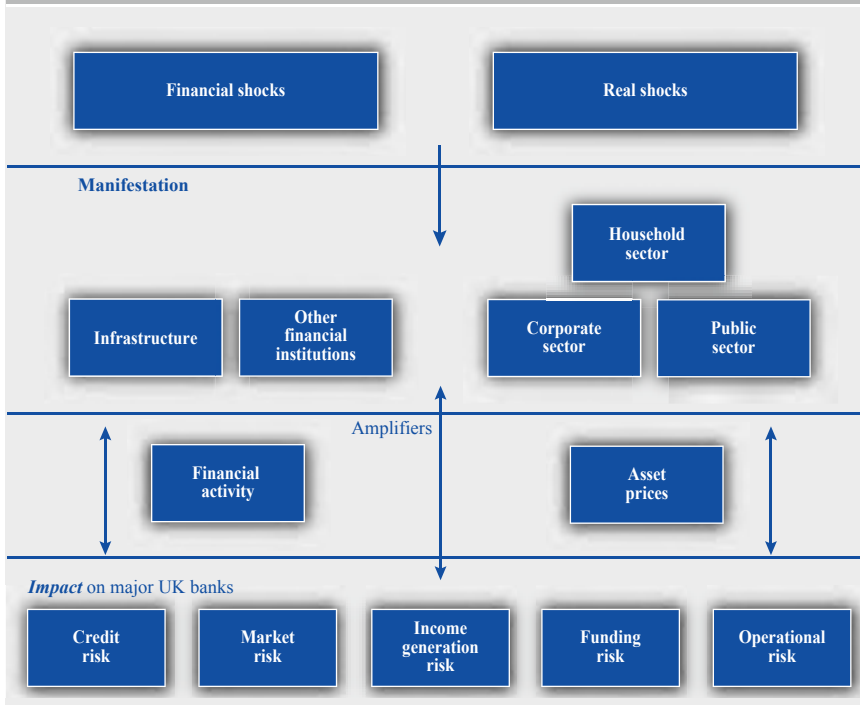
individually and in combination. Results have been published in recent Financial Stability Reports (see Chart 2).<sup>4</sup>

## 2.2 STRENGTHS AND LIMITATIONS OF THE TRADITIONAL STRESS-TEST APPROACH

This approach has a number of strengths. First, it draws on a fully consistent macroeconomic scenario and on statistical estimates of the impact of adverse economic conditions on credit and market exposures. Second, building formal “maps” of transmission of economic shocks onto the financial system facilitates greater analytical consistency and provides enhanced clarity on which channels are important. This aids the understanding of risks. It also highlights which channels are explicitly included in the stress tests, and which are not and are consequently priorities for future work. Third, sensitivity analysis can easily be carried out to assess the impact of altering behavioural assumptions – for example, what would happen if write-off rates on corporate exposures were

<sup>4</sup> Bank of England, *Financial Stability Report*, June 2006 and April 2007. The description above applies particularly for the corporate, household and global imbalances stress. See *A new approach to assessing risks to financial stability* by Andrew Haldane, Simon Hall and Silvia Pezzini, Bank of England, Financial Stability Paper No 2, April 2007, for a fuller discussion.

**Chart 3 Risk transmission**



higher than expected? Fourth, the results can be compared to “bottom-up” stress tests calculated by individual firms, which have developed rapidly in recent years, but which may be less focused on capturing macroeconomic and financial sector feedback.

The traditional approach to stress testing, nonetheless, suffers from some major limitations. Most strikingly, the current treatment of key financial system interactions and feedback effects is often rudimentary. Given that such effects are crucial in assessing the vulnerability to contagion and system-wide stress, that is a significant drawback. Take the illustrative severe stress scenarios published in the Bank of England Financial Stability Report and shown in Chart 2 as a guide. These scenarios are constructed from risk transmission maps for each scenario based on the stylised model in Chart 3. In practice, however, there are important gaps, as can be seen from Table 1, where the channels which have been explicitly quantified in the stress scenarios are shown. In particular, the potential amplification of the shock within the financial system through channels such as an endogenous fall in market liquidity as firms simultaneously seek to lower risk exposures; dynamic hedging behaviour (particularly of “unbalanced” options positions)<sup>5</sup>; and restrictions on lending (a “credit crunch” or “financial accelerator” effect), are not yet built in empirically. And the framework does not yet incorporate the potential contagion and spillover effects which would result from severe strain at, or the default of, a major bank or financial institution.

<sup>5</sup> Bank of England, *Financial Stability Report*, July 2006, Box 5, page 33.

**Table 1 Channels explicitly quantified in stress scenarios**

	Low risk premia	Global imbalance	Global corporate debt	UK household debt	LCFI stress	Market infrastructure disruption
Credit risk, exposures to:						
UK households	•	•		•		
UK corporates	•	•	•			
Overseas households	•	•				
Overseas corporates	•	•	•			
Counterparty credit risk, exposures to:						
LCFIs					•	•
Other financial						•
Market risk in trading book	•	•				•
Income generation risk	•	•	•	•		•
Funding risk	•	•	•	•		•
Operational risk						•
Macroeconomic feedback effects						
Market liquidity						

(a) A circle denotes that a channel is quantified – fully or partially – in the stress scenario impact estimates.

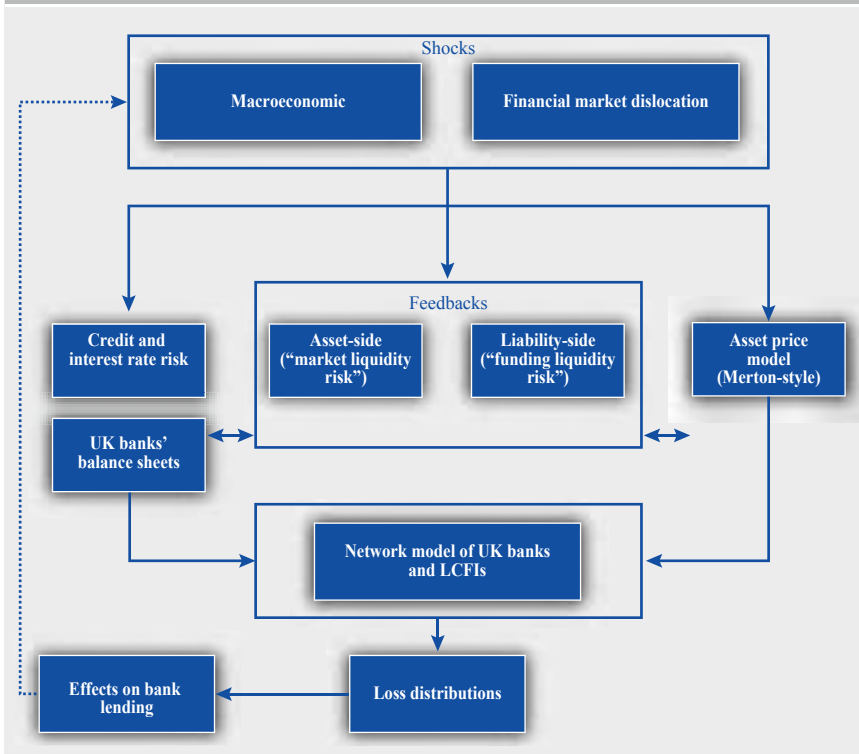
At present, the results from the *top-down* stress tests consequently tend to be relatively “linear”; that is, an “*extreme*” scenario is a “*scaled-up*” version of a more “*moderate*” scenario. As financial instability is by nature inherently non-linear, given the central focus on default, contagion and spillover, this is an important failing. Moreover, the stress tests typically concentrate on the impact of particular adverse scenarios, which individually have a near-zero probability of occurring in practice. There is generally no attempt to derive a distribution of possible outcomes.

Addressing these limitations is an important priority for financial stability authorities, so that “practical” stress testing meets the “ideal” objectives set out above.

### 2.3 CURRENT PRACTICE IN THE BANK OF ENGLAND

Within the Bank of England, we are building a suite of models that allow the transmission channels for potential financial system stress to be mapped out

**Chart 4 The planned suite of models**



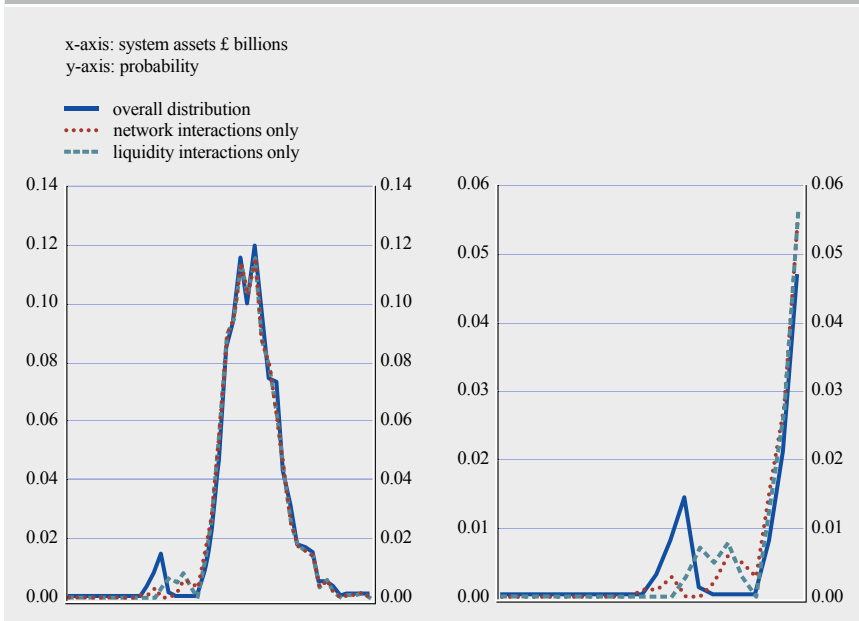
accurately and comprehensively, including in the form of loss distributions. The outputs can also be compared to measures of financial system buffers, such as profits, to provide summary statistics of systemic vulnerability.<sup>6</sup> Others too have been pursuing a similar course. For example, the Austrian central bank has developed a Systemic Risk Monitor to characterise the interaction between shocks and the structure of the banking system and inform the internal policy debate.<sup>7</sup>

A schematic for the planned suite of models is set out in Chart 4 and will be described more fully in future papers. The left-hand side of the diagram emphasises the transmission of shocks to the system through conventional channels of credit and market risk. On the right-hand side, asset-pricing models can be used to facilitate inferences about banks' balance sheet positions and vulnerability to default from market price data (such as equity prices). Given the limitations of balance sheet data and the difficulty of identifying new types of

<sup>6</sup> *A new approach to assessing risks to financial stability* by Andrew Haldane, Simon Hall and Silvia Pezzini, Bank of England, Financial Stability Paper No 2, April 2007, for a fuller discussion.

<sup>7</sup> Oesterreichische Nationalbank (2006), *Systemic Risk Monitor: A Model for Systemic Risk Analysis and Stress Testing of Banking Systems*, Financial Stability Report 11, by Michael Boss, Gerald Krenn, Claus Pühr and Martin Summer.

Chart 5 The distribution of banking system assets

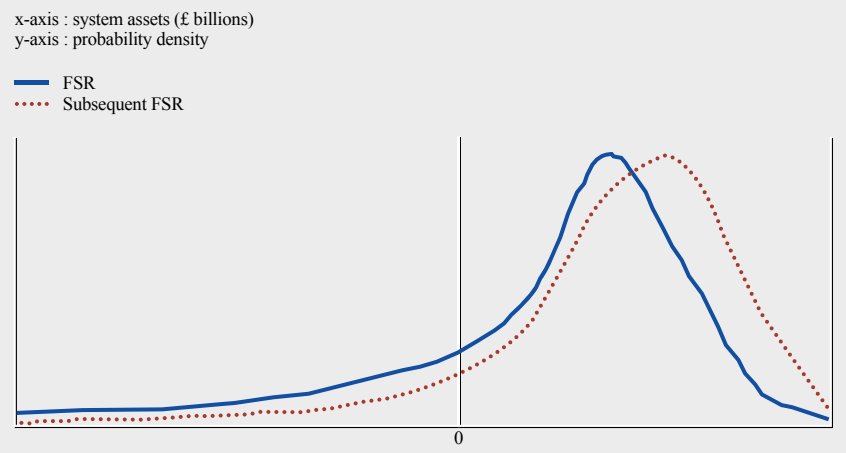


assets and off-balance sheet exposures, the asset-price approach can serve as a useful cross-check to the outputs of the more structural model.

The distinguishing feature of the model suite is the emphasis placed on the *feedback effects* induced by market liquidity risk and funding liquidity risk and their interactions in a network context. In addition, the potential feedback to the macro economy from the behavioural responses of banks individually and collectively to an impairment of their balance sheet position (e.g. through a “financial accelerator” effect) will be incorporated explicitly. The development of the suite is at an early stage but preliminary results from prototype work seem to promise some useful insights. Chart 5 shows an illustrative distribution of future UK banking system assets from the prototype model (the right-hand panel expands the lower tail of the distribution). Notice that the *distribution is explicitly bi-modal* – as one might expect of a system where losses on interbank exposures, and pressures on asset prices and market liquidity from failing firms, may be transmitted through the financial network and may trigger a cascade of defaults. Our suspicion is that the fire-sale of assets by institutions facing default is the source of much of the action here, but more research is needed to be properly certain and before we can ascribe quantitative meaning to the distribution.

Chart 6 illustrates how such distributions might also be tracked over time and compared in successive Financial Stability Reports. When operational, such distributions should help guide judgements on how overall financial system vulnerability is changing. But the approach should also provide considerable additional information on pressure points within the system and on the channels of transmission and potential contagion.

**Chart 6 Distribution of banking system assets over time**



## 2.4 FURTHER DEVELOPMENT

I believe that this broad approach offers an important step forwards in the development of an analytically and empirically robust framework for financial stability work. Of course it is analytically hugely challenging – modelling non-linear tail events with endogenous strategic interactions is always going to be tough! The results will inevitably be subject to major uncertainty. But the approach does start to provide a consistent and coherent framework which should substantially improve the value of top-down stress tests and of risk assessment work.

A particular “operational” aim is to use the results to help improve the focus of risk reduction work and crisis management planning, for example through the identification of “weak points” in the financial system and through improved assessment of the impact of policy interventions. An important element of risk reduction work is to influence the behaviour of financial firms. “Bottom-up” or firm-level stress-testing practices have developed rapidly in recent years. But one challenge is that, as for the authorities, it is hard for individual firms to gauge the likely “systemic impact” of particular shocks, which takes into account macro and financial system interactions and feedback effects. Indeed, in practice, banks often model the effect of even severe macroeconomic shocks as if they were occurring to the bank in isolation. They thus may assume that they have freedom to readjust their balance sheets and lending practices in the event of an adverse shock, without considering whether other banks may be trying to do the same thing and the effect that these behavioural responses may have cumulatively on market liquidity and on the economy as a whole. An important implication is that many firm-level stress tests may consequently underestimate the possible impact of adverse shocks. As I have highlighted, some of the potentially missing effects should be captured in the proposed suite of models. But the proposed enhanced “top-down” approach outlined above may still benefit from additional insights gained from closer dialogue and interaction with major financial firms on their likely reaction to episodes of stress. I consequently think there is merit in more

formal comparison of “top-down” and “bottom-up” stress-testing exercises, and in seeking ways of integrating the two into more formal “systemic” stress tests, where the authorities present an initial scenario to firms and then modify the scenario in the light of feedback on the potential response by firms in an iterative loop. This approach has recently been pioneered by the Dutch central bank.<sup>8</sup> It potentially offers a useful way of improving knowledge of key system-wide interactions, and thus could provide a valuable supplement both to improved “top-down” approaches and to “bottom-up” stress tests which are naturally targeted more closely at the major risks facing individual firms given their balance sheets and positions.

### 3 CONCLUSIONS

There is a major programme of inherently difficult and challenging modelling work ahead for the public authorities and for financial firms. But this work is very important. Development of a more coherent and consistent framework for the analysis of financial stability is a major prize. Ultimately this should improve the understanding and pricing of risk and support better targeting of public policy, focused more closely on containing systemic risk and on the maintenance of the public good of systemic financial stability.

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<sup>8</sup> De Nederlandsche Bank, *Financial stability: is the Dutch financial sector stress-resistant?*, Quarterly Bulletin, December 2006.

# STRESS TESTING: THE SPANISH EXPERIENCE<sup>1</sup>

JESÚS SAURINA<sup>2</sup>

## I INTRODUCTION

Stress testing is an important risk management tool for banks and, in general, for financial companies. A natural area to start to develop stress testing is market risk.<sup>3</sup> There is plenty of information on prices and exposure may vary significantly over time. Moreover, the changes may be so rapid that the impact on the economic value of the firm could be significant. Despite the historical importance of stress testing for market risk assessment, stress testing credit risk is an increasingly important area, not only because of the importance of credit losses for the safety and soundness of a bank but also because more data is becoming available (e.g. data gathered by banks for the implementation of Basel II IRB approaches). Finally, liquidity stress testing is also attracting growing interest.

Stress testing is also an important risk assessment tool for bank supervisors and central banks. Through a sensitivity analysis bank supervisors may assess the impact of an increase of 50% in the probabilities of default (PDs) of mortgages, or through scenario analysis they can gauge what happens if GDP growth falls to 0% in two consecutive quarters. Credit risk, market risk and liquidity risk, as well as contagion among banks, can be simulated in order to assess the resilience of the banking system for both individual firms (profits and solvency) and the whole banking system. Stress testing large and/or complex financial groups may also be of special interest.

Stress testing can be categorised into sensitivity and scenario analyses. They can be implemented by two main approaches. The first one, called the top-down approach, is where someone outside each financial firm (e.g. bank supervisor, central bank, International Monetary Fund (IMF)) carries out the impact analysis of different shocks on banks' profits, solvency and resilience. The second one is the bottom-up approach: with the scenarios provided by an outsider (e.g. supervisor, central bank, IMF), each bank, according to its own internal models and estimates, evaluates the impact of those scenarios on its own balance sheet, profit and loss accounts and solvency ratios.

<sup>1</sup> The views expressed here are those of the author and not necessarily those of the Banco de España. I would like to thank my colleagues J. Delgado, G. Jiménez, A. Martín-Oliver, J. Mencía and C. Trucharte for the very open discussions on stress testing. The paper has also benefited from the comments made by G. Hofmann (discussant) and participants at the ECB conference on "Simulating financial instability". Any remaining errors are my own responsibility.

<sup>2</sup> Director of the Financial Stability Department at the Banco De España.

<sup>3</sup> The Committee on the Global Financial System has carried out two extensive surveys on stress testing: *A survey of stress tests and current practice at major financial institutions*, BIS, April 2001, and *Stress testing at major financial institutions: survey results and practice*, BIS, January 2005.



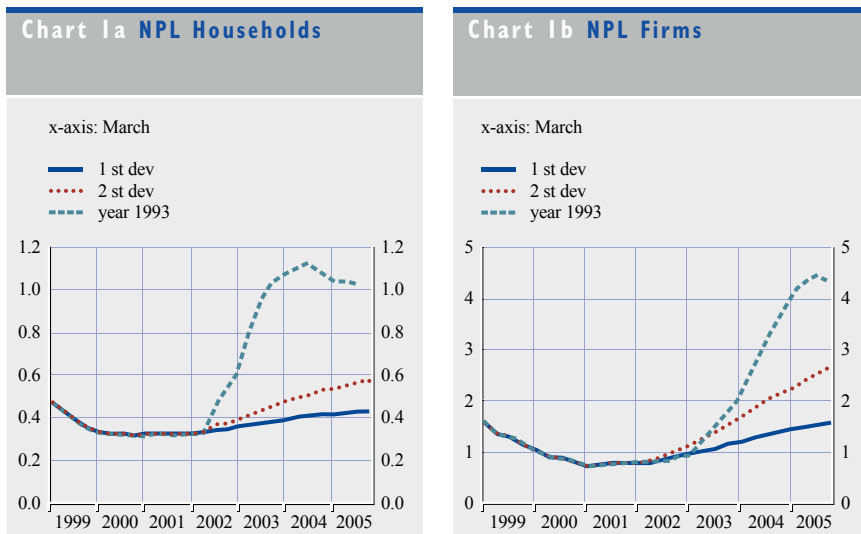
In the rest of this contribution, we present the experience that the Banco de España has gained on stress testing during its Financial Sector Assessment Program (FSAP) carried out in 2005/06 by the IMF, but also before and after the FSAP, focusing mainly on bottom-up and related methodologies. At the end of the note, we also mention some caveats regarding stress-testing analysis for banking supervisors.

## 2 THE SPANISH EXPERIENCE WITH STRESS TESTING

### 2.1 PRE-FSAP

Long before the FSAP on Spain was even planned, we started to work on macro stress testing. Our aim was to assess the impact of changes in macroeconomic conditions on bank problem loans. We developed and estimated a long-term equilibrium relationship between macro variables (GDP growth rate, interest rates and non-performing loan ratios), together with a short-term error correction mechanism (i.e. an adjustment mechanism from current levels to the long-term equilibrium) where unemployment and interest rates were the explanatory variables. The underlying idea of this exercise was to find a long-term relationship between macro variables and non-performing loans, reflecting a stable long-term banking system in Spain over the last 20 years.

Shocks on GDP growth and interest rates of one and two standard deviations plus a crisis scenario (with a deep recession similar to that experienced by the Spanish economy around 1993) can be simulated, and their impact on non-performing loans assessed. Charts 1a and 1b show the impact, distinguishing between loans to firms and to individuals.<sup>4</sup>



<sup>4</sup> A more detailed analysis is presented in J. Delgado and J. Saurina, *Análisis del riesgo de crédito. Una perspectiva macroeconómica*, Moneda y Crédito 219, pp. 11-41, 2004. The English version is available upon request to the authors.

## 2.2 FSAP

During the FSAP, the Spanish financial system and, in particular, the banking system underwent a thorough stress-testing analysis, with important methodological contributions to the general FSAP analysis. The FSAP included a top-down approach, with a macroeconomic model to simulate the results of different shocks, and satellite equations to assess the impact on non-performing loans (NPLs) and, thus, on bank profits, as well as on solvency ratios. But the FSAP also contained a bottom-up approach, focused on the largest Spanish banks and relying on their own internal models for risk measurement and management.

As a general comment, it is important to point out three issues. Banks were eager to participate in the bottom-up FSAP exercise and were well prepared for that. Second, for stress testing credit risk, probably still the most important risk a bank faces, the comprehensive Credit Register database played a central role. Finally, stress testing may be simpler than expected, both conceptually and practically.

### BOTTOM-UP EXERCISE

Seven banks were involved, representing close to two-thirds of total assets of the Spanish banking system.<sup>5</sup> The aim of the bottom-up stress testing was to assess the impact of the shocks provided by the Banco de España/IMF on the balance sheets, profit and loss account, and solvency ratios of each participating bank. We carried out both sensitivity analysis (for market risk, interest rate risk, liquidity risk and credit risk) and scenario analysis (based on four different scenarios: a decline in house prices, an increase in oil prices, a US dollar depreciation, and problems in the two largest Latin American countries). All the banks involved had proper tools to measure and manage the risks analysed and to carry out the stress-testing exercises.

#### A) SENSITIVITY ANALYSIS

##### i) Market risk

Here, the analysis was applied to banks' trading books. The shocks were increases (decreases) in interest rate levels as well as changes in the slope of the interest rate curve, significant and generalised declines in equity prices coupled with increases in market volatility and credit spreads, as well as appreciation (depreciation) of exchange rates. To calibrate the shocks we took the worst monthly change between 1980 and 2004. The assessment was based on the impact of the shocks on the economic value of the trading books and on the solvency ratios of the banks involved. The Banco de España set the magnitude of the shocks, while each individual bank measured the impact of those shocks. There was no way the Banco de España alone could calculate those impacts because of the level of detailed information needed. Thus, the bottom-up approach is the one needed in stress testing market risks.

<sup>5</sup> Santander, BBVA, La Caixa, Caja Madrid, Sabadell, Popular and Bankinter, i.e. the 5 largest commercial banks and the 2 largest savings banks.

## ii) Interest rate risk

We stressed the global financial position of the bank, using the Basel Committee on Banking Supervision methodology on interest rate risk management.<sup>6</sup> The shocks considered were parallel shifts (up and down) in the euro interest rate curve as well as changes in the slope of the curve. We focused on the impact on the economic value and on solvency ratios. As in the case of market risk, the Banco de España calculated the shocks to be applied, and each bank gauged their impact (again, impossible for the supervisor to do it alone).

## iii) Liquidity risk

During the FSAP we developed a new methodology to assess cash flow evolution during a limited period of time. We adapted the UK Financial Services Authority methodology for estimating cash flows for crisis situations.<sup>7</sup> Thus, our liquidity stress testing was not only based on liquidity gaps but also incorporated crisis situations. In practice, we carried out an individual assessment of an isolated crisis on a particular bank for one week and one month with no possibility of central bank help. The confidence crisis was affecting sight deposits, and only in the Spanish market. The objective was to calculate a liquidity ratio (entries over exits of funds) for a week and a month. The shock was calibrated to be similar to the one experienced by banks in liquidity/solvency problems in the past. The stress testing was only carried out on a bottom-up approach, since the Banco de España lacks the detailed information to perform an overall exercise.

## iv) Credit risk

Here we combined a bottom-up and a top-down approach given our availability of data for the whole banking system. As far as we know, credit risk stress testing in the FSAP had never previously been based on PD and portfolio differentiation. We used our Credit Register database (we have monthly information on any loan over EUR 6,000 granted by any bank operating in Spain to both individuals and firms, starting in 1984). To calibrate the shocks for credit risk (input needed for the bottom-up stress testing), we measured the change in annual PD from 1990 to 2004 in both loans to firms and mortgages, and took up to three times that maximum change in PD. We evaluated the impact on loan loss provisions and, subsequently, on profits and own funds.

## B) SCENARIO ANALYSIS

There were four macro scenarios (as mentioned above). We used several macro models (Banco de España, NiGEM and Oxford Economic Forecasting), as well as satellite equations for relevant variables usually not included in those macro models (such as credit and credit losses or non-performing loan ratios). The scenario analysis was performed top down (thanks to the Credit Register), but also bottom up. Each of the seven banks participating in the FSAP assessed the impact of the scenarios on their balance sheets, profits and solvency ratios. Banks

<sup>6</sup> Basel Committee on Banking Supervision, *Principles for the Management of Interest Rate Risk*, July 2004.

<sup>7</sup> Financial Services Authority, *Liquidity risk in the Integrated Prudential Sourcebook: a quantitative framework*, Discussion Paper 24, October 2003.

applied their internal models, based on their own experience, to the scenarios provided by the Banco de España.

## C) ROBUSTNESS

As a robustness exercise we used a new approach that might be called a bottom-up panel data approach where the supervisors were able to assess the impact of the different scenarios on the profits and solvency ratios of each individual bank. The methodology is again simple and it consists of PD modelling using individual bank information over time, and an impact assessment on individual profits and solvency ratios, to obtain average and dispersion analysis results. The underlying idea is that despite an overall sound banking system, there may remain some fragility in particular credit institutions.

This bottom-up panel data approach offered a complete coverage of credit risk stress testing, for both commercial and savings banks (more than 90% of total assets) for the period 1992-2004 with a four business line segmentation of loan portfolios (mortgages; consumer loans; construction and real estate; and other non-financial firm loans). It was based on Credit Register data and the objective was to model NPL determinants (or PD determinants) as a function of macro variables in order to simulate the impact of the same scenarios mentioned before. On top of the former scenarios we added another, much more demanding, one based on a cooling of the economy over two years (1% and 0% GDP growth for the first and second years, respectively).

We were able to calculate the impact of macro variables on non-performing loan ratios and expected losses (ELs), through PDs, and the impact of ELs on profits and capital for each bank. Then, it was possible to obtain the median and the 90th percentile bank.<sup>8</sup>

## D) RESULTS

In this contribution we do not intend to analyse the result of the Spanish FSAP. Rather, we want to describe the methodologies applied, in particular those bottom-up approaches or similar. However, it may be useful to mention that all the stress-testing results during the FSAP showed a highly resilient banking sector in Spain, even when faced by severe shocks. Part of this result can be attributed to the prudential framework operating in Spain and, in particular, to the loan loss provisioning policies implemented by the Banco de España since the start of the new millennium, following a long tradition of prudent supervision in Spain after the severe banking crisis of the late 1970s and early 1980s.<sup>9</sup> Another part should be attributed to the management capabilities of Spanish banks, including state-of-the-art measurement and risk management techniques. Finally, the long

<sup>8</sup> A detailed description of the results is provided in A. Martín-Oliver and J. Saurina, *Normativa prudencial y estabilidad del sistema bancario español*, Banco de España, Notas de Estabilidad Financiera 5, December 2006.

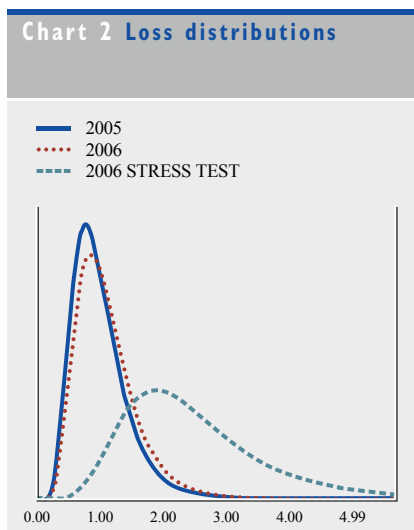
<sup>9</sup> The rationale for such provisioning policies is explained in G. Jiménez and J. Saurina, *Credit cycles, credit risk, and prudential regulation*, International Journal of Central Banking, Vol 2, No 2, June 2006, pp. 65-98.

period of expansion undergone by the Spanish economy (starting in 1994 and not yet interrupted) has also played a crucial role in the ability of Spanish banks to compete more openly, to offer a much more complete array of banking products, and to reinforce their profits and solvency over time.<sup>10</sup>

### 2.3 POST-FSAP

Since the FSAP, the Banco de España has continued to work on stress testing, both on methodologies and on practical issues. Recently, we have been focusing on the calculation of the loss distribution for credit risk.<sup>11</sup> We have modelled 12 sectors (10 industries, mortgages

and consumption loans) representing the whole loan portfolio of a bank using quarterly information (close to 90 quarters). PDs and the number of loans depend on GDP growth rates and interest rates, plus two latent factors uncorrelated with the business cycle and an additional sector idiosyncratic factor. We have also modelled the loss given default (LGD). The Credit Register database has again been the key database. Once the credit loss distribution is calculated we are able to measure the EL and the value at risk (VaR) at a 99.9% confidence level, for instance. Moreover, we are able to stress test the loss distribution across a deep recession (i.e. GDP decline during 4 quarters and slow recovery from there onwards). Chart 2 shows the relative change in the loss distribution after the simulation is applied.



## 3 SOME CAVEATS ON STRESS TESTING

Stress testing is based on data, past data to be more precise. If there is a structural break in the economy (e.g. joining a monetary union with lower levels of interest rates and lower volatility), that may have a significant impact on the long-term relationships among the variables involved in the stress testing and, thus, may imply a shift in the response to shocks. Similarly, if there has been, as one might rather confidently argue, an improvement in risk management by banks, in particular in credit risk measurement and management (securitisation, credit derivatives, transfer of risk, more weight given to risk control departments, etc.), that may also have a significant impact on the response to shocks. Both changes in the economy and in bank management techniques seem to be present in Spain, with the result of an increase in uncertainty about the degree of confidence in

<sup>10</sup>The Banco de España description of the Spanish FSAP can be found in Banco de España, *Notas de Estabilidad Financiera* 5, December 2006.

<sup>11</sup>A detailed analysis can be found in G. Jiménez and J. Mencía, *Modelling the distribution of credit losses with observable and latent factors*, Banco de España Working Paper 0709.

Chart 3a Construction

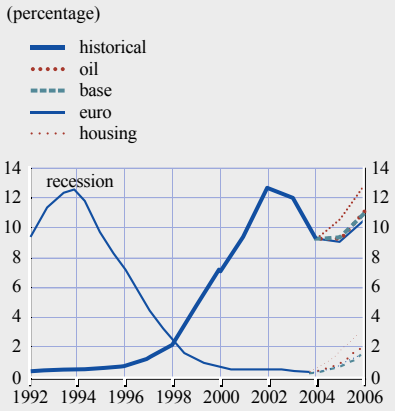


Chart 3b Other economic activities

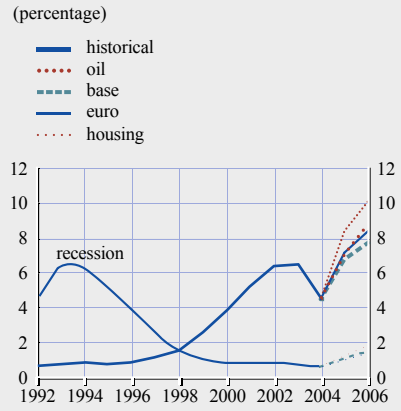


Chart 3c Consumption

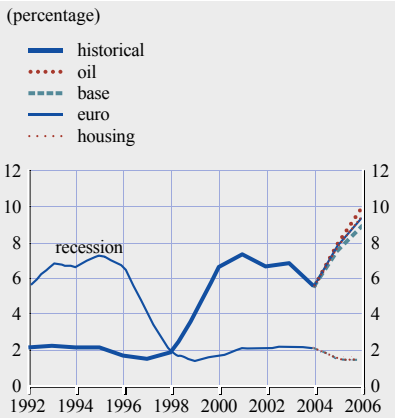
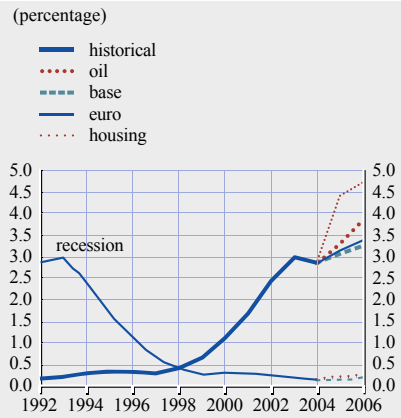


Chart 3d Mortgage



stress-testing results. Moreover, it is not easy to quantify the impact that such changes may have on the final results or their reliability.

Another area of concern is how reliable are stress-test results based on backward-looking data? Depending on the distance from the last recession, the results may change significantly. For instance, depending on the level of the variables subject to the stress, the results may be very different. That is, a stress-testing exercise after a recession will produce worse results than one after a long period of economic expansion.<sup>12</sup> Charts 3a-d show a (rather crude) example of that.

<sup>12</sup>To make things more complex, it may be possible that the probability of changing regime (from upturn to downturn) may be higher the longer the period with no change in regime.

From the bottom-up panel data stress-testing exercise, we obtain a fairly mild increase in NPLs across the four loan portfolio segments and scenarios previously discussed. If we simply reversed the order of those NPLs over time, re-estimated the determinants of those NPLs and simulated the same scenarios, the results would be rather different. Admittedly, this is a crude way to test our claim but, nevertheless, it should be something to bear in mind when assessing stress-test results. In other words, depending on the levels of the variables and their recent dynamics (e.g. distance from the last recession), results are very sensitive.

A third area of concern is how to react to a bad news stress-testing exercise? If we are close to the shock, there is almost no degree of freedom to react. Even worse, it might be counterproductive to react. On the other hand, if we are far away from the shock, are we going to see the problem? Are we going to react? What if, after a recession, where stress testing might be biased towards a worse result, we keep insisting on extra-prudent behaviour of banks in their lending policies? What if, in the middle of an expansionary period, we start recommending more prudent lending, thus undermining a sustainable expansion based on a structural change in the economy? Of course, conversely, if we are too confident of the mild results of our stress testing, we might be helping to fuel a bubble that, when it bursts, might sweep away a significant chunk of wealth and welfare. So, stress testing may increase the complacency of bank supervisors and central banks. These are policy dilemmas that stress-testing techniques and approaches are not going to answer.

To clarify, stress testing is an important tool for assessing the level of risk that individual banks or the whole banking system are exposed to. Spanish banks and supervisors use these tests regularly and intensively. However, the results need to be treated with some caution, in Spain and elsewhere.

## 4 CONCLUSION

There is no mystery in stress testing. We have explained how different techniques and approaches have been applied in Spain. Methodologies for stress testing are relatively simple and cheap. However, data availability and quality are probably more binding. Stress testing is a good risk management tool for banks, as well as for supervisors and central banks, although some caveats arise when interpreting the results, which calls for a prudent reading of those results.

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# MACRO STRESS TESTING – MOST RECENT EXPERIENCES

GERHARD P. HOFMANN<sup>1</sup>

## I “STATE OF THE ART” IN STRESS TESTING

All three presentations so far have been excellent and have given a good “flavour” of stress testing in various countries. Moreover, their different approaches complement each other quite well.

Stress testing is still a relatively new art which more and more countries are applying nowadays. The International Monetary Fund’s Financial Sector Assessment Programs (FSAPs) are probably the most important catalysts in this area as expertise in stress testing is virtually spread around the world by the Fund. As things are in a flux, it is not easy to determine exactly what “state of the art” in stress testing really means. The range of practices is rather wide and is by no means standardised, which is a good thing at this relatively early stage in the development of stress-testing techniques.

The spectrum of stress tests ranges from simple sensitivity analysis (taking into account just one risk factor) to advanced macroeconomic scenario analyses. Nowadays, the latter are quite common among central banks owing to the proximity to overall economic and monetary analysis. And, at the top end of the range, there are highly sophisticated approaches like modelling feedback effects from the banking sector to the real economy, endogenous liquidity as well as contagion effects in the financial system. The main aim of those methods is to try to capture, additionally, indirect second and third-round effects resulting from a stressful event. Given this diversity of methods, stress testing is really a moving target. However, all methods fall into one of two broad categories: top-down approaches (i.e. macro stress testing) and bottom-up approaches (starting from the individual institutions). Typically, both types of tests are carried out simultaneously as they each have their strengths and weaknesses. A major challenge here, as Nigel Jenkinson pointed out, lies in integrating top-down and bottom-up approaches in a consistent manner in order to improve the reliability of stress-testing results.

## 2 COMPLEMENTARY BOTTOM-UP AND TOP-DOWN APPROACHES TO STRESS TESTING

The Bank of Spain’s approach is a good example of solid bottom-up stress testing. Banks themselves (not the central bank) calculate their individual risk figures for credit, market and liquidity risk and apply stress scenarios to them according to the more general guidance given by the central bank. One particular

<sup>1</sup> Member of the Board of Directors of the Federation of the German Cooperative Banks. At the time of the conference Mr. Hofmann was Director and Head of the Banking and Financial Supervision Department at the Deutsche Bundesbank.

strength of this approach is that it uses a very robust data source, as the relevant information is taken directly from the banks' records with the participation of the institutions themselves. The importance of credit spreads under this approach (as highlighted by the Bank of Spain) is confirmed by our own research. In the case of Spain, a possible further expansion of the credit risk stress testing might lie in the inclusion of credit register data, which in Spain cover virtually every bank loan in the economy. This unique data source is a treasure chest which could certainly enrich stress testing. Using credit register data might also help further develop and refine the methodology by means of estimating correlations between the most important risk categories (credit risk, market risk and liquidity risk).

As no method is in itself perfect, some drawbacks are worth mentioning. One caveat regarding the bottom-up approach relates to the dilemma between achieving a high level of comparability of results and the use of data from individual banks' stress tests. This very obvious trade-off has to be resolved by the central bank as the focus should be primarily on the systemic impact of certain stress scenarios. In addition, inconsistencies may arise between the size of a shock and the assumption that such a shock may occur overnight. This relates to the fundamental challenge each stress-testing method will face, namely defining a severe but still meaningful stress scenario. Finally, the Bank of Spain's current method with regard to market risk stress testing focuses on the trading book only (except for interest rate risk) as these data are readily available through regulatory reporting. Data on market risk in the banking book, however, can also be quite important depending on the business model of participating banks. Yet, at the same time, banking book data on market risk are not easy to obtain as there is at present no harmonised regulatory treatment of such risk.

The Bank of England's approaches to stress testing, as presented at this conference, try to capture new elements and address some of the weaknesses of stress testing. With regard to endogenous liquidity, the differentiation between (and the analysis of) market liquidity and funding liquidity is highly relevant. The need for further discussion in this area is very obvious, not least because of the credit market turbulences in August 2007, which led to tight liquidity conditions for some major institutions. Among others, two avenues of further research come to mind here. Firstly, market liquidity may require a market-specific focus. Overall market liquidity for the financial system may look sufficient, but specific and relevant markets, from which systemic shock waves could emerge, may face liquidity problems (as was the case in the ABCP market in autumn this year). In addition, different market segments are linked and both spill-over effects and a redirection of liquidity flows may occur. The second remark refers to the issue of how stable the assumption of endogenous liquidity is. Liquidity conditions under stress are extremely difficult to predict, and yet such conditions are most relevant to financial stability analysis.

Contagion loops, as mentioned by Nigel, are often neglected owing to data constraints. At the same time, they are another critical factor in stress testing, both in terms of interbank relationships and on a cross-border basis. The Working Group on Macro Prudential Analysis of the Banking Supervision Committee is looking into cross-border linkages of banks. This work appears very timely

for a better understanding of contagion loops. Similar remarks apply to macro feedback effects – another quite innovative feature in stress testing. Conceptually, such feedback effects are very appealing, but hard to quantify. Modelling of such feedback loops (second and third-round effects) is at present very ambitious from an econometric point of view.

Last but not least, aggregating risk into a single loss distribution for the whole banking sector, taking into account contagion and feedback effects is a very valuable idea. Our understanding of changes in risk appetite, actual risk taking and resilience of the financial sector is still limited. Moreover, when trying to aggregate risks from different sources and areas, the resulting “model risk” is a challenge which is not easily overcome. Given these limitations, an (often simpler) non-aggregation approach which presents the different areas of risks may still outperform risk aggregation. Anyway, both approaches may be used in a complementary manner, thereby improving the reliability of overall stress-testing results.

### 3 WAY FORWARD AND OVERALL ASSESSMENT

What are possible and promising ways forward on stress testing? Firstly, owing to its rich experience of FSAPs, the IMF has the best horizontal view of stress-testing applications in various countries. At the same time, the IMF can serve as a multiplier in spreading good stress-testing practices. Possible refinements are stress tests tailor-made to specific countries and/or regions sharing the same fundamental conditions and financial environment. Moreover, cross-border stress testing may be appropriate. Here, it appears even more important to try to assess the relevant cross-border relationships and channels through which stress can be transmitted. Secondly, as stress testing should be considered a challenge for all countries around the globe, even if with varying scope and intensity, the exchange of information and findings is critical. There is a joint project by the IMF and the Deutsche Bundesbank to provide an Internet Based Stress Testing Platform (IBST-Platform) for central banks. The platform offers some highly relevant features, ranging from discussions of current literature to an ongoing exchange of information on stress testing-related topics and on conferences. Sharing information is key to taking these issues to the next level and promoting good stress-testing practices globally.

With regard to substance, just a few remarks are to be made. The key question is not a technical one. Rather, it is the fundamental issue of whether stress testing can improve the diagnostic abilities of central banks and supervisors with regard to financial instability, ideally at an early stage when unfavourable developments are unfolding. It appears within reach to define a holistic concept of stress testing covering all relevant areas as well as second and third-round effects in some forms of feedback mechanisms. Yet, at the same time, these concepts are quite difficult to implement. While it is good to have high goals, the gap between sophisticated and very appealing concepts/ideas, on the one hand, and sound implementation, on the other, probably remains the biggest challenge for further progress in stress testing. In this overall context, a very important observation is that stress-testing

methods and practices in good times when markets, institutions and infrastructure work, by and large, satisfactorily may create an unrealistic sense of comfort as major assumptions may not hold in times of crisis. For example, important correlations used in stress testing beforehand may – and almost certainly will – break down in times of crisis. To replicate potential stages of future reality will hardly be possible as each crisis is potentially different. However, this does not mean that stress testing cannot play a useful role in deepening our understanding of markets, institutions and infrastructure. It is simply a “health warning” to say that stress testing cannot be considered as a mechanistic toolbox which allows a forecast of what will actually happen. Central banks and supervisors are very much aware of this caveat.

Despite the unpredictability of the next crisis, the endeavour to design extreme, but plausible, stress tests can be of tremendous value. Such an approach may create and increase the awareness of specific types of risks which may otherwise be overlooked by both the private and the official sectors. A much deeper understanding of risk factors in the financial sector as well as of the resilience of major systemic institutions will be the outcome. Serious discussions of risk scenarios with banks and the actual conduct of stress tests can make a substantial contribution to reducing systemic risk in the financial sector. Therefore, stress testing, if understood and used correctly, has its proper place in the analytical toolbox of those who are responsible for financial stability.



## **SESSION II**

### **MACRO STRESS TESTING – METHODOLOGICAL CHALLENGES**

#### **A TRAVERSE FROM THE MICRO TO THE MACRO**

*Charles Goodhart*

#### **MODELLING INSTABILITY OF BANKING SYSTEMS AND THE PROBLEM OF MACRO STRESS TESTING**

*Martin Summer*

#### **MACRO STRESS TESTING – METHODOLOGICAL CHALLENGES**

Comments by *Sylvie Mathérat*

## A TRAVERSE FROM THE MICRO TO THE MACRO

CHARLES GOODHART<sup>1</sup>

The purpose of regulation is to counter market failure, not to make those regulated behave in a fashion conformable to the regulators' preferences. The most serious market failure (i.e. the one that affects the real economy most) is the risk that the behaviour of some banks (or other financial intermediaries) may so impinge on other banks, financial intermediaries, or markets, as to cause a systemic financial crisis. It is, of course, probable that the crisis will be marked at some stage by the failure of some financial institution(s), but the initial cause could be a withdrawal of funds, e.g. from the interbank market, a cessation of lending to some key borrowers, or a fire-sale unloading of assets, by other banks or financial intermediaries.

Tim Geithner, President of the FRBNY, noted that a common characteristic of financial crises has been:

“[T]he confluence of a sharp increase in risk perception, and the subsequent actions taken by financial institutions and investors to limit their exposure to future losses. As asset prices declined and volatility increased in response to increased concern about risk, firms moved to call margin, to reduce positions and to hedge against further losses. These individual actions had the aggregate effect of inducing even larger price declines and further heightening perceptions of risk, ultimately propagating and amplifying the effects of the initial shock.<sup>2</sup>”

This is a reason why the common form of stress test whereby individual banks (financial intermediaries) are faced with some adverse scenario, and asked whether they would survive in such circumstances, is insufficient. Almost always the answer from each individual bank is that they would (except in such extreme examples that the government would have to step in anyhow). But the shock to each bank's profits, capital and risk aversion would probably be such that they would curtail their lending and shift their investment portfolio towards safer assets. As the quotation from Tim Geithner illustrates it is this second (and subsequent) round behavioural response that could propagate and amplify the crisis. These latter responses are not caught by the current generation of stress tests.

In the rest of this short paper I shall discuss three ways whereby such second (and subsequent) round effects may be assessed, so that the aggregate system's overall final equilibrium may be estimated:

1. by iteration with individual banks;

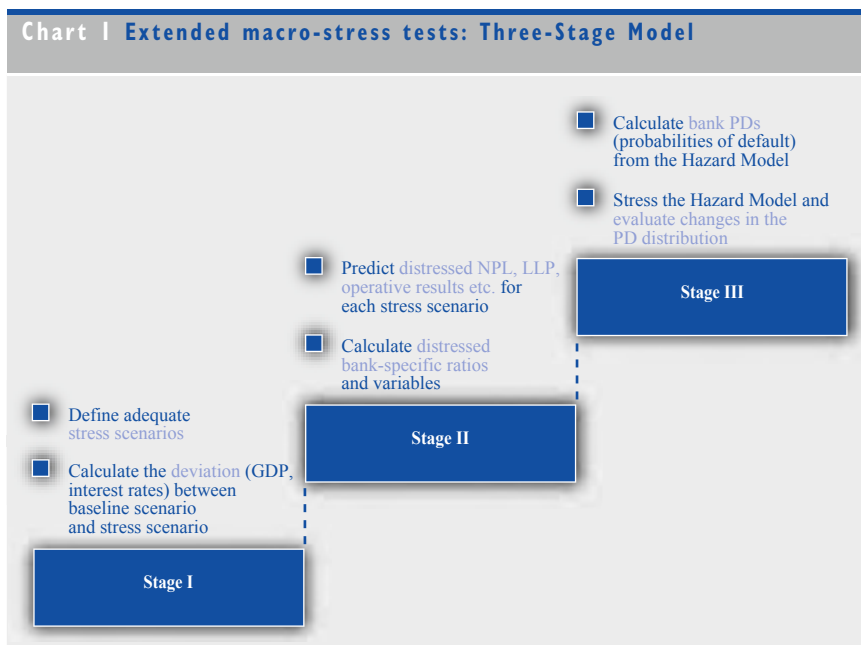
<sup>1</sup> Member of the Financial Markets Group at the London School of Economics (LSE).

<sup>2</sup> “Hedge funds and derivatives and their implications for the financial system”, remarks at the 2006 Distinguished Lecture, sponsored by the Hong Kong Monetary Authority and the Hong Kong Association of Banks.

2. by estimating the portfolio effect on all banks, taken together, of changes in the marginal conditions of individual banks;
3. by a top-down model that allows us to simulate the effect of shocks on the economic behaviour of the main banks in the system.

Let me start with the first of these, i.e. iteration with the individual banks. In principle, it should be possible to ask each bank not just how its profits and capital base would be affected by some adverse shock, but what would be the effect on its whole balance sheet of assets and liabilities. Given the attempted restructuring of all the banks' portfolios, those in charge of the exercise could again, in principle, revise the initial scenario of asset prices, non-performing loans, etc., to present the banks with a scenario adjusted to take account of the banks' own second-round responses; this procedure could continue in theory through as many rounds as anyone thought it useful to play. To the best of my knowledge no such iterative exercise has ever been attempted, and it is dubious whether it would be worthwhile. How accurate would, or could, each bank's respondents be about their hypothetical response to a major shock (and indeed could the full conditions in which such a shock occurred ever be properly depicted). Given each individual bank's simulated responses, could those running the exercise then feed these back accurately into a revised (quasi-equilibrium) macroeconomic scenario of prices and quantities? I doubt whether the iterative procedure is the way forward, though it might be worth having an experiment in a country where only a handful of banks comprises the bulk of the banking sector.

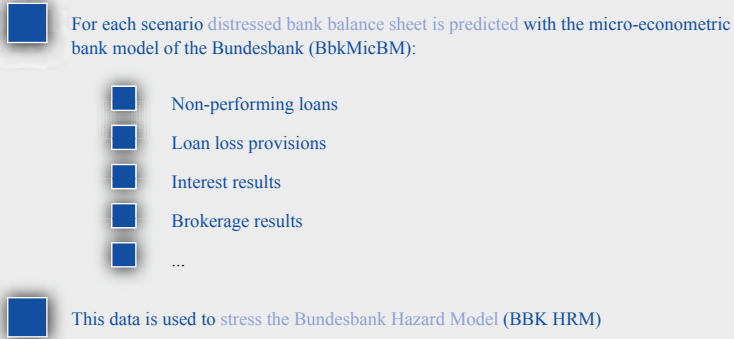
So, let us move on to the second route: estimating the portfolio effect on all banks, taken together, of changes in the marginal conditions of individual banks. Here there has been considerable progress recently, including work by the prior



Source: Thilo Liebig, Bundesbank

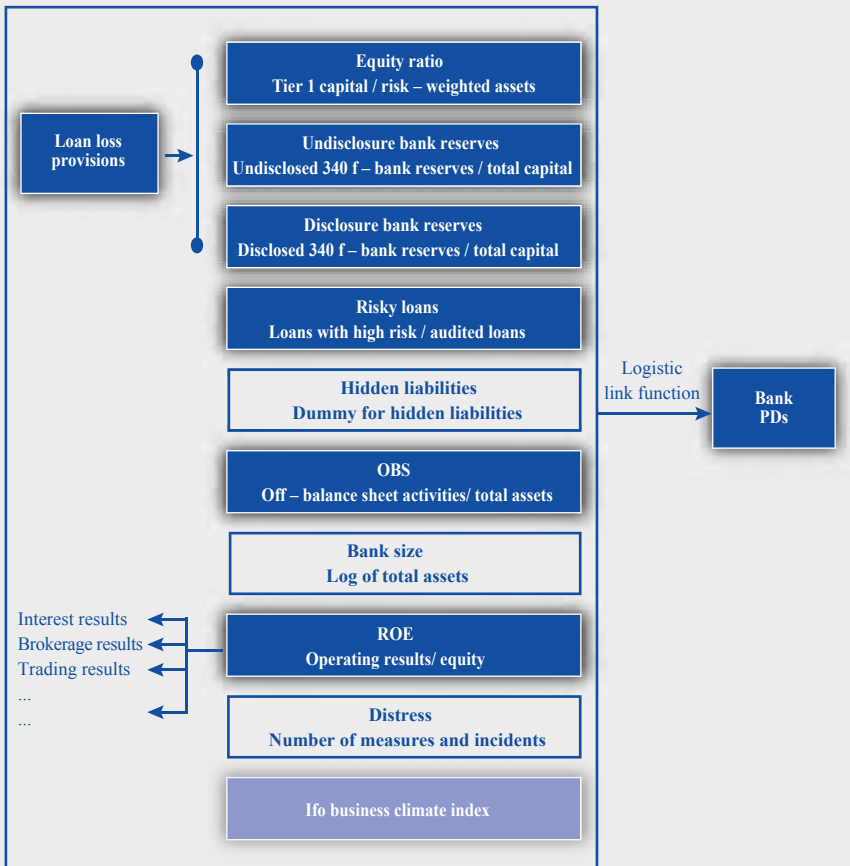


## Chart 2 Extended macro-stress tests: Stage II - Forecasting distressed bank balance sheet data



Source: Thilo Liebig, Bundesbank

## Chart 3 Extended macro-stress tests: Stage III - Stressing the Bundesbank Hazard Model



Source: Thilo Liebig, Bundesbank

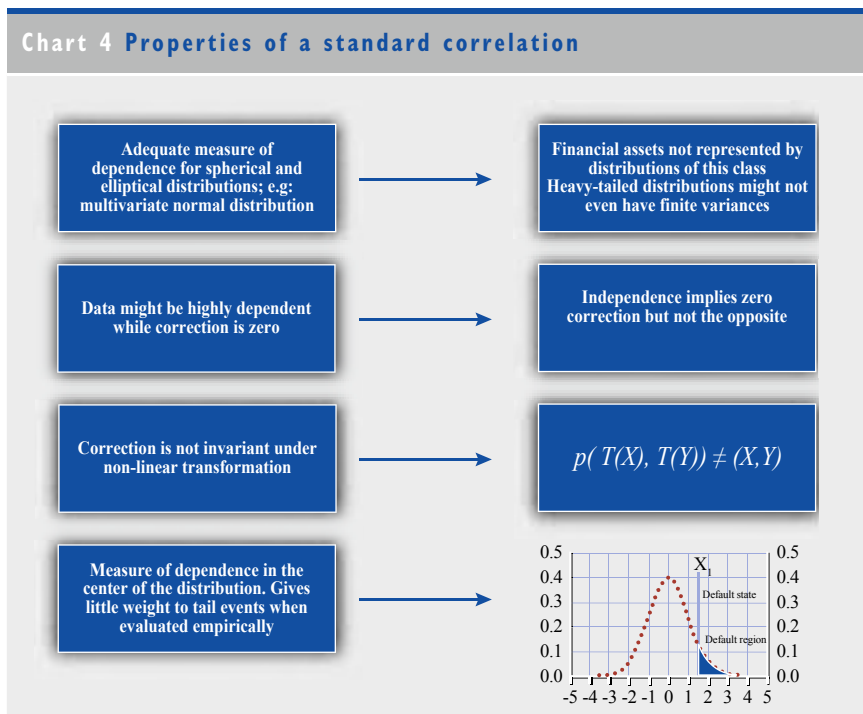
speaker, Martin Summer. In practice, I am going to reproduce the slides presented recently by Thilo Liebig of the Bundesbank (Charts 1-3). The first stage is to use the central bank's macro-model, augmented wherever possible by sector-specific credit history data, to estimate, in the bank (i.e. top-down), the likely bank-specific results, and hence the probability of default (PD) of each major bank.

The next stage, having got an estimate of each bank's individual PD is to try to work out what is the risk to the (full) set (or subset) of banks, i.e. the fragility/stability of the system as a whole. This is a complicated issue because the use of standard correlations in such cases is not appropriate (Chart 4).

I have been working with a colleague, Miguel Segoviano at the IMF, who thankfully has been doing all the technical work and maths, to explore a Copula approach, using an entropy-based estimation procedure (Charts 5 and 6) to derive an aggregate Banking Stability Index.

An example for Canada of this BSI and joint PD is shown here (Chart 7). Please do not ask me technical questions about this; go directly to Segoviano.

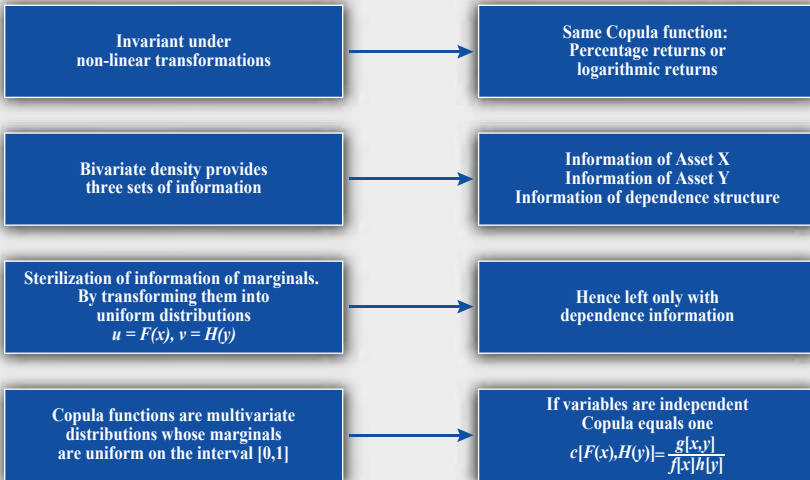
Such methods do represent a considerable advance, but I do still have a few reservations. The initial macroeconomic model, from which individual banks' PDs are estimated, is calculated from historical data and in that sense already incorporates some average of the banks' own responses to shocks, for example in the estimates of sectoral non-performing loans. But if the banks' responses on this occasion are not consonant with the past average, the calculated BSI and the initial



Source: International Monetary Fund

## Chart 5 Properties of Copula functions

Describe linear and non-linear dependence of any type of distribution



Source: International Monetary Fund

assumed macro-shock may be out of kilter with each other. As in the iterative approach, the exercise proceeds from the macro to the micro-individual PDs. We can then use Segoviano's, or another, technique to estimate an overall BSI, but, as yet, that does not feed back again to the initial macroeconomic starting point.

In my view the proper way to integrate the actions, and potential failures, of banks within the macroeconomy is to include them in an overall model. This is, however, difficult for several reasons. First, unlike almost all extant micro-models, endogenous default must be a key feature of the model, and default is intrinsically a non-linear event. Second, banks, and their clients, cannot all be similar, representative agents; otherwise either all banks, or no bank, default simultaneously, which is hardly either realistic or helpful to supervisors in

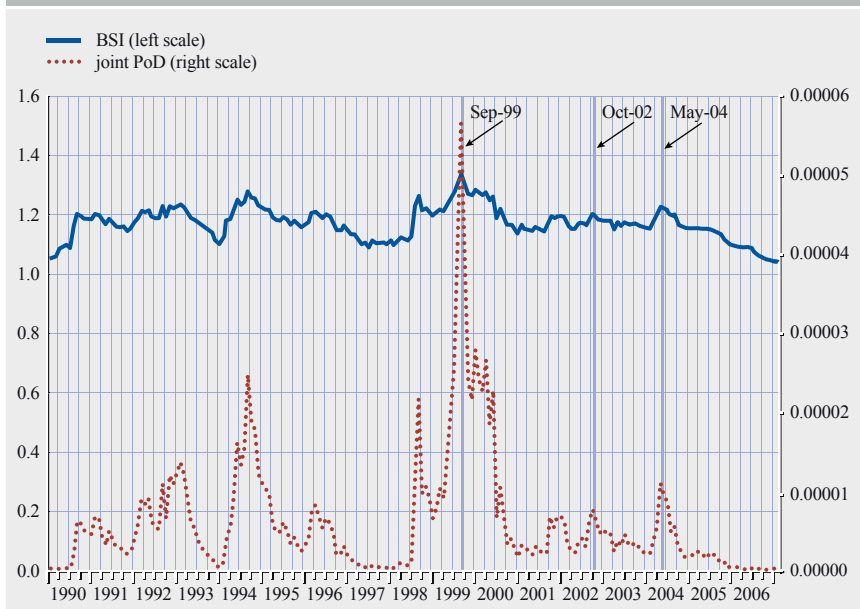
## Chart 6 Entropy-based approach

In contrast to the "standard" Copula approach

- 1. Using entropy-based estimation, we infer the multivariate density of the portfolio (CIMDO density)
- 2. This density has the Copula embedded within it
- 3. We "extract" the Copula; i.e. the CIMDO-Copula, via Sklar's Theorem
- ...

Source: International Monetary Fund

**Chart 7 Banking Stability Index and Joint Probability of Default**



Source: International Monetary Fund

practice. Third, financial markets must be incomplete, or else all eventualities could be hedged in advance. Such non-linearities and heterogeneity amongst agents inevitably increase the dimensionality and complexity of the model, but a fourth requirement is that such a model must be capable of being taken to the data, if it is to be practically useful, and not just an academic *jeu d'esprit*.

Dimitri Tsomocos, who again has been responsible for the technical modelling, and I, and a number of other colleagues, have been working on model(s) of this kind. The crucial element, which is the treatment of default, derives, however, from earlier work by Martin Shubik. In this, agents are assumed to choose strategies which give differing probabilities of default, depending on what state of the world ensues. Note the consonance with stress tests! The model, and its solution, is, of course, top-down, to be estimated in-house, but its solution in practice requires an essential input from the supervisors, which is an assessment of the relative risk aversion of each of the (main) individual banks. A number of papers relating to such models, and the appropriate treatment of default, are included in the Bibliography, for the benefit of those who would like to pursue this subject further.

I do not, in the short period allocated to me here, have the time to go through the model in any detail. There are, however, numerous papers and a forthcoming book.

Our model incorporates heterogeneous banks and capital requirements in a general equilibrium model<sup>3</sup> with incomplete markets, money and default. It extends over two periods and all uncertainty is resolved in the second period. Trade takes

<sup>3</sup> For an extensive description of this variant of the model see Goodhart et al (2005).

place in both periods in the goods market. In the first period agents also borrow from, or deposit money with banks, mainly to achieve a preferred time path for consumption. Banks also trade amongst themselves, to smooth out their individual portfolio positions. The central bank intervenes in the interbank market to change the money supply and thereby set the interest rate. Capital adequacy requirements (CARs) on banks are set by a regulator, who may, or may not, also be the central bank. Penalties on violations of CARs, and on the default of any borrower, are in force in both periods.

One reason for developing models of this kind is that they could be used to overcome one of the main weaknesses of the current methodologies for assessing systemic stability. Such methodologies are often based on stress, or scenario, tests. In such tests, a scenario is assumed wherein some bad state occurs, and the banks are then asked what that might do to their profitability and capital adequacy. But this usually measures only a first-round effect. If such bad outcomes did happen, the banks would often respond to these first-round effects by reducing their loan extension and becoming themselves more conservative. This would have second-round effects on asset prices, risk premia, and real economic activity, usually then amplifying the original first-round effect. While it is possible, in principle, to iterate through various rounds of effect in collaboration with the (main) commercial banks, in practice this is virtually never done. Instead, using a (centralised) model, such as ours, does enable one to estimate the equilibrium outcome; that is one of its main purposes. Of course our model depends on several variables that are difficult to observe, such as the degree of risk aversion and the risk strategies being adopted by both banks and their borrowers. But these are key fundamental elements in the determination of systemic stability. As all sensible central bank officials know, it is just when (over) confidence during periods of boom and expansion leads banks and their borrowers to accept (or ignore) more risk in pursuit of higher returns that the seeds of the next crisis are sown. It happens all the time.

Our model is certainly not the last word; indeed it is only a start; and others can, will and should do better. But I believe that it is the way to go.

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# MODELING INSTABILITY OF BANKING SYSTEMS AND THE PROBLEM OF MACRO STRESS TESTING

MARTIN SUMMER<sup>1</sup>

## I INTRODUCTION

Central banks and international financial institutions have recently taken strong interest in quantitative models of financial instability. Models have the advantage that they allow assessing situations that have not yet occurred.

This includes thought experiments about situations of financial distress and crises. Having a clear idea about the implications of certain stress scenarios for the financial system is a definite advantage for an institution in charge of safeguarding financial stability. In this paper, I discuss some of the issues that arise in current approaches to modeling financial instability.

As an example, to put the discussion of these issues into context, I use the model Systemic Risk Monitor (SRM).<sup>2</sup> This model has been developed at the Austrian central bank (OeNB) for banking system risk assessment and stress testing. Since recently, it is being regularly used by OeNB's financial stability division (see Boss et al. (2006)).

By organising my discussion around the SRM model, I confine myself to models of the banking system. Most of the modeling efforts of financial instability at central banks have turned their focus on the banking system. The financial system, as a whole, clearly has more elements than that. The insurance sector and some of the key security markets play an important role.

The banking system is a natural focus for mainly two reasons: First, bank credit is a major source for financing enterprises and households. Credit expansions and contractions have major repercussions on the macro economy and the business cycle. Banking crises have therefore big impacts on the real economy. Second, central banks have been involved in banking supervision and hold many data on banks and the banking system that support them in their task and in their main function of maintaining price stability. Focusing on the banking system therefore highlights a part of the financial system with a major macroeconomic impact and where a rich source of data is usually available at central banks.

Focusing on the banking system does, however, not imply that models of banking system instability ignore the interactions with other parts of the financial system or with the economy as a whole. To the contrary:

<sup>1</sup> Head of the Economic Studies Division at the Oesterreichische National Bank (OeNB).

<sup>2</sup> The SRM model and the results from the model presented in this paper have been all developed in various joint projects with my colleagues Michael Boss, Thomas Breuer, Helmut Elsinger, Martin Jandačka, Gerald Krenn, Alfred Lehar and Claus Pühr. The discussion of the SRM model and its output uses results from Boss et al. (2006). All views presented in this paper are the views of the author and do not necessarily represent the views of OeNB.

Capturing these connections is the key challenge for any attempt to model banking system instability.

The paper is organised as follows: In Section 2 I discuss three key differences between risk analysis at financial institutions and the risk analysis at central banks. Section 3 explains why the literature on quantitative risk management has been particularly attractive for central bank researchers who were confronted with the task of designing a stress test. I argue that this has led to a conceptual set-up of many stress testing models that is perhaps not sufficiently rooted in economics. I then explain in detail the SRM-model in 4 and try to bring some of the general points I have made in Section 2 and Section 3 into perspective. Section 5 explains the data used by SRM and Section 6 shows some applications. Finally Section 7 concludes.

## **2 RISK ANALYSES AT FINANCIAL INSTITUTIONS AND AT CENTRAL BANKS: THREE KEY DIFFERENCES**

Quantitative models of financial instability have moved to the top of the research agenda of many central banks only very recently. There is yet no clear paradigm about the key elements of such models. Most of the models seem to share a common approach though: They are strongly rooted in the literature on quantitative risk management (see McNeil et al. (2005)). This literature developed mainly from the needs of banks and insurance companies to determine their capital requirements.

In a nutshell, the quantitative risk management paradigm can be described as follows: Given is a certain portfolio of financial instruments. It is assumed that for the given portfolio the value of the individual portfolio positions over a given time horizon are completely determined by a set of (exogenous) risk factors. The development of risk factors - and as a consequence the value of the portfolio - are subject to uncertainty. By making assumptions on the probability law that drives the evolution of risk factors, a gains and loss distribution for the portfolio can be derived. This distribution is then the tool to decide whether the institution holds appropriate exposures or enough capital given its risk preferences (and potential additional regulatory requirements).<sup>3</sup>

There are three main reasons why models of financial system stability used at central banks have to go beyond this framework: the first reason is that central banks have to take the perspective of the system as a whole rather than that of a single institution. At this level of analysis interdependencies and interactions between financial institutions become crucial and they have to be taken into account in the model.

There is a second reason why a plain quantitative risk management framework is not enough for a central bank: It is not clear that it has the same objectives as a risk

<sup>3</sup> When I refer to the quantitative risk management framework, I confine myself to the narrow definition described in this paragraph. A quantitative risk management framework in general could of course look very different from that.



manager of a financial institution. At the single institution level the objective is clear. The institution wants to have a precise idea of its own risk taking and wants to avoid insolvency with a certain probability that is consistent with its risk preferences. For a central bank in charge of maintaining financial stability the main goal is that it is not impaired in its function of maintaining price stability. The ultimate goal is to guarantee price stability and to avoid real losses to the economy as a whole that might occur as a consequence of financial crises. Clearly this is an objective for which it is much harder to find a precise definition and to implement it practically. When central banks model financial institutions, their potential problems are only its indirect concern. What ultimately matters are consequences for the real economy, for employment and growth. In contrast, for a risk manager of a financial institution the objective is very clear. Given the risk preferences, he has to ensure that the portfolios he has to supervise are consistent with these objectives and the probability of the institution becoming insolvent is below a certain threshold.

The third reason why modelling financial instability for a central bank is more intricate than simply applying a quantitative risk management framework is that it is unclear by which instruments it can react to certain quantitative assessments of the potential risks in the system. Again for a risk manager in a financial institution the instruments at hand are very clear.

When an institution finds that it has too much risk in its portfolio it has to hold more capital or it has to decrease its risk exposure. Clearly, at a system level there is no clear cut instrument that can be applied as a consequence of a risk analysis along the lines of a quantitative risk management framework.

In my view, current models have taken the approach of starting from the quantitative risk management framework adapt these models for the needs of central banks from there. It seems that only with respect to the first step, going from a single institution perspective to the system level, some progress has been made. As far as the other two aspects are concerned, defining a clear objective function and identifying suitable instruments by which the objective can be achieved the territory seems so far uncharted.

### **3 MODELLING THE BANKING SYSTEM WITH A STRESS TESTING PERSPECTIVE**

During the last two decades the economics literature on banking has flourished. A huge part of this literature has been summarised in textbook treatments starting from the mid of the 1990s.<sup>4</sup> While this literature is very rich, the models that emerged from it do not lend themselves easily to a framework that is useful for stress testing. The reason is that the majority of the new models have a microeconomic, single-bank oriented perspective. They deal with various information economic and incentive related issues of banking, for instance, why banks exist, the microeconomics of lender borrower relationships, as well as various incentive problems and its economic consequences that follow from this particular relationship. The

<sup>4</sup> For an overview see Greenbaum and Thakor (1995), Freixas and Rochet (1997))

microeconomic literature on questions of systemic risk is mainly formulated in the context of the famous Diamond Dybvig bank runs model (see Diamond and Dybvig (1983)), which also gives no direct guidelines for stress testing. The models from this literature yield mainly a rich variety of conceptual insight but do not directly lead to the formulation of reduced form equations that could be used with banking data collected at central banks or at regulatory institutions.

The macroeconomic analysis of banking has focused on the link between the banking system and the real economy: on the role of credit in the transmission of monetary policy, on the role of credit constraints and financial imperfections in the business cycle and on financial structure and economic development. As with the microeconomic literature on banking, this literature has yielded many and rich conceptual insights about the role of the banking system for the macro economy as a whole. But again these models do not lead to a practical framework for stress testing that can be used in conjunction with banking data as they are usually collected at central banks or regulatory institutions.

Against this background, the quantitative risk management framework seems an attractive point of departure for researchers that have to provide quantitative stress testing tools. A quantitative risk management framework is formulated in terms of portfolio positions and risk factors, both concepts that can be easily matched with data, while abstracting away from behavioural assumptions. The abstraction from behaviour (in the sense that portfolios are assumed given) clearly has drawbacks. First of all, it only makes sense for a relatively short horizon, while banks are locked with whatever decisions they took in the past. Second, it abstracts away from the fact that the value of risk factors and for this matter of portfolios is usually endogenous and a function of behaviour. This endogeneity seems to be particularly important during crises and stress and can therefore not be taken into account by a quantitative risk management framework. On the other hand it allows a useful - though limited - perspective on a question of crucial importance for a stress testing exercise. It can answer the question:

How would a given system of portfolios react to changes in risk factors by the pure mechanics of balance-sheets plus an insolvency rule. Once confined to such a balance sheet mechanics perspective the open question is how to proceed from the quantitative risk management framework, which is formulated for individual institutions, to the perspective of the system. One answer how this can be done is given in the systemic risk monitor model.

To clarify terminology, I should add that the term balance-sheet-mechanics does not necessarily mean that the individual balance sheet positions are taken from accounting information. The term balance-sheet is used in this paper in a conceptual sense rather than in a literal accounting sense. Thus, if information allows, any asset or liability position of a bank that is available at market values can be used in the model.

## 4 SYSTEMIC RISK MONITOR: THE OeNB APPROACH TO BANKING SYSTEM RISK ASSESSMENT AND STRESS TESTING

Systemic Risk Monitor (SRM) is a balance-sheet-mechanics model in the tradition of the quantitative risk management literature. These models are often also referred to as structural models. The reason why such a perspective is attractive was already outlined in Section 3. A balance-sheet-mechanics model does not only map banking data into insolvency and crises scenarios. By the system perspective, interactions enter the picture and the contagion of insolvency becomes a natural part of the balance-sheet-mechanics at the system level. SRM offers a clear perspective on this issue.

In SRM, the banking system at the beginning of a quarter is described as a system of balance sheets or portfolios of assets and liabilities. In the construction of these portfolios for the Austrian banking system, three major categories of positions are conceptually distinguished. The first category encloses positions of marketable securities such as stocks, bonds, or assets and liabilities denominated in euro or in foreign exchange. The second category contains all loans with counter-parties outside of the banking system, mainly corporations. The third category contains all positions held among the Austrian banks, interbank loans as well as interbank shares. The three categories can be distinguished by the complexity of the function mapping risk factor changes into losses (or gains) of the portfolio values.

For marketable securities, the situation is fairly simple. Supervisory data allow us a fairly coarse reconstruction of positions of market values of securities that are held on the bank balance sheet. The picture is coarse because individual stocks are lumped into Austrian and foreign and interest, while currency sensitive instruments are mapped into broad maturity and currency buckets. Consider, for instance, a simple stock portfolio consisting of Austrian and foreign stocks. Risk factor changes are then the logarithmic changes in the Austrian and a foreign stock price index. To calculate gains or losses from the stock portfolios we can use a linearised approximation of the loss function. This amounts then to simply multiplying the position values with the risk factor changes to get the portfolio gains and losses. For currency sensitive positions, we can equally arrive at gains and losses by using linearised losses and the relevant risk factor changes, that is changes in different exchange rates. Interest risk is approximated by assuming that values of interest sensitive positions in the various maturity buckets are present values of an equivalent zero coupon bond. The change in interest rates and the maturity bucket (in the case of a zero coupon bond equivalent to the duration), determines the approximate change in the present value of the positions. In this way, we can approximate interest rate risk using interest rate changes for different maturities and different currencies.

For loans to non-banks, the situation is more complicated because the dependence between loan losses and risk factors is more indirect. We don't have a simple analogue to market returns. Defaults of loans in particular industry sectors - the units to which we can break down loans in SRM - are driven by default indicators. The probability distribution of these indicators depends mainly on risk factors describing the aggregate state of the economy, i.e. the driving risk factors

are macroeconomic variables. Due to the discrete nature of the default indicators linearised losses are of little importance. Therefore, SRM uses a credit risk model to calculate losses from corporate loan portfolios. The basic idea is that the default probability of a loan in a particular industry sector – say construction – depends on a set of macroeconomic variables according to a function, the parameters of which are statistically estimated from historical data. Given a realisation of macroeconomic variables and the implied probability of default for different industry sectors, loan defaults are assumed to be conditionally independent.

Under this assumption, a loan loss distribution can be derived for each bank for each value of macroeconomic risk factor changes. Loan losses are then calculated by independent draws from these loan loss distributions. For loan losses, therefore, the function mapping risk factor changes (changes in macroeconomic variables) to loan losses is more complicated.

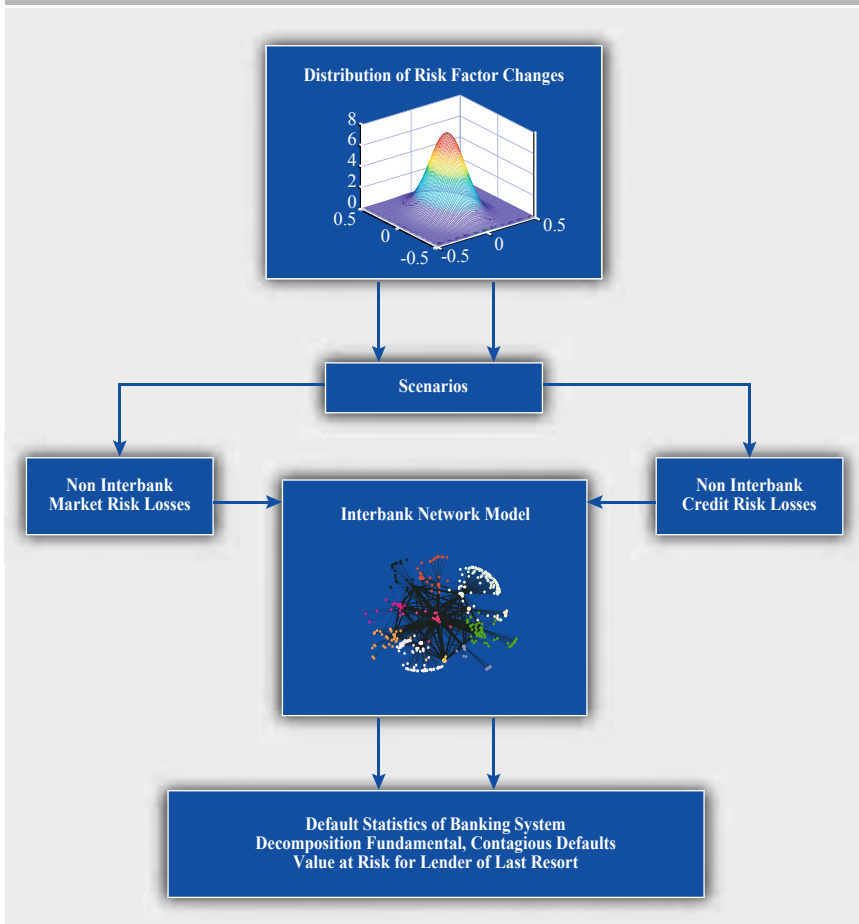
Finally gains and losses from interbank positions, are calculated by the use of a network clearing model. The basic idea of this model is to capture interbank loans and shares by a matrix of all bilateral positions as observed at the observation time. Risk factor changes that have an impact on the value of loans and market positions together with the network of interbank loans determine for each bank whether it can fulfil its interbank promises or not. If one or more banks are unable to fulfil their interbank obligations for a particular realisation of risk factor changes, a clearing procedure redistributes the value of insolvent institutions among the creditors until all financial claims after the realisation of risk factor changes become consistent. Thus in the case of interbank positions, the function mapping risk factor changes into interbank losses is a fairly complicated function of market and credit losses and the clearing procedure. All these losses (gains) in combination determine the gains and loss distribution in SRM.

Whereas the modelling of non-interbank market and credit losses is rooted in standard quantitative risk management techniques the combination with an interbank network model to arrive at total gains and losses in the banking system in SRM are new (see Elsinger et al. (2006a)). Both generalisations of standard individual risk management techniques, the simultaneous consideration of portfolio values across the system for given risk factor changes and the resolution of bilateral claims via a network clearing model, focus on two major issues for an institution in charge of monitoring systemic financial stability, i.e. the probability of joint default of institutions and its financial consequences.

#### **4.1 CALCULATING SYSTEMIC LOSSES**

A graphical description of the model structure is given in Chart 1. The chart displays the modular construction of SRM. At the top of Chart 1 is a model of a multivariate risk factor change distribution. This distribution is estimated every quarter based on past observations of market price changes and changes of macroeconomic variables that have an important impact on default probabilities. The modelling strategy treats the marginal risk factor distributions and the dependency structure separately. While marginal distributions are chosen according to statistical tests that select for each risk factor a model which gives

Chart 1 Basic structure of the SRM model <sup>1)</sup>



1) Banks' non-interbank portfolios are exposed to shocks from a risk factor change distribution of market and credit risk factors. The value of interbank positions is determined endogenously by the network model and a clearing mechanism that makes all financial claims consistent ex post after shocks have been realized. The clearing of the interbank market determines the solvency of other banks and defines endogenous default probabilities for banks as well as the respective recovery rates. The output consists of insolvency statistics, a decomposition into fundamental and contagious defaults and an estimate about the amounts of liquidity a lender of last resort has to stand ready to inject into the system.

the best out-of-sample density forecast of changes in each risk factor over a three-month horizon, the dependence is modelled by fitting a grouped t-copula to the data. Together the marginal distribution and the copula characterise the multivariate risk factor change distribution. For the simulation of scenarios, vectors of risk factor changes are drawn at random from this distribution.

Each draw of risk factor changes from the multivariate distribution characterises a scenario. Scenarios are then translated into profits and losses at the system level by the procedures described above. This is achieved in two steps. In a first step,

each scenario is analysed with respect to its impact on the value of non-interbank market and credit positions.

These positions are then combined with the network model. The output of the clearing model gives the final result for the banking system for each scenario. Simulating many scenarios, we get a distribution of insolvency and gains and losses for the banking system that allows us to make probability assignments for insolvencies over a three-month horizon.

We use three main risk concepts to look at the banking system. Since the risk of bank defaults, in particular of joint defaults and the large-scale breakdown of intermediation, is of major interest to the central bank we put a particular focus on bank defaults and default probabilities. The network model allows us to distinguish default events that directly result from changes in risk factors from defaults that result indirectly from contagion of insolvency through interbank relations. We call these defaults fundamental defaults if they result directly from risk factor movements and contagious defaults if they are a consequence of interbank insolvency contagion. Apart from analysing the number of fundamental and contagious defaults, we ask what amount of funds a lender of last resort would have to mobilize to prevent contagious defaults or to keep the number of fundamental defaults within certain limits in a given quantile of scenarios. We call this the value at risk of a lender of last resort. Using our model we can analyse the contribution of certain risk factors or certain institutions to this number at a system level. Finally, we also look directly at the distribution of gains and losses in the system.

## 4.2 STRESS TESTING

An advantage of a quantitative model is that it allows the consideration of hypothetical situations. In the context of systemic risk assessment one-kind of thought experiments is of particular importance. Usually it is of interest how the risk measures for the banking system will behave under extreme developments of risk factor changes. Such thought experiments are known as stress testing. Systemic risk monitor provides a coherent framework to consistently conduct such stress testing exercises.

At this stage, it becomes crucial that the analysts who undertake the stress tests have a very clear idea about the risk measures that are most relevant for them. This topic has been addressed in Section 3. While SRM has three clear risk concepts they are very much driven by the quantitative risk management framework and are not derived from a fundamental concept of financial stability. While it seems very plausible that any definition of systemic risk and financial stability will encompass, in some way or the other, risk concepts used in SRM, it is an open issue what is the most useful measure of system risk for a central bank. As long as there is no clear concept of the relevant risk measures, we will have a situation where each stress testing model will have its own idiosyncratic concepts and it will be difficult to compare results from different stress testing models.

Within the framework of the quantitative risk management paradigm SRM takes a clear stance what it means to perform a stress test: In a stress test one or more risk

factors of interest are constrained to take extreme values, like a certain drop in GDP, or a hike in short-term interest rates. Since we have a complete model of the multivariate risk factor distribution we can then perform a model simulation conditional on the constraint that certain risk factors are at their stressed values. The risk measures of the model can then be studied relative to the baseline simulation based on the unconditional risk factor change distribution calibrated to historical data.

The main advantage of this approach is the consistency with the dependence structure of the risk factors and therefore the consistency with the quantitative framework. Such an approach is advocated by Elsinger et al. (2006b) or Bonti et al. (2005) and it is used in SRM. Thus rather than looking at single scenarios SRM uses the information about the whole risk factor distribution in a stress test. This approach weights scenarios conditional on a stress scenario by their (conditional) probabilities and takes into account the dependence between many risk factors via the conditional risk factor distribution.

Why is this stress testing approach labelled a macro stress test? This labelling is justified for two main reasons. The first reason is that SRM takes a system perspective and does not look at individual institutions in isolation. Second, key macroeconomic variables, like real GDP and their dependence with other key variables, like stock indices, exchange rates and interest rates are taken into account in the risk factor distribution. The way in which macroeconomic variables are taken into account in SRM are, at the moment, purely statistical. The risk factor distribution is not derived from a specific empirical macro model. In principle, there is no conceptual obstacle to replace the risk factor distribution model as it is currently used in SRM by a different model which is more rooted in macro econometrics and macroeconomic theory. An example in this respect is, for instance, Pesaran et al. (2006).

## 5 DATA

The main sources of data used by SRM are bank balance sheet and supervisory data from the monthly reports (MAUS) to the Austrian central bank (OeNB) and the database of the OeNB major loans register (Großkreditevidenz, GKE). In addition, we use default frequency data in certain industry groups from the Austrian information provider and debt collector Kreditschutzverband, financial market price data from Bloomberg, and macroeconomic time series from OeNB, the OECD and the IMF International Financial Statistics.

Banks in Austria file monthly reports on their business activities to the central bank. In addition to balance sheet data, MAUS contains a fairly extensive assortment of other data that are required for supervisory purposes. They include numbers on capital adequacy statistics, interest rate sensitivity of loans and deposits with respect to various maturity buckets and currencies, and foreign exchange exposures with respect to different currencies. In our analysis, we use a cross-section from the MAUS database of all reporting banks in the relevant observation period.

To estimate shocks to bank capital stemming from market risk, we include positions in foreign currency, equity, and interest rate sensitive instruments from MAUS. For each bank, we collect foreign exchange exposures for USD, JPY, GBP, and CHF only, as no bank in our sample has open positions of more than 1% of total assets in any other currency at the observation date. We collect exposures to foreign and domestic stocks, which are equal to the market value of the net position held in these categories.

For the exposure to interest rate risk we use the interest rate risk statistics, which provide exposures of all interest sensitive on and off balance sheet assets and liabilities with respect to 13 maturity buckets for EUR, USD, JPY, GBP, CHF, and a residual representing all other currencies. On the basis of this information we calculate net positions in the available currencies - neglecting the residual with respect to four different maturity buckets: up to 6 months, 6 months to 3 years, 3 to 7 years, more than 7 years. For the valuation of net positions in these maturity buckets we use the 3 month, 1 year, 5 years and 10 years interest rates in the respective currencies.

This procedure gives us a vector of 26 exposures, 4 FX, 2 equity, and 20 interest rates (4 maturities for each currency), for each bank. Thus we get a  $N \times 26$  matrix of market risk exposure.

To analyse credit risk we use in addition to the data provided by MAUS the major loans register of OeNB (GKE) which provides us with detailed information on the banks' loan portfolios to non-banks. This database contains all loans exceeding a volume of € 350, 000 on a loan by loan basis.<sup>5</sup>

We assign the domestic loans to non-banks to 13 industry sectors (basic industries, production, energy, construction, trading, tourism, transport, financial services, public services, other services, health, private households, and a residual sector) based on the NACE-classification of the debtors. Furthermore, we add regional sectors (western Europe, central and eastern Europe, North America, Latin America and the Caribbean, the Mid East, Asia and the Far East, the Pacific, Africa, and a residual sector) for foreign banks and nonbanks individually, resulting in a total of 18 non-domestic sectors. Since only loans above a threshold volume are reported to the GKE, we assign domestic loans above this threshold to the domestic residual sector. This is done on the basis of a report that is part of MAUS and provides the number of loans to domestic non-banks with respect to different volume buckets. For non-domestic loans no comparable statistic is available. However, one can assume that most of cross-border lending exceeds the threshold of € 350, 000 and hence the associated risk can be neglected.

The riskiness of an individual loan to domestic customers is assumed to be characterised by two components: the rating which is assigned by the bank to the respective customer and the default frequency of the industry sector the customer belongs to. The banks rating is reported to the GKE and is mapped within the

<sup>5</sup> The GKE database covers about two third of all loans of Austrian banks in terms of nominal values.



OeNB on a master scale, which allows assigning a probability of default to each loan. The default frequency data are from the Austrian information provider and debt collector Kreditschutzverband (KSV). The KSV database provides us with time series of insolvencies and the total number of firms in most NACE branches at a quarterly frequency starting in 1969. This allows us to calculate a time series of historically observed default frequencies for our 13 industry sectors by dividing the number of insolvencies by the number of total firms for each industry sector and quarter. The time series of default frequencies is explained by macroeconomic risk factor changes using an econometric model. By this estimated equation we can translate macroeconomic risk factor changes in probabilities of default for each industry branch. These default probabilities serve as input to the credit risk model. To construct insolvency statistics for the private and the residual sector, where no reliable information on number of insolvencies and sample size is available, we take averages from the data that are available. Default probabilities for the non-domestic sectors are calculated as averages of the default probabilities according to the ratings that are assigned by all banks to all customers within a given foreign sector.

A remark about the specific Austrian data situation might be in order here. While the availability of a loan register and a fairly huge amount of bank supervisory data is certainly an advantage in approximating positions accurately it is not necessary to have exactly the same data situation to apply a modelling logic like in SRM. If, for instance, a loan register is unavailable there might still be other possibilities to approximate a loan loss distribution, if the modellers have some idea about how the loan portfolio of large institutions is approximately structured. This knowledge might then be used to formulate assumptions about the distribution of loan exposures for individual institutions that can help in calibrating a loan loss distribution.

Another example is Elsinger et al. (2006b), where it is shown how stock market information might be used to model the risk of non-interbank assets and how this analysis can be combined with a network model to generate an analysis with the same basic logic as in SRM. It might be an interesting exercise to think about a minimal set of data requirements that allow for an SRM-like analysis.

## **6 APPLICATION: RISK ASSESSMENT AND STRESS TESTS**

Stress testing with SRM is performed by comparing a simulation based on a stress scenario with a simulation under scenarios without stress. In a stress test one or more risk factors in the multivariate distribution of risk factor changes is set to a stress value and a simulation of the system wide loss distribution is undertaken based on the conditional distribution under the stress hypothesis. The time horizon in SRM is always a quarter.

The quarterly horizon might seem excessively short for a stress test. A severe shock to the banking system unfolds over a longer time period and it would be interesting to study the dynamics of the system for longer periods after a stress situation has occurred. While this observation is certainly valid, it should be borne in mind that within a quantitative risk management framework only short

horizons make sense conceptually. A model that would be able to study the longer-term dynamics of the banking system following a situation of distress can't proceed along the logic of a pure balance sheet mechanics model. Models with longer-time horizons have to model the behaviour of key players. This is a much more difficult exercise. Still the short horizon can be interesting for an analysis focused on financial stability issues. The model is able to organise a huge amount of micro data in a way that potential problems in the system come into perspective and can be quantified.

We will now illustrate output generated by SRM by looking at some examples based on a recent simulation for the last quarter of 2005. These examples are based on Boss et al. (2006). We present our results always for a base line simulation, based on the date of the last quarter 2005 and two stress tests: stress test number one simulates an unexpected drop in GDP.

Stress test number two assumes a rise in the three-month euro interest rate by 120 basis points.

## 6.1 FUNDAMENTAL AND CONTAGIOUS DEFAULTS

The network model generates a multivariate distribution of bank insolvencies across scenarios. This multivariate distribution contains information on the marginal distributions of individual bank defaults as well as on default dependency among the banks. We interpret the relative frequency of default across scenarios as a default probability.

Our method allows a decomposition of bank insolvency cases into those resulting directly from shocks to the risk factors and those that are consequences of a

**Table 1 Probabilities of fundamental and contagious defaults<sup>1)</sup>**

Number of Banks	Base Case		GDP-Stress		Interest-Stress	
	fund.	cont.	fund.	cont.	fund.	cont.
0	74.49%	0.00%	68.58%	0.00%	0.00	0.00%
1 to 5	25.51%	0.00%	31.27%	0.00%	100.00	0.00%
6 to 10	0.00%	0.00%	0.13%	0.00%	0.00	0.00%
11 to 20	0.00%	0.00%	0.05%	0.00%	0.00	0.00%
21 to 50	0.00%	0.00%	0.02%	0.02%	0.00	0.00%
more than 50	0.00%	0.00%	0.00%	0.00%	0.00	0.00%
total	100.00%	0.00%	100.00%	0.02%	100.00	0.00%

1) A fundamental default is due to the losses arising from exposures to market risk and non-bank credit risk, while a contagious default is triggered by the default of another bank that cannot fulfil its promises in the interbank market. The probability of occurrence of fundamental defaults alone and concurrently with contagious defaults is observed. The observation period is December 2005. The time horizon is one quarter. The column Base Case shows the result for a simulation without stress. The Column GDP-Stress shows the case of a stress test with an unexpected drop in GDP. The third column Interest-Stress shows the stress test with a 120 basis point increase in the short term (three-month) euro interest rate.

domino effect. Bank defaults may be driven by losses from market and credit risks, (fundamental default). Bank defaults may, however, also be initiated by contagion: as a consequence of other bank failures in the system (contagious default).

We can quantify these different cases and are able to give a decomposition into fundamental and contagious defaults. Table 1 summarises the probabilities of fundamental and contagious defaults both in the basic simulation as well as under both stress scenarios. These probabilities are grouped by the number of fundamentally defaulting banks.

Table 1 shows that in the base case simulation we have no scenario where in total more than five banks will default fundamentally. Among all the scenarios, including up to five fundamental defaults all scenarios show no contagion. This result is consistent with the findings in Elsinger et al. (2006a) where it is shown that contagion is a rare event given a risk factor change distribution calibrated to historical data. In situations of stress the picture changes, i.e. when we have a drop in GDP where up to 50 banks default fundamentally and there can also be some contagion once we have 21 to 50 fundamental defaults. The stress test for an interest rate hike looks less spectacular. The simulation shows no contagion effects but at least one and up to at most five banks are expected to default. The analyst using SRM has the opportunity to look deeper into the micro structure of these results and find out details about the institutions that are most severely hit.

## 6.2 DISTRIBUTION OF PD ACCORDING TO RATING CLASSES

Table 1 gives us the aggregate picture. To get a more precise picture about the distribution of risk within the banking system we map the probabilities of default into the OeNB rating classes, which has seven non-default rating classes and eight default classes. This distribution of ratings that is implied by our simulation can be seen in Table 2.

Table 2 shows that in the base case simulation about 95% of banks are expected to be in a triple A rating at the end of the first quarter of 2006. Under the assumptions about our two stress scenarios the number of top rated institutions decreases slightly. The biggest increase under stress can be observed in the lower

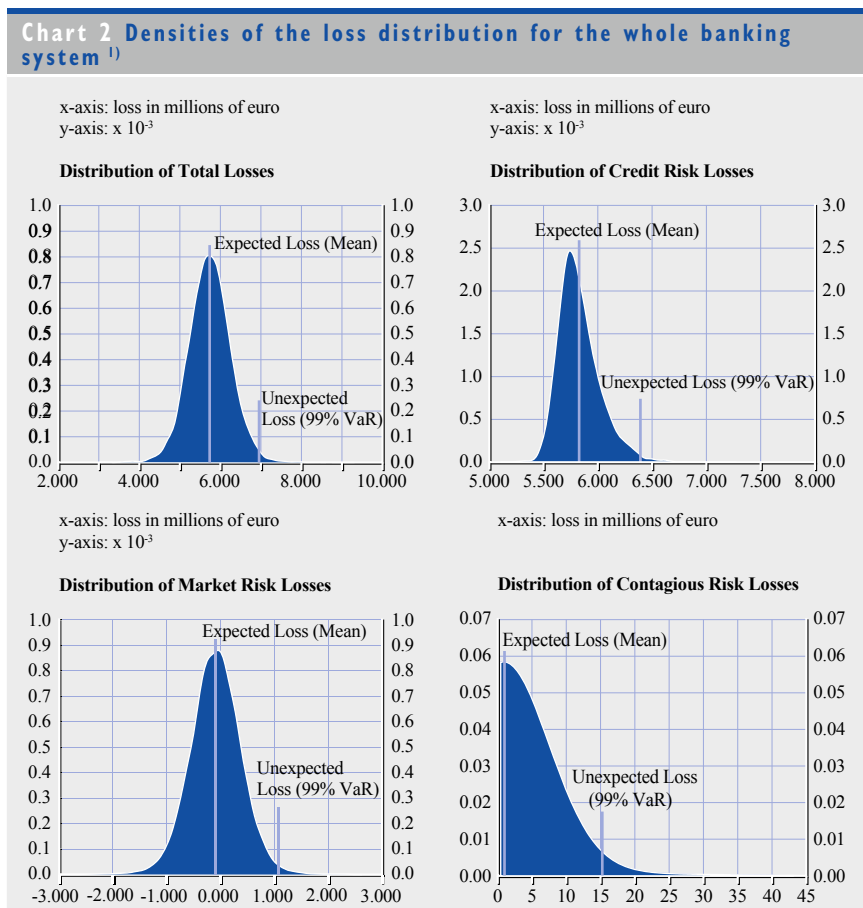
Class	OeNB MS	Base Case		GDP-Stress		Interest-Stress	
		abs.	rel.	abs.	rel.	abs.	rel.
1	AAA	800	94.67%	779	92.19%	791	93.61%
2	AA	0	0.00%	0	0.00%	0	0.00%
3	A	8	0.95%	13	1.54%	7	0.83%
4	BBB	15	1.78%	22	2.60%	15	1.78%
5	BB	13	1.54%	19	2.25%	15	1.78%
6	B	8	0.95%	9	1.07%	14	1.66%
7	C	1	0.12%	3	0.36%	2	0.24%

rating classes. The number of banks and the rating class just above the default class triples in the first stress scenario (drop in GDP) and doubles in the second (increase in the euro interest rate).

### 6.3 AGGREGATE LOSS DISTRIBUTIONS

Going from insolvencies to the distribution of losses over the next quarter we can draw pictures of the losses due to credit and market risk as well as due to the combination of both losses.

Contrary to familiar pictures from the practice of risk management these distributions are derived from an integrated analysis of all portfolio positions and its change in value due to the entire distribution of risk factor changes. Thus rather than analysing credit and market risk in isolation these graphs give us the results from an integrated analysis. Chart 2 shows four loss distributions. From the figures



1) The densities are shown for the entire portfolio and separated according to market and credit risk as well as according to the losses due to contagion.

**Table 3 Costs of avoiding default<sup>1)</sup>**

	Base Case		GDP-Stress		Interest-Stress	
	95%	99.5%	95%	99.5%	95%	99.5%
Quantiles	95%	99.5%	95%	99.5%	95%	99.5%
Resources	29.16	33.16	29.16	101.34	1.24	29.76

1) In the first row we give estimates for the 95, 99, and 99.5 percentile of the avoidance cost distribution across scenarios. Amounts are in million euros.

we can see – as in standard quantitative risk management – whether or not the system has enough capital to absorb extreme losses. Therefore, loss distribution figures give a first overview of the shock absorption capacity of the system.

## 6.4 VALUE AT RISK FOR THE LENDER OF LAST RESORT

A relevant aspect of our model for the regulator is that it can be used to estimate the cost of crisis intervention. We estimate the funds that would have to be available to avoid contagious defaults or even fundamental defaults for different confidence levels. A lender of last resort's cost of preventing fundamental default is calculated as the amount required to prevent banks from becoming insolvent. A lender of last resort's cost of preventing contagious defaults is calculated as the amount required to prevent all but fundamentally defaulting banks from becoming insolvent. Hence, interbank liabilities are not fully insured but just enough to prevent contagion. Table 3 reports our results for the base line simulation.

Since defaults occur rarely in the base scenario, the amounts that must be available to prevent default in most of the scenarios are low. In a stress the amount of funds that have to be mobilised by a lender of last resort increase but they remain still very low. The analysis shows that for the particular quarter of December 2005, a lender of last resort can expect that even if crises scenarios simulated by the model do actually occur in case of crises intervention the amounts to be mobilised will be small.

## 6.5 CHANGES IN SYSTEM-WIDE VAR UNDER STRESS

Finally we analyze the changes in value at risk of the distribution of losses relative to regulatory capital. That is we look at the distribution of losses in percent of regulatory capital and look at the quantiles of this distribution.

**Table 4 99% quantile of the distribution of losses<sup>1)</sup>**

Rel. Var	Total	Market	Credit	Contagion
Base Case	13.58%	2.11%	12.35%	0.03%
GDP-Stress	16.95%	5.68%	12.52%	0.05%
Interest-Stress	15.56%	4.34%	12.40%	0.04%

1) Relative to regulatory capital for total losses, losses from market risk, losses from credit risk and losses from contagion risk. This relative VaR is shown for the baseline simulation, for the case of a GDP-stress test and for the case of an interest rate stress test.

In our case we analyse the 99% quantile or the 99% value at risk. We look at these measures for the different subcategories, total losses, market losses, credit losses and contagion losses. The results are reported in Table 4.

## 7 CONCLUSIONS

I have made an attempt to present the basic ideas behind SRM and the OeNB approach to macro stress testing. At the same time, I have used this particular model to discuss some general problems and issues that arise in models of banking system instability.

I have argued why the framework of quantitative risk management models provides an attractive starting point for a stress testing framework. Its main attraction comes from the fact that the model is developed with concepts that can be matched very well with banking data available at central banks and regulatory institutions. Extending the quantitative risk management framework from an individual institution perspective to the system level provides an interesting framework to organise a huge amount of data about the banking system. This allows bringing some key issues of banking system instability into perspective over the short run: probabilities of default, risk of joint default of major institutions, the potential of insolvency contagion through the interbank network, quantification of the amount of potential liquidity assistance.

The quantitative risk management framework has also drawbacks and I have tried to point out some of them in my paper. It circumvents some fundamental questions that are difficult to deal with but that definitely need an answer to put the whole activity of stress testing into perspective.

What is the key risk measure an institution in charge of safeguarding and maintaining financial stability wants to look at? How is the output of a stress testing analysis used within a central bank or a regulatory institution?

Should we have particular policy instruments that can be used to react to results from risk assessment and stress testing or should the output of such models merely be a source of information for internal communication within the central bank. How does the analysis link with monetary analysis? I think that all of these questions are, at the moment, more or less open and there is much work to be done in this area. I believe that future research will show that stress testing will need a whole set of models that all highlight different important aspects. It is my hope that within the universe of these models the general ideas of SRM and the balance-sheet-mechanics approach to stress testing will have a useful role to play.

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# MACRO STRESS TESTING-METHODOLOGICAL CHALLENGES

## COMMENTS BY SYLVIE MATHÉRAT<sup>1</sup>

Methodological challenges for macro stress testing banks are multifaceted. The purpose behind the three papers presented in this session is to tackle some of these challenging issues.

In particular, macro stress testing is set up to work on bank-based information, but at the same time, to address system-wide stability issues. Against this backdrop, finding accurate methodologies to properly link micro-based information to a macro-prudential assessment is key, though methodologies in that field of interest have not been completely developed or validated. We are still at an early stage.

In addition, implementing a stress testing exercise requires measuring interdependencies within the financial sector, but also assessing interactions between the real and financial sectors, including feedback and second-round effects. In that context, the objective followed in a stress testing exercise may involve the integration of contagion effects and potential cross-border linkages in the assessment of individual reactions of banks to shocks.

Devising a macro stress testing framework also involves consistency and comprehensiveness, so as to encompass the majority of risks borne by banks, and to take account of correlations between the different risk factors potentially affecting their balance sheets. Here, the question at stake is whether it is possible to develop a comprehensive framework by avoiding an inaccurate presentation of the different risks at stake and of the links between these risks.

In addition to these fundamental questions raised, some recent changes in the economic and financial environment have also triggered new challenges for macro stress testing. In particular, banks' risks assessment and supervision now need to be implemented in the context of globalised financial markets, including the emergence of super-sized banking institutions, whose activity has largely become cross-border. This situation obviously triggers additional channels of contagion, which need to be captured by stress testing exercises.

Furthermore, these large and complex financial institutions (LCFIs) operate on diversified and complex markets. This challenges the traditional banking model that has been used thus far, also in the field of stress testing. More specifically, the increase in non-bank activity in the banking sector (namely insurance and UCITS), the existence of unregulated counterparties (namely hedge funds) in the trading and banking books of financial institutions, as well as the brisk development of credit risk transfer (CRT) markets have changed the nature of banking activity and the entire financial system's dynamics. These changes have

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explicitly favoured the emergence of non-linearities, which necessarily involve adjustments in the way the financial system is developed for stress testing.

These new challenges have important policy implications that supervisors have started to undertake. First, the Basel II framework proposes a set of procedures under Pillar 2. In particular, as regards the advanced approaches of Basel II, Pillar 2 proposes a comprehensive stress testing framework, including different risks in an integrated manner, and requires banks to make an explicit link between these stress tests and their own assessment of economic capital. Second, several supervisors and financial stability actors have engaged in the closer monitoring of CRT markets, a necessity that appears more tangible than ever, following the financial turmoil occurring in the summer of 2007. This is, for example, the case for the Banking Supervision Committee of the ECB, as well as the Joint Forum. Third, there is a clear tendency amongst the community to improve the qualitative and quantitative knowledge of banks' exposures to unregulated entities, such as hedge funds. The Financial Stability Forum has, for example, engaged in a specific survey on hedge funds.

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All three papers under review address several of these methodological challenges. Konstantinos Tsatsaronis questions the validity of the "traditional" relationships usually simulated through macro stress testing exercises, given the rapid expansion of CRT markets, and analyses the consecutive changes in the underlying dynamics of these relationships. From this analysis, he draws conclusions on the data and methodology requirements for stress testing. Martin Summer proposes a comprehensive framework to address different risks and also accounts for contagion through domino effects. Finally, Charles Goodhart and Miguel A. Segoviano Basurto develop a methodology to take account of banks' heterogeneity and potential interdependencies by compiling a Bank Stability Index.

First, Konstantinos Tsatsaronis discusses the implications of CRT markets for the functioning of the financial system and the banking sector. Policy implications of CRT markets are diverse. On the one hand, credit derivatives have a positive impact as they offer an opportunity for banks to transfer their risk to other investors. On the other hand though, they also have negative effects as they generate new channels through which contagion can arise.

As regards risk assessment, the development of CRT markets has generated new difficulties, namely due to the fact that the existence of credit derivatives tends to call into question the traditional banking model. In particular, the structure of banks' income is changing, more emphasis is being put on fee income compared with interest margins. Furthermore, the valuation of credit derivatives implies a discrepancy between the original book value of assets and the ultimate risk exposure. Thus, the risk profile of individual banks is not necessarily embedded in data directly extracted from their balance sheet. As a consequence, measuring the impact of a shock on the banking sector through balance sheet data may be misleading. This also explains why the new European prudential reporting under

Basel II (COREP) is primarily based on banks' effective risk exposures and not on notional amounts.

The emergence of CRT markets has also triggered changes in the financial system's dynamics, namely by increasing the importance of markets' expectations. Indeed, origination business is much more sensitive to market's willingness to absorb related risks than the capacity of individual players to manage it. Against this backdrop, contagion effects may be even more important and it is therefore necessary to find ways of including them in stress testing exercises.

Martin Summer addresses systemic risk through the Systemic Risk Monitor (SRM) that has been implemented at the Oesterreichische Nationalbank (OeNB), the central bank of the Republic of Austria, in order to develop expertise on Austrian supervisory data for systemic purposes. The underlying objective of such a system is to assess the resilience of the Austrian banking sector to different risk factors. This is a completely integrated framework for stress testing, where risk factors' scenarios are designed using multivariate techniques. The credit risk assessment goes from the match of loan losses (non-interbank) to different macro and financial risk factors scenarios. In parallel, the SRM develops a market risk assessment by analysing the dependence between the market value of bonds and stocks held by banks and fluctuations in risk factors. Finally, a bank's network model adds up interbank knock-on effects to the impact of the exogenous shocks, initially measured in terms of credit and market value for an individual bank's balance sheet.

The advantage of the framework proposed by Summer lies in its comprehensive approach, embedding different risks at stake in the same assessment. In that sense, it is relatively easy to draw policy conclusions as this system provides us with a simple metric to assess the banking sector stability, both in terms of banks' value and net interbank position. In addition, it is possible to derive a "Lender of last resort cost", defined as the amount of capital needed to bail out a defaulting bank. Nevertheless, one of the drawbacks resides in the very structural shape of the model, where there is little room for simulating individual behaviours of banks in terms of incentives or strategies. It is therefore rather difficult to tell a consistent story about how the different risk factors impact banks' joint probability default (PDs) or correlations stemming from the network model.

Charles Goodhart and Miguel A. Segoviano Basurto propose an alternative methodology to derive banks' joint PDs, finding a specific metric to quantify banking systems' (in)stability. They simulate the impact of different stress scenarios on individual banks, and find a way to aggregate these impacts in a non-linear way, designing a specific framework that would take account of contagion. The emphasis is put on the dynamics in the contagion of shocks through the banking system (default dependency).

The methodology applied to measure default dependency is different to Summer's approach. First, they obtain individual banks' PDs using the Bundesbank model, where they consider the banking system as a portfolio of banks. Each bank in the portfolio has a corresponding PD, which is derived from the macro-econometric

estimate of key banking variables such as loan loss provision ratios or net results, a methodology which is common practice amongst the macro stress testing community. Banks' individual PDs are obtained through a logistic transformation of the estimated deviation of the bank's key data from the baseline. The next step of Goodhart and Segoviano Basurto's work is to compute banks' joint PDs, using Gaussian Copulas. Indeed, correlation is not the right concept to take account of interdependence in a context of non-linearities and tail events such as those arising during periods of stress. The third step consists of determining the systemic default or the probability of all banks defaulting given that one bank defaults. This measure of the systemic default provides the basis of the Bank Stability Index. It is important though to underline, at this stage, that the Copulas' methodology is highly computational and may be very complex to implement for a system of several banks (even for ten banks). Despite this reservation regarding computation, it is worth noticing that Goodhart and Segoviano Basurto adopt a very innovative approach to simulating default dependencies. They propose a global framework to derive joint PDs for banks and make the link between individual PDs more explicit. In addition, they take better account of individual features and incentives, as individual banks' risks profiles are embedded.

In terms of policy implications, both Summer's and Goodhart and Segoviano Basurto's papers highlight the importance of micro/macro links and second-round effects in stress testing. They also emphasise that contagion is the essential driver of financial crises. Furthermore, Goodhart and Segoviano Basurto draw attention to the necessity of relying upon accurate individual banks' PDs, conferring thus an important role for the design of early warning systems. From a supervisory point of view, both papers allow us to construct some kind of noxiousness index for a given bank, the underlying assumption being indeed that the default of large and complex institutions will have a higher impact on the systemic default than a smaller bank's default.

\* \* \*

The analysis of these three papers draws me first to the conclusion that cross border banks' interdependencies are clearly a concern for financial stability actors. Contagion is the stumbling block of all the reflection that has been generated recently in the field of macro stress testing, and the presentations here clearly demonstrate the same concern. The main difficulty to cope with these issues consists of finding the right balance between good monitoring of risk taking by individual banks, in order to limit potential contagion of individual defaults (domino effects), and at the same time, ensuring that individual solutions to risk limitation do not contradict the equilibrium at the system level. Namely, common risks exposures would equally expose banks to the same risk, at the same moment in time.

The second concluding remark pertains to the challenges for macro stress testing. The Pillar 2 regime will help us indirectly, given that it requires banks to carry out their own stress testing exercises and to match their results to economic capital. All this work will not only contribute towards increasing the sophistication level of banking stress testing, but also pave the way for setting a bridge between macro and

micro stress testing. As perfectly highlighted by our three distinguished speakers today, we need to move towards a second generation of stress testing exercises, which will capture both second-round effects and the profound changes in the financial environment that occurred over the past four years (CRT, non-regulated entities, originate and distribute banking model, etc.). As financial stability actors, this should be our common challenge for the future.



## **SESSION III**

### **TESTING FINANCIAL STABILITY ARRANGEMENTS – RECENT EXPERIENCES IN THE CONDUCT OF DOMESTIC CRISIS SIMULATION EXERCISES**

#### **CONTINGENCY PLANNING AND SIMULATION EXERCISE: PRACTICAL APPLICATIONS**

*Michael Krimminger*

#### **HUNGARIAN FINANCIAL CRISIS SIMULATION EXERCISE – CENTRAL BANKING PERSPECTIVE**

*Tamás Kálmán*

#### **RECENT EXPERIENCES IN THE CONDUCT OF DOMESTIC CRISIS SIMULATION EXERCISE**

*Comments by Mauro Grande*

# CONTINGENCY PLANNING AND SIMULATION EXERCISES: PRACTICAL APPLICATIONS

**MICHAEL KRIMMINGER<sup>1</sup>**

The Federal Deposit Insurance Corporation has initiated and completed a series of contingency planning exercises in recent years. A principal mission of the FDIC is to ensure that in the event of a large bank failure, the FDIC is in a position to maintain public confidence and stability in the banking system.<sup>2</sup> One important way that the FDIC seeks to accomplish this mission is conducting realistic simulation exercises. These exercises have been designed principally to identify key issues posed in the resolution of a complex bank and to improve the FDIC's preparations for any future crises.<sup>3</sup> The following discussion focuses on exercises conducted within the FDIC and not on broader contingency planning exercises conducted by other components of the US government.

Although aspects of these exercises inevitably consider macroeconomic or broader financial sector conditions and events, the FDIC exercises have centred on crisis management and resolution issues involving a single or small number of troubled insured banks. The reason for this relatively narrow agenda is that the FDIC's goal is to ensure maximum preparedness of its staff and planning to accomplish its defined statutory mission of implementing the "least costly" resolution of any failing bank, while minimising disruption from any bank failure. Of course, the accomplishment of this statutory mission becomes substantially more difficult for larger and more complex banks.

Consideration of the legal and policy background for the FDIC's participation in the management of banking crises and the resolution of failing banks will provide a helpful context to its simulation exercises.

## BACKGROUND ON THE FDIC'S ROLES AND IMPETUS FOR SIMULATION EXERCISES

As an independent deposit insurance agency for member banks, the FDIC has three primary responsibilities: to act as a supervisor, an insurer, and a receiver for member institutions. Two of these roles — those of insurer and receiver — require that the FDIC play an active role in resolving failing and failed FDIC insured institutions. The interaction between the FDIC as insurer and the FDIC as receiver

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<sup>2</sup> See Remarks by Sheila C. Bair, Chairman, Federal Deposit Insurance Corporation at the Exchequer Club; Washington, DC, March 21, 2007.

<sup>3</sup> Throughout this paper, I will use "bank" to refer to all depository institutions insured by the FDIC. These depository institutions include commercial banks, savings banks, and savings associations chartered variously by the Office of the Comptroller of the Currency, the Office of Thrift Supervision, and the states.

is important in promoting the efficient, expeditious, and orderly resolution of failed banks to maintain confidence and stability in the US banking system.

First and foremost, the FDIC was established to insure bank deposits. This role of insurer promotes the stability of the financial system by guaranteeing the timely funding of insured deposits and public faith in the US banking system in times of stress. The FDIC fulfils this role when a bank fails by paying insured depositors either by direct payment or arranging for the assumption of the deposits by another financial institution.

The importance of this role was critical in the bank and thrift crisis of the 1980s and early 1990s. Despite the huge number of bank and thrift failures during this period, there was no evidence of serious runs or credit flow disruptions at federally insured institutions.

Most importantly, no depositors suffered any losses in respect of their insured deposits.

Today, the FDIC has additional powers to evaluate the risks in individual insured institutions and assess premiums for deposit insurance coverage based on those risks. With the adoption of the Federal Deposit Insurance Reform Act of 2005, the FDIC now has the ability to make deposit insurance much more risk sensitive by differentiating more between banks and charging riskier institutions higher insurance premiums.

When a depository institution fails, the FDIC is normally appointed receiver of the institution by the courts or other authority with jurisdiction. The FDIC's role as receiver is important because it is responsible vis-à-vis the creditors of the receivership for efficiently recovering the maximum amount possible on their claims. The FDIC itself also becomes a creditor of the receivership. By paying the insured depositors or by arranging the assumption of the debts by another institution, the FDIC steps into the shoes of the depositors as a creditor (legally, as subrogee). By returning a significant portion of the failed institution's assets to the private sector quickly, the FDIC, as receiver, helps replenish the insurance fund while contributing to the stabilisation of weakened local economies.

The FDIC's role as a federal supervisor for member institutions also complements and supports its roles as insurer and as receiver. Under US law, the FDIC is the primary federal supervisor for state-chartered insured institutions that are not members of the Federal Reserve System and is a "back-up" supervisor for all insured institutions. Through its role as a banking supervisor, the FDIC works with other federal banking supervisors and with state supervisors to regulate and examine insured banks. Through a number of cooperative forums, such as the Federal Financial Institutions Examination Council, the FDIC and other regulators coordinate their examination and supervision policies and practices to enhance cooperation and consistency. In these ways, the FDIC helps control the risks to the deposit insurance fund through access to supervisory evaluations of insured institutions and by participating in their supervision. Access to current, accurate information about the businesses and risks of individual insured banks



is a critical part of the FDIC's strategy for charging risk-based premiums for insured institutions and for most effectively resolving failing institutions at the least cost to the deposit insurance fund.

Working closely with other federal and state regulators, the FDIC has been effective in managing the resolution of failing banks in a way that minimises the losses to the deposit insurance fund and disruption to consumers and the economy. Its effectiveness is based upon a number of complementary elements, which include well-trained staff, strong legal powers, and the US legal, institutional, economic, and financial infrastructure. It is important to recognise that the FDIC's success in resolving failing banks depends on laws and practices adapted to the surrounding US market environment and that those laws and practices could not be blindly applied in other environments without modification to adapt them to different conditions. For example, a well functioning insolvency system must have well-designed insolvency laws, but it must also have laws that provide a basis for commercial activity, grant creditor and debtor rights, and otherwise promote predictable commercial outcomes. Beyond the legal issues, the maturity of market mechanisms in a country will determine whether certain insolvency processes, such as auctions, bulk asset sales or others, will be effective and maximise value by accessing a large enough pool of potential buyers. Such processes will also be affected by the reliability and transparency of prices and financial data, which themselves are dependent on the legal infrastructure and the presence of a trained cadre of financial and legal professionals.

However, there is a consensus that certain broad principles apply irrespective of differences in economic and other infrastructure elements. These principles are based on the normally complementary, but sometimes conflicting, goals of maximising the value of the estate for the benefit of all creditors within an equitable, transparent, and predictable process while minimising the cost of the resolution.<sup>4</sup> These goals result from the function that insolvency rules fulfil in the national economic life – returning financial assets to productive uses by mediating claims against insolvent companies or individuals. More broadly, these goals can be divided into three complementary components: reducing legal and financial uncertainty, promoting efficiency, and providing fair and equitable treatment for affected parties.

Much like generally recognised common components of effective banking insolvency laws, US law for the resolution of depository institutions insured by the FDIC seeks to accomplish four key goals.<sup>5</sup> First, US law applies relatively clear criteria for initiating insolvency proceedings. Clear, mandatory criteria

<sup>4</sup> See John F. Bovenzi, “Resolving Large Complex Financial Organizations”, comments delivered at the 38th Annual Conference on Bank Structure & Competition, Federal Reserve Bank of Chicago (May 10, 2002); Group of 10 Contact Group on the Legal and Institutional Underpinnings of the International Financial System, “Insolvency Arrangements & Contract Enforceability” (Sept. 2002) (G-10 Report).

<sup>5</sup> See G-10 Report; Global Bank Insolvency Initiative, “Legal, Institutional, and Regulatory Framework to Deal with Insolvent Banks”; Financial Stability Forum, “Guidance for Developing Effective Deposit Insurance Systems” at 8-11 (Sept. 2001); IMF Legal Dept., “Orderly & Effective Insolvency Procedures” (1999).

permit prompt and decisive action before the bank's equity is exhausted. Adopted in 1991 as part of the Federal Deposit Insurance Corporation Improvement Act (FDICIA), the PCA prescribes mandatory measures for undercapitalised institutions.<sup>6</sup> As an institution's capital declines, additional supervisory controls may be imposed in an effort to stem the erosion of its capital position. However, once an institution's tangible capital is equal to or less than 2% of total assets, it is defined as "critically undercapitalised" and a conservator or receiver must be appointed within 90 days unless the institution can improve its capital ratio or the period is extended. In effect, mandatory action requirements create the supervisory discipline that enhances market discipline.

Second, the FDIC has the duty to reimburse depositors up to the insured maximum as soon as possible, while minimising the cost to the deposit insurance fund. While depositor confidence in the guarantee is based on the certainty of repayment, it is equally based on the speed of repayment. A recent World Bank report presenting country survey data demonstrated that the average time until insured depositors received their money was 9.6 *months* across both developed and developing countries.<sup>7</sup> With such lengthy delays, the deposit insurance guarantee lacks credibility and is unlikely to be effective in stemming depositor "runs."

A related part of the process must be an obligation to minimise the costs of the insolvency process. The FDI Act simply requires that the FDIC adopt the resolution strategy that is "least costly" "of all possible methods"<sup>8</sup> to the deposit insurance funds. US law also prohibits the use of insurance funds in a manner that benefits shareholders. While these requirements clearly limit the flexibility given to the FDIC, they serve as controls on expenditure of deposit insurance funds and on delays in recognition of losses on non-performing assets.

The US system also includes a provision permitting an exception to the "least costly" requirement only if the "least costly" resolution "would have serious adverse effects on economic conditions or financial stability" and an alternative resolution "would avoid or mitigate such adverse effects". Determining that the "least costly" resolution would have such consequences is left to the Secretary of the Treasury, in consultation with the President, and upon the recommendation of two-thirds of the votes of the FDIC's Board of Directors and the Board of Governors of the Federal Reserve System. This is commonly referred to as a systemic risk determination.<sup>9</sup> Even if a systemic risk exception were approved for a resolution, this only means that the FDIC can adopt a resolution strategy and protect uninsured depositors and creditors beyond the minimum necessary for

<sup>6</sup> FDICIA required federal regulators to establish five capital levels ranging from "well-capitalised" to "critically undercapitalised". These levels serve as the basis for the PCA and, as the capital level declines, the regulators can impose increasingly stringent controls on the institution. Those controls may include limits on deposit-taking and other business restrictions. 12 U.S.C. § 1831o(b)(1).

<sup>7</sup> See Asli Demirgüç-Kunt, Baybars Karacaovali, & Luc Laeven, "Deposit Insurance Around the World: A Comprehensive Database" at 43-44 (June 2005); see also Rosalind L. Bennett, "Failure Resolution and Asset Liquidation: Results of an International Survey of Deposit Insurers", FDIC Banking Review, Vol. 14, No. 1 (Fall 2001).

<sup>8</sup> 12 U.S.C. § 1823(c)(4).

<sup>9</sup> 12 U.S.C. § 1823(c)(4)(G).

the least costly resolution, but it does not eliminate the imperative of minimising losses incurred by the FDIC. These policy choices require the FDIC to focus its contingency planning, and related simulation exercises, on bridge banks and other transactions for failed banks that seek to quickly pass insured deposits to open insured banks along with the more valuable assets from the failed institution. In effect, the United States has adopted a policy that seeks to protect the deposit insurance fund by severely restricting exceptions to the least cost test.

A third component of US bank insolvency law is that as soon as the FDIC is appointed to take over a failing bank, the FDI Act grants the FDIC, as receiver or conservator, immediate power to control, manage, marshal, and dispose of the bank's assets and liabilities. This authority enables the FDIC to immediately sell many of the assets of a failing institution to an open bank or to an FDIC-created bridge bank – and, in effect, to maintain critical banking functions. If the public goal is preservation of funds and assets for repaying depositors, then a receiver needs flexibility and the ability to act quickly to maximise recoveries.

A bridge bank is a new national bank chartered by the OCC and controlled by the FDIC. The bridge bank has all of the powers and attributes of a national bank, subject to some limitations, and may continue for two years with three one-year extensions possible.<sup>10</sup> In many cases, a bridge bank resolution for a larger bank is the only practical solution since an immediate sale of assets is unlikely and the business of larger institutions typically involves more complex banking operations, such as payment processing, capital markets, and securitisation transactions, which would all lose any franchise value if they were temporarily halted or sold piecemeal. It is important to remember that a bridge bank resolution continues, seamlessly, if possible, with the failed banks' valuable business operations and restructures other operations, but it eliminates the control and management of the bank by its shareholders, who become only subordinated creditors. As a result, the bridge bank strategy can allow the maintenance of critical banking functions, while limiting moral hazard through terminating shareholder and management control, imposing the first losses on shareholders, and assessing losses against other creditors and uninsured depositors, where possible, under the statutory depositor preference system.<sup>11</sup>

Finally, the FDI Act provides the FDIC, as conservator or receiver, with strong legal powers that promote flexible and decisive action to limit the disruption arising from the failure, to maximise recoveries on assets and to minimise delays in providing money back to depositors. These legal powers include independence from undue interference by other governmental bodies, the ability to terminate contracts, the power to enforce contracts, the authority to sell assets, the right to avoid fraudulent or unauthorised transfers, and broad flexibility to design resolution and asset sales structures to achieve the goals of the resolution.<sup>12</sup>

<sup>10</sup> 12 U.S.C. § 1821(n).

<sup>11</sup> The depositor preference distribution scheme is codified at 12 U.S.C. § 1821(d)(11).

<sup>12</sup> See 12 U.S.C. §§ 1821(d) and (e); 1823(e).

## OBJECTIVES OF THE FDIC EXERCISES

The FDIC's roles as deposit insurer, supervisor, and receiver, as well as the foregoing statutory structure specifying its powers and responsibilities as resolution authority for banks have defined the goals for the FDIC's contingency planning exercises. The primary objective of these simulation exercises has been to identify and work through the difficulties that would be faced in resolving a crisis with a large, complex bank with potentially systemically significant operations. The process undertaken by the FDIC has been to engage in a series of simulations involving hypotheticals for increasingly larger and more complex banks. In order to explore specific practical issues in such resolutions, these simulation exercises initially focused on discrete functions that would be involved in the resolution of a bank. Over time, the FDIC's exercises have built upon the prior lessons and examined progressively more complex institutions and the overall challenges in resolving the entire institution with the complex interplay of related functions and businesses.

These exercises have focused on the practical hurdles to protecting insured depositors, identifying and resuming critical banking operations, and initiating and implementing a bridge bank resolution. The following description provides some background on the principal difficulties that have been the subject of simulation exercises.

First, the initial resolution process for the bank must be completed virtually overnight. Analyses by the FDIC and processing firms, as well as the FDIC's simulation exercises, have confirmed that a large bank that occupies an important role in the payments infrastructure cannot be closed for any extended period. These pressures are only increased by the around-the-clock nature of modern payments and settlements. Under normal payments processing procedures, settlement for payments transactions must be completed within brief time windows or the transactions must be returned to the preceding banks in the chain of transactions. If the failed bank cannot process those transactions in a timely manner and returns are required, this could lead to cascading settlement interruptions. In addition to the disruption to depositors, creditors, and other banks, any extended shut-down of payment processing will result in a growing backlog of unprocessed payment items that will overwhelm the bank's, and its contractors', processing capabilities. If this occurs, it will be virtually impossible to resume processing and the bridge bank will not be operable. Consequently, the bank, or a succeeding bridge bank, cannot be closed for any extended period if it is to retain its role in the payment process or its franchise value.

FDIC simulation exercises have explored several aspects of the need for virtually immediate continuation of processing operations. The participation in the development and observation of the exercises by private firms actively engaged in providing processing services to banks was instrumental in the lessons learned. One simulation exercise, in particular, covered issues relating to the structure of the holding company and bank, loan commitments, exceptions, voice response unit/call centre, branches/web sites, holds, claims, foreign branches, correspondent banking, communications, wire transfers, accounting and balancing, cash and

official items, daylight overdrafts, deposit rates, FDIC reporting requirements, other subsidiary insured institutions, and daily bridge bank management reports. Among the key lessons of this exercise were the importance of gaining a detailed understanding of the bank's structure and operations and the difficulties involved in dealing with non-bank affiliates that perform critical banking functions. These issues, and many others, create significant hurdles for a seamless transition to a bridge bank. For these reasons, the FDIC continues to refine its contingency planning and to conduct simulations both of specific aspects of the closing and bridge bank process and of the broader decision-making processes necessary for a smooth transition process.

Second, if depositor protection is to be limited to the legally guaranteed amount plus some conservatively estimated "advance dividend," a prompt and accurate determination of the amount of deposit insurance due to each depositor is necessary. The first hurdle is making an accurate determination of the deposit insurance coverage available to each depositor within the time available. The US deposit insurance rules can be complex to apply when depositors hold multiple accounts in different capacities. If the bank's deposit records do not provide the key information needed under those rules or the bank's systems are technically inadequate this will be a daunting task. Advance dividends to limit the disruption of payment processing are a necessity if a large bank – even if it is not systemically significant – is to continue critical business operations. In effect, an advance dividend simply makes funds over the insured amount immediately available to depositors based on an assessment of the actual, realisable value of the bank's assets. This requires immediate and accurate estimates of resolution losses and the ability to fund the corresponding advance dividend quickly. The impact on settlement processes from overdrawn accounts and return items means that the time available for doing so is very limited. If substantial "haircuts" are imposed on uninsured deposits, the bank's existing infrastructure and systems for processing payment items returned due to insufficient funds may be overwhelmed by a rapid increase in such items.

Past FDIC simulation exercises have illustrated the significantly more difficult process of applying the US deposit insurance rules to the much larger volumes of deposit claims involved in the resolution of large, complex banks. Simulation exercises have sought to explore different alternatives for determining deposit claims by conducting hypothetical closings with "dummy" deposit data using the standard deposit insurance process and FDIC staff assigned to such tasks. Using these results as a "baseline" for the time required for deposit insurance determinations, the exercises have explored time and efficiency savings from varying shortcuts and enhancements from the prior standard process. One of the results of these exercises, detailed analyses, discussions with bankers, and work with private consultants, has been the FDIC's proposals for substantial enhancements to the deposit insurance determination process. In December of 2005, the FDIC sought public comment on a proposed rule-making in order to receive comments on ways to improve the claims administration process. The proposed rules will require larger banks to make improvements in the capabilities of their deposit systems to facilitate a prompt deposit insurance determination in the event of any large bank failure. It is expected that these rules will be finalised during 2008.

Third, continued operations of any significant part of the banking business – such as securities trading or clearance and settlement – will require the active participation of the failed bank’s employees. This cannot be assumed, but it can be facilitated if the resolution authorities come prepared with assurances to the bank’s employees about temporary salaries and benefits. Pre-planning of the steps to gain employee cooperation and, if necessary, contractor assistance is essential. To date, all FDIC simulation exercises have operated on the assumption that the failed bank’s staff would continue to assist in the bridge bank’s operations and that any gaps in staffing and assistance in technical oversight can be provided by contractor support. Future simulations will be designed to test the effectiveness of contractor assistance and current contract arrangements.

Fourth, banking operations that may be systemically significant are often inextricably linked with other operations and cannot be easily detached from the overall banking franchise. For example, certain clearing and settlement functions for financial markets are often dependent on credit facilities and depository account operations of the primary banking business. It would be very difficult to separate the clearing and settlement functions from the related credit and depository operations. As a result, those clearing and settlement functions and the related credit and depository operations must either be transferred wholesale to the bridge bank or replacements for those operations must be found to service the clearing and settlement requirements. Transfer of all related banking operations to the bridge bank create additional management difficulties and could create additional potential losses borne by the creditors or the public. The complications of this process increase when a vital part of the systemically significant function is performed in another corporate entity outside the control of the banking authorities – such as in an affiliate of the bank’s holding company or in a domestic or foreign third party.

Prior FDIC simulation exercises have been designed to test the analyses necessary to determine whether certain banking operations add to the recoverable value of the banking franchise and how to assess the value of related operations. In addition, the FDIC has included fact patterns in exercises in which affiliated companies or third parties provide services that are essential to the banks operations. The judgments and analyses necessary in such cases are difficult and designing simulation exercises to test the decision-making and the trade-offs in such situations is difficult. The design of simulations must recreate the “fog” of uncertain or absent information about such arrangements that is likely to be present during crisis management for a large complex bank. In addition, exercises with new facts (such as the processing affiliate demands, additional funding or may file bankruptcy) introduced during different stages of the simulation have been used to examine the decision-making process for these issues.

## **CONCLUSION**

The FDIC uses simulation exercises to evaluate the effectiveness of FDIC contingency plans and the adaptations of its normal resolution practices necessary to resolve increasingly larger and more complex banks. Consequently,

FDIC simulation exercises have been designed to evaluate different resolution strategies and the practical ways to implement those strategies for resolving larger and more complex banks.

The FDIC exercises have centred on the practical crisis management and resolution issues created by resolving US banks within the specific US legal and policy framework. As a result, the exercises have frequently been designed to test specific resolution strategies, such as those for determining depositor claims, under differing fact patterns. The lessons learned from the FDIC's practical experience with the smaller banks that have normally failed in the United States and from the simulation exercises for larger and more complex banks, have been applied to identify the key issues and necessary changes in specific resolution functions for larger banks. In addition, those lessons have formed the building blocks for more complex simulation exercises designed to test strategic decision-making as well as practical resolution functions.

The past and future simulation exercises form an integral part of the FDIC's ongoing contingency planning efforts for larger and more complex banks. Future simulation exercises are expected to include more exercises involving other US regulators and, perhaps, foreign counterparts. The growing complexity of global banks and the global financial system require both a better understanding of comparative laws and policies for the resolution of banking crises, but also practical exercises to test and refine the responses to such crises.

# HUNGARIAN FINANCIAL CRISIS SIMULATION EXERCISES – CENTRAL BANKING PERSPECTIVE<sup>1</sup>

TAMÁS KÁLMÁN<sup>2</sup>

## INTRODUCTION

The last episode of banking crises in Hungary occurred in 1997-1998, at which time the central bank could not rely on pre-specified principles and procedures for crisis management. Ad-hoc decisions were made under time pressure. Therefore, the central bank of Hungary (MNB) considered it necessary to develop the principles of emergency liquidity assistance (ELA) and the internal procedures for managing financial crises. In addition, the MNB has made considerable efforts in the last few years to enhance domestic crisis management arrangements in order to facilitate a coordinated response of the national authorities responsible for safeguarding financial stability in a potential emergency situation.

Just as there is a need for peace-time manoeuvres to train armed forces, simulation exercises could probably serve as the only tool to detect the potential shortcomings of crisis management arrangements in normal times. In this context, the MNB took up the lead in organising domestic financial crisis simulation exercises:

- The *first Hungarian financial crisis simulation exercise* was held in October 2005 with the joint participation of the MNB, the Hungarian Financial Supervisory Authority (HFSA) and also the Ministry of Finance (MoF). The central bank and the supervisory authority took an active role in devising and carrying the exercise out, while the Ministry of Finance took part as an observer.
- In February 2007, a *second financial crisis simulation exercise* was organised, but this time with the active participation of the MoF.

This note, which aims to give an overview of the most relevant aspects of these exercises, is structured as follows. The main objectives of the exercises are presented in *Section I*. *Section II* addresses some considerations that arose during the design of the exercises. *Section III* identifies the major policy findings of the exercises. *Section IV* concludes by illustrating the peculiar challenges of the Central European countries with regard to crisis management arrangements, namely the implications of an extremely high presence of foreign investors in the banking sector.

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## I OBJECTIVES OF DOMESTIC FINANCIAL CRISIS SIMULATION EXERCISES

The organisation of crisis simulation exercises has helped to strengthen domestic cooperation and coordination processes, and has led to a better understanding and addressing of crisis situations in the following ways:

- *Smooth information exchange between authorities:* All of the authorities have a wealth of information available in a crisis situation, which needs to be shared in a timely manner. In addition, updated information should be required from the financial institution(s) in trouble. In this context, the exercises helped to specify a set of information items that might be relevant to assess a potential crisis situation, and in this way to structure and optimise the information-sharing processes mentioned above.
- *Changing views on the systemic assessment of a crisis situation:* As the assessment of the systemic implications of a crisis could not be based on the whole set of updated information in an abrupt crisis, and there is an inherent uncertainty regarding the future implications of a crisis, the different authorities may come to different conclusions. In this context, the exercises created an opportunity to observe how intensively and efficiently the supervisor and the central bank exchanged their views and find out the reasons for potential differences in their conclusions, as well as at which stage of the crisis they decided to involve the MoF in discussions.
- *Coordination of policy responses by authorities:* Exercises were aimed at testing whether there are any conflicts of interest between the national authorities during the management of a credit institution's idiosyncratic crisis, and how they coordinate their policy decisions. As a potential policy tool for managing crises, public communication was also evaluated on the basis of the messages conveyed to the public by authorities to restore confidence in the financial system.

In addition, the exercises also served to test internal decision-making procedures at individual authorities.

*The second exercise could be considered as a step forward, as it also gave the opportunity to test:*

- the potential role of the MoF in crisis management and whether state intervention is a “realistic” tool in fast-moving crisis situations;
- the cooperation and coordination processes among the three authorities;
- the possibility of market solutions;
- the efficiency of the developed communication strategy; and
- the MoU for crisis management between the MNB and the HFSA.

It should be noted that both of the exercises concentrated on domestic cooperation and did not examine the potential for cross-border contagion effects or simulate the foreign authorities.

## 2 DESIGN OF SCENARIOS: SHOULD THEY BE REALISTIC?

The scenario of the exercises used fabricated data with a fictitious banking system in order to avoid the risk of leakage, but at the same time an effort was made to *represent the main features of “real” banks and the “real” Hungarian banking system* as a whole.

*The replication of vulnerabilities of the banking system in the scenarios raised some concerns.* According to the results of regularly conducted stress tests, the Hungarian banks’ shock-absorbing capacity even under extreme scenarios is very high:

- *Liquidity risk:* The liquidity stress tests showed that banks overall still have a high liquidity stress-bearing capacity. At the same time, the Hungarian banks controlled by strategic foreign investors are becoming more exposed to a potential inter-group contagion through their increased reliance on funds from the parent banks, or to the developments in international money markets through their direct financing activities (which are usually facilitated by the owners). This latter aspect was one of the features of the scenario.
- *Credit risk:* Based on the results of stress tests using sector-specific credit risk models, the banking sector is robust and has sufficient capital to withstand the impacts of the severe shocks examined. According to the results of the most recent tests, the most significant shock scenario would lead to losses of less than 10 per cent of the banking sector’s capital.
- *Market risk:* Top-down stress tests used to quantify the impact of potential exchange and interest rate shocks showed that the assumed shocks would have only marginal effects on banks.<sup>3</sup>

Therefore, *the “real” banking data had to be substantially or even unrealistically modified both in terms of liquidity and capital position*, in order to generate a financial crisis situation with potentially serious contagion implications.

In addition, *most negative reaction of stakeholders was assumed*, e.g.:

- i) a massive and quick withdrawal of wholesale deposits;
- ii) a lack of, or delay in, support from banking group members (difficulties with regard to the transferability of collateral and liquidity); and
- iii) the reluctance of market participants to provide interbank funds on an unsecured basis.

This raises the question whether the financial crisis scenario should be fully or mostly realistic. Since the overall objective of exercises is to observe cooperation and coordination procedures between authorities, in our view, the application of macro scenarios used in the reports on financial stability would not considerably contribute to the success of the exercises.

<sup>3</sup> More details can be found in the *Report on financial stability*, April 2007, which is available at [http://english.mnb.hu/Engine.aspx?page=mnben\\_stabil&ContentID=9555](http://english.mnb.hu/Engine.aspx?page=mnben_stabil&ContentID=9555)

In addition, the substantial changes to the “real” banking data and the assumed negative reaction of the stakeholders could be deemed appropriate. First, to prepare authorities for the most severe cases, a scenario should not replicate the current healthy situation of the banking system, which is subject to change due to a macroeconomic shock or an unanticipated disturbance at an individual institution. Second, by assuming the most negative reactions of stakeholders, the exercises provide the possibility to simulate the most severe outcome of a potential crisis situation.

### 3 OUTCOME OF HUNGARIAN EXERCISES: CHALLENGES FOR DECISION-MAKERS

Overall, the exercises confirmed the domestic authorities’ high willingness to cooperate with each other in order to respond to potentially systemic crisis situations in the most efficient way. The participants in the exercises considered the financial crisis exercises as instructive and valuable experiences, as a number of lessons were drawn on how the existing domestic crisis management arrangements should be further enhanced.

The findings and specified challenges are grouped in three groups: (i) information-sharing; (ii) systemic assessment; and (iii) coordination of policy responses.

#### 3.1 INFORMATION-SHARING

The exercise confirmed that both the MNB and the HFSA aimed at continuous information-sharing from the first signs of a potential financial crisis situation, which helped the authorities to assess the situation on a same-information basis. However, at certain stages of the exercise, the intensity of information-sharing was sub-optimal, which was likely due to the speeding-up of information flows on the unfolding problems in the financial system.

The efficiency and timeliness of information-sharing have been or will be further developed taking the following findings into account:

- *Obtaining information from the credit institution in trouble:* The exercise confirmed the importance of well-structured information collection in a crisis situation. This issue was adequately addressed in the internal procedures of authorities. To mention a problem detected during the first exercise in this context, there were situations where both the central bank and the supervisory authority requested additional information from an institution on the same topic, but in a different structure and by different deadlines. In order to decrease the burden on the institution in trouble, the authorities considered it necessary to harmonise their extraordinary data requirements. (The structure of information collection is now part of the MoU for crisis situations between the MNB and HFSA.)

The MNB has already tested on a large market participant whether it would be able to provide the data in the specified structure at short notice.

- *Interaction with parent companies and other market participants:* The exercise demonstrated that no framework was defined for which domestic authority should contact the parent company and require information on its intended steps to stabilise the situation at its foreign establishment. Coordinated external communication could be facilitated by the clear definition of the authorities' responsibilities with regard to interaction with parent companies and other market participants. In this context, another general problem detected during the simulation exercise was that some of the required documents and commitments from the owners, which would enable domestic authorities to take temporary measures to ensure the continuity of operation, may not be available at short notice (e.g. these may need the approval of the Board).

## 3.2 SYSTEMIC ASSESSMENT

One of the most important aims of the simulation exercises was to test the authorities' ability to assess the systemic implications based on the information available at short notice, and how efficiently they could share their views and potentially come to a common conclusion.

The following are the main lessons regarding the systemic assessment of the crisis situation:

- *Adequateness of the information base:* The exercises confirmed that in a financial crisis situation the authorities are able to pool the relevant information for the assessment of the systemic implications. This information base is available from: (i) the performance of their normal functions (e.g. supervision of institutions, operation of payment systems); and (ii) additional data requirements on institutions.
- *Effectiveness of analysis:* In the first exercise, the authorities exchanged their views on the potential systemic implications of the crisis situations; however, these discussions did not reflect the richness of information which was available to them. In the second exercise, the central bank and the supervisory authority made much less effort to exchange views on their systemic assessments and the potential policy measures to resolve the crisis. This was presumably due to the fact that in the last few years there has been more intensive communication between the authorities, and they felt more confident, and more aware of each others' feasible reactions and steps.

As a response to this outcome, the authorities decided to develop a common analytical methodology for systemic assessment, which is to contribute to more comprehensive and effective assessments and discussions in crisis situations. In this context, an additional aspect of cooperation could be raised, namely, whether one of the authorities should take up the coordination role in carrying out the systemic assessment of a crisis. As the central bank is in a better position to have an overall picture of the potential impacts on the financial sector, financial markets and market infrastructures, it might be considered appropriate for the central bank to take up this role and the final responsibility for carrying out assessments on systemic implications in a crisis situation. In addition, the MNB would have a special interest in making the systemic

assessment, as the systemic nature of the crisis would be a main aspect to be considered with regard to the deployment of its policy tools.

- *Timing of the MoF's involvement:* During the exercises, the MNB and the HFSA assessed the situation and determined whether and at which stage the management of the situation needed the MoF's involvement. However, the MoF indicated that it would have needed information on the potential systemic implications of the crisis situation at earlier stages, to be able to make a decision in a timely manner when the crisis required its intervention.

### 3.3 COORDINATION OF POLICY RESPONSES

The following findings could be mentioned regarding the deployment and coordination of different policy tools:

- *The adequacy of policy tools available to authorities:* The exercises demonstrated that *flexibility* should be ensured with regard to the policy tools. In the context of ELA, the decisions should be based on broad principles enabling the central bank to decide in the light of the potential systemic implications of the disturbance. (For instance, banks with small market shares could be considered systemic when market confidence is at stake.) During the deployment of supervisory tools (e.g. the appointment of a supervisory commissioner), the sensitivity of market confidence should receive special care to avoid the exacerbation of the situation, in particular if the problem is liquidity alone.
- *Public communication:* During the first exercise, the handling of outgoing information was coordinated between the authorities, and there was the risk that the content of outgoing information would exacerbate the crisis situation. Therefore, the central bank considered it necessary to develop an *ex-ante strategy on the timing and content of outgoing information* in case of a bank crisis. As a result, the public communication in the second exercise was more coordinated and effective, particularly in the way how it helped restore market confidence and normal market conditions. However, the exercise confirmed the importance of cautious public communication, and called for the refinement of communication strategy, bearing in mind that the scope and severity of the crisis could quickly change. In addition, the second exercise drew attention to the fact that conflicts of interest may arise between the department responsible for communication and the one for financial stability. The Communication Department would be in favour of providing concrete, even bank-specific, information to calm down the market, while the Financial Stability Department would be more cautious and prefer more general messages to safeguard the credibility of the central bank.
- *Coordination of policy tools between authorities:* Based on the experiences of the first exercise, the MNB and the HFSA considered it beneficial to elaborate an *MoU for crisis situations* with the aim of increasing the efficiency of cooperation. After the second exercise, this MoU would be complemented by a trilateral agreement.

However, it can be concluded that crisis simulation exercises help to detect potential conflicts of interest, even when an MoU clearly defines the division of responsibilities. For instance, the division of tasks with regard to the

initiation of market solutions arose in the second exercise as an additional area to be specified.

The testing of market solutions raised concerns about how to simulate market reactions without the involvement of a “real” market participant. In practice, it might be difficult to enhance or orchestrate private sector solutions without the active involvement of authorities (i.e. sharing risks by providing ELA or a state guarantee).

### 3.4 THE OVERALL ASSESSMENT OF THE EXERCISES

*The Hungarian simulation exercises are deemed a considerable step towards better cooperation and information-sharing between the national authorities in crisis situations.* In particular, the following benefits could be highlighted:

- (i) the conclusions drawn from the exercises were very useful for revealing shortcomings in internal procedures and for harmonising information requirements of authorities;
- (ii) the authorities have agreed on the development of a common analytical framework for systemic assessments which is to contribute to more comprehensive and effective discussions in crisis situations; and
- (iii) they helped clarify the respective roles and responsibilities of national authorities and the definition of principles on cooperation, and enhanced the development of ex-ante domestic agreements for crisis situations.

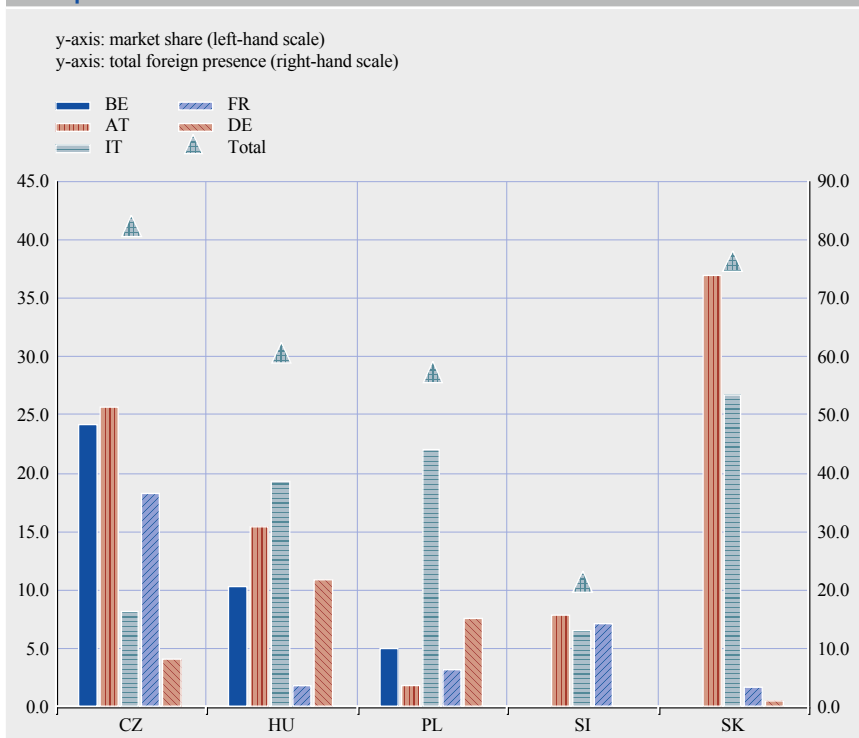
## 4 OUTLOOK: THE NEED FOR REGIONAL COOPERATION

This last section draws attention to the peculiar feature of the Central European countries, namely the strong presence of foreign assets in the domestic banking sector.

As *Chart 1* illustrates, in some of these countries large European banking groups have almost complete control over the banking sector, e.g. in the Czech Republic and Slovakia they have a total market share of more than 75%. In addition, the Hungarian and Polish financial systems have also extremely high interlinkages with other European financial systems.

This specific feature of these banking systems would call for intensive cross-border communication among the respective authorities, both in normal times and in emergency situations. With regard to crisis management issues, it would pose a challenge for authorities of different jurisdictions to exchange information and their views on the assessment of the crisis situation, as well as to reach solutions for resolving the crisis in an optimal way at the group level. In this context, the enhancement of domestic arrangements could only be the first step of the authorities’ preparation in these countries. *Efficient crisis management would necessitate a second step: the development of cross-border arrangements.*

**Chart I The foreign presence in the financial systems of Central European countries**



Source: Banking Supervision Committee.

*In addition to the EU-wide arrangements in this field, the following regional arrangements could be deemed appropriate with regard to the special case of Central European countries:*

- (i) the organisation of regional exercises among the authorities of these countries and the ones where the parent banks of potentially systemic establishments are situated;
- (ii) the setting-up of networks for crisis management (in accordance with the BSC/CEBS recommendation), particularly with regard to large banking groups having operations in the region and potential systemic relevance in at least one of these countries. These networks, in addition to their potential role in a crisis situation, could serve as a platform for developing regional arrangements in normal times; and
- (iii) the organisation of workshops among these countries to exchange views on the specific vulnerabilities of these countries and the potential preventive actions which could be taken.

With respect to these Central European countries, to constrain exercises to the domestic level, without regard for the specifics of these countries, may give rise to the risk that the national authorities tend to believe that they are ready to smoothly cooperate with each other after a few domestic exercises. As a potential

crisis situation in the Central European region would probably have cross-border implications, it would be important to widen the cross-border cooperation, to establish operational mechanisms for cooperation and to organise regional exercises taking into account the specific structure of cross-border banking groups operating in the region.

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# RECENT EXPERIENCES IN THE CONDUCT OF DOMESTIC CRISIS SIMULATION EXERCISES

## COMMENTS BY MAURO GRANDE<sup>1</sup>

Financial crisis simulation exercises are conducted by public authorities (central banks, supervisory agencies, ministries of finance) with a responsibility for financial stability to an increasing extent at the national level. They are undertaken either on a stand-alone basis or as a joint effort. As shown in the three presentations, the main objective of a simulation exercise is widely shared and that is to ensure an adequate level of preparedness in terms of procedures and human resources to manage a real crisis. The scope of the exercise, by contrast, can vary in relation to its specific focus.

Public authorities tend to carry out exercises at the national level on a regular basis in order to maintain knowledge over time and to learn new lessons for possible enhancements of existing arrangements. This is achieved by increasing the degree of realism of each exercise while aiming to keep the level of complexity manageable. While area-wide exercises tend to be more extensive with regard to the geographical and institutional scope, domestic exercises are able to test a larger number of aspects in greater depth.

The three presentations clearly indicate that the organisation, conduct and assessment of a simulation exercise at the domestic level are a complex endeavour requiring the examination of many different elements.

## SCOPE OF AN EXERCISE

In preparing a simulation exercise, the first issue is to define carefully its scope in terms of elements to be tested. A simulation exercise can cover many aspects in principle and therefore it needs to be focused on the scope in order to be meaningful. The focus will determine the main areas of attention and action of participants and may be relevant also for assessing the outcome of the exercise. In general, a simulation exercise can have *two* main focal points.

The first focus can be on *contingency planning*. Given that in a real crisis the main tasks and procedures within an institution would need to be carried out in a swift and effective manner, contingency procedures are defined in advance in order to ensure this objective. Therefore, a simulation exercise would concentrate on the existing procedures for crisis management within an institution or among institutions in order to assess their adequacy.

The second focus can be on *policy decision-making*. In a real crisis, it can be expected that the decision-making process becomes more complex given the larger number of factors to be considered, the number of institutions involved

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and the tight time pressure. Arrangements are normally in place to ensure that the cooperation and coordination both within and among public authorities work smoothly in a crisis situation. Therefore, a simulation exercise could test the adequacy of these arrangements and in particular their ability to deliver an optimal decision-making process in a context of difficult choices to be made on the basis of different structures of incentives.

The two focuses are not mutually exclusive, but they entail separate and distinct elements of the crisis scenario. Therefore, while both can be present, the usefulness of a simulation exercise seems to be enhanced when one focus prevails.

## MAIN ELEMENTS OF AN EXERCISE

There are three main elements which need to be borne in mind when conceiving a simulation exercise in order to ensure its effectiveness.

The first element is *neutrality*. An exercise should be neutral in terms of the outcome for the crisis scenario. As in real life all crises are different, the exercise should not aim to deliver a particular outcome in terms of a crisis solution, but rather seek to stimulate different possible alternative paths to solving a crisis. A second dimension relates to the question as to whether or not an exercise should be neutral from the viewpoint of the institutional set-up. In general, it can be argued that the incorporation of the institutional (e.g. legal and regulatory) aspects would render a simulation exercise more realistic and, as such, is worth pursuing. However, this is likely to increase the degree of complexity especially in the case of an area-wide (cross-border) simulation.

The second element is the *right balance between realism and complexity*. In any simulation exercise, there should be some degree of realism. If the exercise had no connection with real situations, it would be useless. On the other hand, an excessive degree of realism could render the exercise very difficult to manage. The right balance between the two dimensions is reached by pondering the following factors.

First, on *location*, the choice is between a common place and the work place. With a common place, the exercise focuses more on the participating individual professionals and its success depends heavily on their individual characteristics. By contrast, by running the exercise in the actual work place, the focus shifts from the individual professionals to the authority itself and thus the exercise reflects better the overall behaviour of the institution as a whole.

Second, on the *time length*, the running of the exercise in real time would increase realism by definition, but the cost in terms of disruption of regular tasks would be very high. In addition, the engagement of the players would decrease as the momentum of the test diminishes with time, and so would the content value of the exercise.

Third, on the *nature of data*, using real data concerning financial institutions and the related environment would ensure a high degree of realism of the exercise as well as a high degree of involvement of the participants. However, the usage of real — instead of fictitious — data may also pose problems, in that the objective of neutrality could become more difficult to achieve and the potential impact of a leakage would be higher.

Finally, on the *nature of players*, it would be advisable to use as far as possible the actual professionals who would be dealing with the crisis in real life. However, given that it is unfeasible to cover all the relevant subjects, the use of actors is unavoidable. The role of actors in the test is important in that their responses should be credible and help increase the degree of realism.

A third element is *surprise*. If participants know in advance the main elements of the exercise, they can prepare their reactions and thus a large deal of relevance of the exercise would be lost. Surprise depends on many factors. First, it entails maintaining the design and details of the exercise highly confidential. The wider the institutional and geographical scope of an exercise, the more difficult it is to achieve this objective. Second, uncertainty about the scope and nature of the financial crisis needs to be built into the crisis scenario. This can be pursued mainly by maintaining ambiguity on whether the crisis reflects an underlying liquidity or solvency problem and on the potential systemic implications of the crisis. Third, some elements mentioned above in relation to the right balance between realism and complexity are relevant in this context as well. For instance, the use of fictitious data reduces the degree of surprise since the participants would need some time to familiarise themselves with the data.

## ASSESSMENT OF AN EXERCISE

An important element of any simulation exercise is how its outcome should be assessed. The main point is that the way in which the crisis is or is not solved during the exercise is not important as such. The reason for this is that each real crisis is unique and its resolution is simply impossible to anticipate in advance. The key element to assessing the performance of a simulation exercise is *whether or not there are lessons* to be learnt regarding the processes which led to a specific outcome. If there are lessons to be drawn, the exercise can be regarded as a success since it can contribute to enhancing the existing arrangements. By contrast, if few lessons are drawn, then this would be regarded as a failure since it would give a false sense of security; while it is also unrealistic to assume that one can be fully prepared for any kind of crisis that might occur.

The lessons drawn from an exercise can provide a great deal of information about the adequacy of existing frameworks for financial crisis management both within and across institutions. Given that these frameworks are normally general in nature, an exercise can bring to light the specific actions that authorities would take in a crisis situation, the existence of possible obstacles of different (e.g. legal, regulatory and behavioural) nature to the smooth interplay both within

and among authorities and possible inefficiencies in the procedural steps for crisis management.

The outcome of an exercise is normally a function of two factors, namely the *design of the scenario* and *the participants' reactions*. While the first element can, to a large extent, be controlled by the creators of the scenario, the second element is unpredictable. There is a clear relation between the two. By designing the scenario in such a way that participants are confronted with different choices, the latter will be confronted with unprecedented situations and thus will be asked to identify appropriate reactions which, in turn, will render the unfolding of the exercise interesting and insightful.

Finally, it should be underlined that the preparation and conduct of an exercise has a very positive impact on both *organisers* and *participants*. For the organisers, planning and thinking in a systematic way about the main elements and the unfolding of a crisis is a positive process which may be useful in other contexts as well (e.g. financial stability monitoring activities). For the participants, coping with the challenge to make assessments and take decisions under very tight time constraints is an invaluable experience. In the end, the true experience tells us that the successful management of financial crises relies heavily on the ability of key individuals to respond quickly and effectively to the swift unfolding of events.



## **SESSION IV**

### **CROSS BORDER FINANCIAL CRISIS SIMULATION EXERCISES**

#### **CHALLENGES FOR STRESS TESTING FINANCIAL SYSTEMS**

*Andreas Ittner*

#### **TESTING THE INTERACTION BETWEEN AUTHORITIES OF COUNTRIES WITH SIGNIFICANT BANKING INTERNLINKAGES**

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# CHALLENGES FOR STRESS TESTING FINANCIAL SYSTEMS

ANDREAS ITTNER<sup>1</sup>

Over the past two decades, dynamic financial market developments have created a business environment for banks and other financial intermediaries that is far more volatile than it was some 20 years ago. In fact, several periods of turmoil and crisis situations which has raised concerns about the stability of the overall financial system including possible repercussions on the real economic sector, have affected financial markets in recent years. Consequently, maintaining and enhancing financial stability has become an increasingly important objective for central banks as well as for other financial regulatory authorities. In the light of this development, stress testing of financial systems and financial crisis simulation have become important tools for these institutions in order to: (i) quantitatively assess the potential impact of a hypothetical crisis scenario on the financial system; and (ii) ensure the appropriate reaction of involved institutions in case of the occurrence of such a scenario.

Though both tools are equally important as they address two different aspects of financial crisis, financial crisis simulation has received increased attention only recently, while stress testing has already been used by central banks for many years. At the Oesterreichische Nationalbank (OeNB), first activities in this regard date back to as early as the late 1990s.<sup>2</sup> Despite this fairly long history of research and application of stress testing at the OeNB, I am convinced that there are still many open questions in this area, and in the following I would like to identify some of the challenging issues that we currently face in the field of stress testing financial systems.

Stress tests at central banks or other regulatory authorities – in the following referred to as macro stress tests<sup>3</sup> – differ from those at commercial banks. First, macro stress tests aim to assess the impact of a crisis scenario on the entire financial system and its stability rather than on an individual portfolio of financial instruments. Second, for central banks financial stability is only one objective, while their ultimate goal is to avoid an impairment of the real economy that might occur as a consequence of a financial crisis. Third, for central banks

<sup>1</sup> Director of Financial Stability and Banks Inspection Section, Oesterreichische Nationalbank. The author would like to thank Michael Boss for his valuable remarks in the course of the preparation of this contribution.

<sup>2</sup> For an early publication see: OeNB, *Stress Testing, Guidelines on Market Risk*, Vol. 5, 1999. Many other articles on research and application of stress testing can be found in various issues of the OeNB's financial stability report.

<sup>3</sup> Please note that the term macro stress test is used frequently in a (slightly) different context, namely for: (i) stress tests including various risk factors accounting for mutual dependencies between them, also called multi-factor stress tests; (ii) stress tests regarding macroeconomic crisis scenarios, like a recession, using macroeconomic risk factors like GDP, the unemployment rate, etc.; and (iii) for stress tests with respect to the entire financial system. As it was understood that in the course of the conference the term macro stress testing was most commonly used according to the third interpretation, the respective definition also applies in the following.

it is not obvious with which instruments it can react to potential risks in the system, while commercial banks – at least in principle – can reduce or offset their position at risk.<sup>4</sup> These additional aspects lead to additional requirements for macro stress tests.

Due to the fact that macro stress tests focus on the entire financial system, they have to take the perspective of the system as a whole rather than that of a single institution. At the system's level, risks stemming from interactions and inter-linkages between individual institutions become crucial and hence have to be taken into account. The Systemic Risk Monitor (SRM)<sup>5</sup> – a model for analysing systemic risk and stress testing banking systems, which has been developed at the OeNB and is now regularly used for quantitative financial stability assessment of the Austrian banking sector – has made some first attempts in this regard. The SRM relies on an integrated model for market and credit risk combined with a network model of the Austrian banking system in order to assess contagion risk within the interbank market. While the SRM captures contagion risk through mutual financial inter-linkages between institutions (debt and equity), other channels of contagion between banks could be relevant as well. For example, problems in one specific bank could negatively affect confidence in the overall banking system and as a consequence a bank run could spill over from one bank to other institutions without any major direct financial involvement of the banks. In addition, contagion is not restricted to the banking sector itself; it could also refer to spillover effects between different financial and non-financial sectors or between countries or regions.<sup>6</sup> While at least some of these aspects could in principle be included in existing modelling frameworks like the SRM, more research is needed regarding the respective modelling approaches.

As has been stated above, the classical framework of quantitative risk management, which is also used by the SRM, is meaningful only for a relatively short time horizon. In the context of macro stress tests, this horizon could be too short to capture the full impact of a crisis scenario on financial stability. This in turn raises the questions regarding behavioural assumptions. In addition, the value of risk factors and hence the value of banks' portfolios is usually endogenous and a function of the behaviour of market participants which could lead to feedback effects that are typically crucial under stress. An example of this would be the fall of real estate prices given multiple defaults on loans secured by mortgages. Given the wide variety of such feedback effects that one might think of, it is not possible to include all of them in one single framework. However, additional research is needed regarding the question of behavioural assumptions as well as feedback effects in the context of macro stress test models.

<sup>4</sup> See the contribution of Martin Summer, *Modelling Instability of Banking Systems and the Problem of Macro Stress Testing*, in these conference proceedings.

<sup>5</sup> For an overview of the model including some results, see Michael Boss, Gerald Krenn, Claus Pühr and Martin Summer, *Systemic risk monitor: A model for systemic risk analysis and stress testing of banking systems*, Financial Stability Report, 11:83–95, 2006.

<sup>6</sup> Some efforts have been made to model spillover effects between countries using complex macroeconomic models. For an example, see IMF, *Spain: Financial Sector Assessment Program - Technical Note - Stress Testing Methodology and Results*, IMF Country Report No. 06/216. 2006.



Finally, I would like to address another shortcoming of most existing stress test models that is – though widely known – not yet fully resolved. Most quantitative models used for stress testing are estimated on the basis of historical data. As a consequence, these models capture statistical dependencies between the risk factors under consideration as they have been observed in the past and hence to a large extent in normal times. However, it is well known that these statistical dependencies could be very different in times of stress, which is usually referred to as correlation breakdown. Though there are solutions to this problem at least from a theoretical point of view, many macro stress test models in use do not account for this fact. Within the framework of the SRM, an attempt was made to solve the problem of correlation breakdown using a so-called Copula approach<sup>7</sup> for the joint distribution of risk factor changes. In principle, this approach allows the modelling of different statistical dependencies in normal times (i.e. in the central region of the joint distribution) and in times of stress (i.e. in the tails of the joint distribution). However, the actual parameterisation of the Copula is still based on historical data and hence can at best capture statistical dependencies between risk factor changes as they have been observed in the course of historical stress scenarios, which are included in the data set used for estimation. Though in recent years much attention has been devoted to capturing mutual dependencies of risk factors in the context of macro stress testing, the problem of correlation breakdown would still need some deeper insights.

Despite the shortcomings of current methodologies, of which I tried to address some, stress testing is a very useful tool for central banks and other regulatory authorities for the quantitative assessment of financial stability. However, one should keep in mind the limitations set by these methodologies, which can be largely traced back to the classical risk management framework, which is commonly in use. Within this framework, we can address the question of how the financial system described by a *given* system of portfolios is affected by a crisis. In order to get a more realistic picture of the effects of a hypothetical crisis scenario, one should take into account feedback effects and behavioural assumptions regarding the restructuring of banks' portfolios under stress. Also within the classical risk management framework many aspects need further analysis. As an example, I addressed the problem of correlation breakdown. Summing up, stress testing is indeed a useful tool to assess the stability of financial systems. In order to account for the specific aspects of stress testing in this context, a wide range of additional research is needed, and I have tried to identify some of the most relevant directions for this.

Let me now turn to the second issue, the financial crisis simulation. I believe that crisis simulation exercises in general, and cross-border crisis simulation exercises in particular, serve an important overall purpose: the purpose to be well prepared. As we have discussed during the previous session, being well prepared is not always without difficulties on the national level; being well prepared on the cross-border level adds not only one but several layers of complexity. When considering the time line of a crisis situation between its detection and its resolution, the meaning of “being prepared” varies.

<sup>7</sup> To be more precise the SRM uses a t-grouped Copula approach.

Thanks to the efforts of the Task Force on Crisis Management we will soon have an EU common framework for assessing the systemic aspects of a crisis situation. This will surely help to constructively discuss diverging assessments and, in my opinion, should be tested during an EU-wide exercise as soon as possible. This leads to a fundamental issue: how closely should the underlying scenario of the exercise reflect the complexity of a real crisis?

If we try to build a scenario which very closely reflects reality, we have to be aware that we increase the complexity of the model but also of the exercise as a whole. If we try to map reality as far as possible into the scenario, we will have an exercise with numerous variables, correlations, feedback mechanisms and behavioural reactions. This might be challenging from an academic viewpoint, as it would represent a step towards a higher level of theoretical sophistication and a number of intellectually fascinating puzzles. Furthermore, we can argue that such an exercise would cover nearly all relevant aspects. However, these advantages come at substantial costs in practical application. The high level of complexity and the demand for large sets of real-time data reduce the value of complexity in times of distress, when decisions have to be made quickly on the basis of incomplete data and under considerable uncertainty.

In my opinion, we should rather focus on the applicability of the underlying models and procedures from a cost-benefit perspective. Crisis situations are (per se) highly complex. Therefore, we should try to reduce the complexity of the exercise as much as possible and base it on the strictly necessary minimum level of complexity. That should provide for scenarios reflecting exceptional but plausible events and highlighting the major interactions among key endogenous and exogenous variables. We should accept that the scenarios will have to be simple and concentrate attention on thoroughly testing the operative procedures and the mechanisms for the exchange of information and the coordination of policy measures taken. If these pivotal elements of crisis management do not work well under distress, highly sophisticated scenarios would be of limited use anyway. Understanding how the procedures in place work in crisis situations is the main purpose of crisis management exercises. As it is not possible to predict all facets of the development of each individual crisis, we should – first of all – concentrate on the procedures which allow us to have a tested tool to react to any particularities of an individual crisis in a timely, coordinated and yet profound manner.

# TESTING THE INTERACTION BETWEEN AUTHORITIES OF COUNTRIES WITH SIGNIFICANT BANKING INTERLINKAGES

THORVALD GRUNG MOE<sup>1</sup>

## I INTRODUCTION

The establishment of Nordea in 2000 propelled cross-border banking issues onto the agenda of policy-makers in the Nordic region. Since all the four merging banks were large in their home countries, the establishment of the new bank raised new policy issues related to home-host supervisory responsibility, financial stability, crisis management, emergency liquidity assistance and deposit insurance. Later, the bank's expansion in the Baltic region accentuated these issues. The "Nordea case" has since been associated with the challenges of cross-border banking, in particular for banking groups with large subsidiaries or branches in host countries.<sup>2</sup>

The cooperation between central banks and supervisors in the Nordic region obviously increased after the Nordea merger, and several MoUs have since been signed (both bilateral and multilateral). A crisis simulation exercise was conducted in 2002 and a new one is planned for this year.<sup>3</sup> In addition, several national exercises have tested specific aspects of our crisis resolution policies.

Today I will review our experiences with these exercises. I will first give you a brief overview of the Nordea group and some of the policy issues it raised for us. Second, I will review the 2002 exercise and the lessons learnt from testing the interaction between authorities of countries with significant systemic interlinkages. Third, I will touch on some of the policy discussions that followed and also mention briefly the forthcoming exercise (about which I obviously cannot say much). Finally, I will offer some views on the challenges ahead, with respect to the design and organisation of cross-border financial crisis simulation exercises and the policy issues involved.

I conclude that crisis simulation exercises are useful tools for testing financial instability. They provide a complement to stress testing and enable us to "visualise" different crisis scenarios. They can also be used to test crisis resolution policies and procedures. Our Nordic experience with regional crisis simulation exercises is limited, but together with national exercises, they have triggered a lot of important policy and procedural work related to crisis management.

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<sup>2</sup> The IMF has dealt with these issues in the Global Financial Stability Report (IMF, 2007a) and the Euro Article IV consultation (IMF, 2007b). BIS (2007) also deals with the issues of international banking.

<sup>3</sup> A Nordic-Baltic simulation exercise was held in Stockholm in October 2007, i.e. after the ECB conference.

As for future simulation exercises, I would prefer to keep them rather simple. But then some of the unresolved policy issues need to be addressed. A key challenge here is the mismatch between global institutions and national regulations. Simulation exercises can be useful in identifying some of these difficult issues, but they are not well suited to resolving them. However, they can be very useful in helping us all to be better prepared for the next crisis – when it comes.

## 2 “THE NORDEA CASE”

Nordea was established through the merger of the largest bank in Finland (Merita Bank) and the third largest bank in Sweden (Nordbanken) in 1995. Later in 2000, the second largest banks in Denmark (Uni Bank) and Norway (Kredittkassen) were added. Nordea has since expanded into the Baltic region and Poland, but most of its lending is still in the Nordic region. In 2005, Nordea was the 21st largest bank in Europe, with total assets of EUR 215 billion.<sup>4</sup>

Nordea is today organised with subsidiaries in all the Nordic countries, although there have been plans to transform the group into a European company (SE) with branches in all countries. Even though this transformation has been delayed, the bank already operates along business lines.<sup>5</sup> The holding company for the banking group is located in Sweden, after an interim period where the parent bank was in Finland. The market shares of Nordea are currently 30-35% in Finland, 15-20% in Denmark, and 10-15% in Norway and Sweden (based on total assets in each local market).

The establishment of Nordea gave us a head start on cross-border banking issues in the Nordic region. The supervisors recognised that new modes of cooperation were required, and the central bank governors quickly decided to form a contact group to study issues related to financial crisis management in cross-border banks, in particular for banks with large, systemically important subsidiaries.

In 2001, the contact group started to analyse who should extend emergency liquidity assistance (ELA) to Nordea if the bank ran into a serious financial crisis. Since the parent bank was at that time located in Finland, the Bank of Finland was the natural choice. But it was also argued that Sveriges Riksbank should provide ELA, since the holding company for the whole group was in Sweden at the time. This question was discussed in the contact group during the first year without any definite conclusion being reached, and it was then decided to test the issue in a crisis simulation exercise together with the Nordic supervisory authorities.

<sup>4</sup> The Swedish state holds 20% of the voting shares in the holding company, although the government has announced its intention to sell these shares.

<sup>5</sup> E.g. the Norwegian retail market is split into three regional areas, all reporting directly to HQ in Stockholm.

### 3 THE 2002 CRISIS SIMULATION EXERCISE

The 2002 exercise was designed to test the interaction of Nordic central bankers and supervisors in response to a liquidity problem in a large cross-border bank. Twenty-four senior staff met in Oslo for a full day of crisis simulation. The case used real data from Nordea as a basis for a three-stage crisis scenario that was discussed and “resolved” in three parallel groups. We developed a fairly “classic” case, with a rogue trader initially causing large losses in the parent bank; then in stage two another bank in the group was affected, with strong negative market reactions as a result. And finally, in the third stage of the crisis, the bank’s capital ratios fell below the legal minimum and we had to deal with both liquidity and solvency problems.

In the first stage of the crisis, the parent bank approached Sveriges Riksbank (as the home country authority of the holding company) with a request for ELA. At this point, the capital situation in the bank was still comfortable and all authorities agreed that the application should be rejected.<sup>6</sup>

When the losses increased in stage two of the exercise, it was evident that the bank needed ELA. The first reaction was to ask the Bank of Finland (as the home country authority of the parent bank) to respond to the bank’s request. However, since the parent bank in Finland had fairly limited collateral, it was suggested that Sveriges Riksbank was better placed to act as the lender of last resort. The loan could then be secured with collateral from the subsidiaries in Denmark and Norway. As expected, this led to interesting discussions about national mandates, legality of asset transfers and possible ring-fencing.

When the losses escalated further in the third stage of the exercise, the bank’s solvency also became an issue. Was the bank insolvent? How could we tell? Could it recover? How quickly would the supervisor be able to provide a solvency judgement? And when should the ministries of finance be involved and what would they do? Since the ministries were not participating in this first crisis simulation exercise, this last question was not pursued further.<sup>7</sup>

### 4 LESSONS LEARNT

*The simulation exercise was very useful.* Even though the exercise was fairly simple, it was still realistic enough to test the interaction among regional policy-makers. It formed the basis for some very useful networking and provided a trigger for further work. (There is still a difference between face-to-face meetings and just speaking with someone on the phone.) Since the case information dealt primarily with financial data, the three groups were not really given the opportunity, nor the time, to conclude the ELA discussion. However, the exercise confirmed what we had expected, i.e. that there would be disagreement and real conflict of interests related to the provision of ELA.

<sup>6</sup> All participants were still in a very cooperative mood and discussed how a possible joint ELA could be secured with collateral from the different subsidiaries in the group.

<sup>7</sup> This was later an argument for including them in the subsequent crisis simulation exercise.

*The crisis simulation exercise highlighted the potential for ring-fencing.* This was an important lesson that perhaps was a bit surprising – given the initial cooperative spirit among the participants. Two ring-fencing issues were identified: (i) the problem with narrow national mandates and (ii) the difficulties in arranging for the transfer of assets between entities in the cross-border group, or even cross-border pledging of collateral.

National supervisors acted in the best interest of their national depositors, and it was difficult for them to agree to asset transfers from “their” sound subsidiaries. As one of the participants put it: “I would really like to cooperate, but I simply do not have the legal mandate to do this.” Even the pledging of local collateral for a joint ELA operation was difficult. The underlying concern was obviously the potential losses that might follow, if the bank was considered to be insolvent at a later stage.

These ring-fencing issues have since been widely debated. The Committee of European Banking Supervisors (CEBS) has for example discussed whether the mandates of European supervisors should be expanded to include an EU-wide objective.<sup>8</sup> The EU Commission has also identified the transfer of assets as an important, but complex issue that is relevant for effective crisis management. And the European Banking Federation has recently asked for more flexible liquidity regulations to avoid “trapped pools of liquidity”. So the 2002 simulation exercise really identified some important issues.

*The crisis simulation exercise also highlighted the importance of being well prepared.* As the crisis evolved, we were constantly faced with various legal, technical and practical questions related to crisis management. Was the transfer of assets compatible with company law? Could we rewind a settlement? And how quickly could the bank produce a revised balance sheet? The exercise identified a whole set of new cross-border policy issues, and helped us focus on necessary improvements in our national crisis management policies. In Norway, we have since reviewed the practical aspects of our ELA policy, including our collateral policy, and together with the supervisory agency, the banking associations and the deposit guarantee scheme, we have reviewed our procedures for deposit payout and closure rules for banks. Our aim is to be able to conduct a quick closure and payout of a financially weak bank. This will make our crisis management policies more credible and enable us better to withstand pressure for official bail-outs.<sup>9</sup>

## **5 REGIONAL POLICY DISCUSSIONS**

After the 2002 simulation exercise, the policy discussions continued separately in the regional contact groups for the central banks and the supervisory agencies. The central bank group focused in particular on the roles of (i) the parent bank,

<sup>8</sup> In Australia and New Zealand, legal amendments have been added that impose obligations on the relevant cross-border authorities to consult each other and try to avoid detrimental cross-border actions; see DeSourdy (2006).

<sup>9</sup> Gieve (2006) also stresses the need for practical preparedness.

(ii) the home country authority, and (iii) the deposit guarantee fund, in a liquidity crisis:

- How much support could we expect from the parent bank in a liquidity crisis?
- What was the role of the home country central banks in a subsidiary structure?
- Could the national deposit guarantee schemes assist in a cross-border crisis?

During 2003, the central bank group prepared two memoranda of understanding (MoUs): one for the “Management of a financial crisis in banks with cross-border establishments” and one specifically for the “Management of a financial crisis in Nordea”. Both were rather innovative at the time. However, they dealt primarily with practical arrangements related to the handling of a financial crisis, including who should take the lead role and what information should be obtained and analysed from the bank concerned. The key issue of who should extend emergency liquidity assistance (ELA) to Nordea if the bank ran into a serious financial crisis was not resolved by the group, and the MoUs therefore remained rather vague on this issue.<sup>10</sup>

The subsequent policy discussions were complicated when Nordea in June 2003 announced its intention of forming a European company, with the objective of creating one legal entity with business in all local markets conducted through branches (see Nordea, 2003). However, this planned transition has been greatly delayed, due to several regulatory and tax issues that are currently under consideration. But at the time, their announcement triggered new policy discussions in our regional groups, as we had to figure out the home-host responsibilities for the new branch structure as well. Since this is a well-known theme, I will just highlight three issues that were raised during this phase of our discussion.

First, we agreed that the responsibility for managing a financial crisis in a large cross-border bank rested primarily with its owners and management. We noted that problems in one part of a subsidiary banking group could be solved by making use of the collective financial strength of the whole group, although we recognised that ring-fencing could be a problem. We nevertheless felt that the parent bank, as a 100% owner, would be more supportive of the subsidiary. In addition, the parent bank would normally have funding and its reputation at stake in the subsidiary. Thus, if the parent would not support its subsidiary bank, it would most likely be insolvent, and in that case ELA would not be appropriate anyway.

Second, we continued to discuss who should be responsible for ELA in the event that it was given. The home country central bank (Sveriges Riksbank) would

<sup>10</sup> A press release by Riksbanken (2003) stated: “Since each individual crisis situation is different, the MoU does not indicate which remedial measures will be taken. However, since the MoU concerns cooperation between central banks, the possibility to provide liquidity will be a main issue”.

prefer to share the burden – also for the new European company bank (see Nyberg, 2003). But the host central banks argued that Nordea was already run very much like a branch bank, and that ELA or capital support should therefore be provided by the home country authorities. In the end, the regional policy dialogue gradually slowed down due to lack of progress on this issue.

Third, the home country authorities (in Sweden) also wanted shared responsibility for the deposit guarantee in the planned new European company bank (see Nyberg, 2005). It was suggested that this could be done with some form of compensation from the guarantee schemes in the host countries. However, this was a tricky issue related to the interpretation of the European directive and needed to be discussed at the EU level as well.

So at this point, our regional policy dialogue tapered off and the home-host issues were lifted up to the European level. The rest is history. Crisis resolution of large cross-border banks suddenly emerged on the agenda almost everywhere together with a host of other related policy issues (such as deposit guarantee reform, liquidity regulation, bankruptcy and reorganization, large exposures, hybrid capital, stress testing, etc.). The regulatory challenges ahead are indeed formidable.

## **6 THE NEXT SIMULATION EXERCISE**

Burden sharing is a key topic for the forthcoming Nordic-Baltic simulation exercise. The objective will again be to test the authorities' handling of a cross-border financial crisis. The focus of the exercise will be the coordination of decision-making between affected authorities and countries in the Nordic-Baltic region. The ministries of finance will participate in this exercise, as burden sharing – in the form of direct capital support or guarantees – will have to be decided by them.

It remains to be seen if we can agree on sharing the burden of resolving a crisis in a large cross-border bank. Some authorities will certainly argue that their local subsidiary is not systemic, while others might argue that the crisis should be resolved without the use of public funds. The exercise could also include issues related to early intervention and the role of hybrid capital in pre-insolvency write-downs, a topic which is currently under discussion in CEBS. The pressure on public funds would obviously be eased if private capital (including hybrids) could play a greater role in going-concern crisis resolution.

## **7 CHALLENGES AHEAD**

The key challenge ahead is to create simple, realistic and useful crisis simulation exercises for cross-border financial crises. This will not be easy, since the policy issues are complex and the number of relevant authorities is so large. Designing EU simulation exercises for 27 countries is a real challenge, but is it the right



challenge?<sup>11</sup> Some simplifications are needed if we are to make progress. We need to address the unresolved home-host issues.

Bond (2006) notes that “business and structural realities of modern international banking, and the supervisory approach which accompanies them, pay little regard to national boundaries”. Goodhart (2004) adds that this “interaction of an internationally inter-penetrated banking system with a system of national supervision and national burden allocation could well turn out to be a dangerously weak institutional feature”. Global banks are increasingly run along business lines (even though they are organised as subsidiaries!) and there is growing tension between their global expansion and the national legal and fiscal realities. This is the fundamental home-host conundrum!

The home-host issues are in fact not new. They were initially addressed by the Basel Committee in 1975 (and subsequently in 1983, 1992, 1997, 2000 and 2005). The topics have been discussed at numerous conferences and there are thousands of articles on home-host issues and crisis management. A cynic might observe that there is not much hope of finding a solution to this conundrum soon.

However, the EU has in fact made quite some progress (especially when compared to other regions), even though it is not always given due credit. For example, the Winding-up Directive has introduced uniform rules (based on the single entity principle) for the resolution of bankrupt (branch) banking groups. The new Capital Requirements Directive (CRD) includes several new provisions on home-host interaction. CEBS is actively pursuing its convergence mandate, with tangible results.<sup>12</sup> And the EU Commission is pushing ahead with a broad-based regulatory agenda in response to requests by the European ministers of finance. Nevertheless, there are still strong national interests that could delay the convergence process.

Some have therefore suggested a more radical approach. IMF (2007b) recently observed that “Europe’s financial stability framework is running behind market developments and holding up financial integration, and that a financial stability framework will need to be built upon a foundation of joint responsibility and joint accountability for large complex financial institutions”.<sup>13</sup> Many would argue that such an approach is premature. The ECB (2007) notes that it would be prudent to give the CRD process and the new Lamfalussy framework for the banking sector<sup>14</sup> some more time before new policy actions are considered. The

<sup>11</sup>Up to three authorities from each of the twenty-seven countries could potentially be involved in a single exercise.

<sup>12</sup>See the CEBS website for a list of consultation papers and progress reports: <http://www.c-eps.org/>

<sup>13</sup>Garcia and Nieto (2007) note that “the current EU arrangement would be equivalent in the U.S. to allowing federal charters for national banks without having the OCC (Office of the Comptroller of the Currency) to supervise them, the Federal Reserve to provide ELA and oversee the holding company, or the FDIC to act as receiver and deposit insurer for failed national banks”.

<sup>14</sup>A new institutional infrastructure to facilitate supervisory convergence in the EU financial sector; the Committee of European Banking Supervisors (CEBS) has the mandate for the banking area.

EU Commission (2007) also notes that “any further shift in supervisory powers requires a prior debate and greater clarity about which Member State would pay the fiscal burden if a cross-border bank failed”.

In theory, the IMF and the EU approach should be able to achieve the same outcome: an efficient and stable financial sector in Europe. For the decentralized EU approach to yield an optimal outcome there is, however, the need for some incentive adjustments. It is especially important that the current externalities related to cross-border banks are better reflected in the “prices” the key players face. I would like to offer three suggestions (none of them new) that could advance the convergence process (and thereby simplify the crisis management process and our crisis simulation exercises):

- National mandates of central banks and supervisors could be extended to allow for a “European dimension”. This would oblige home country authorities to consider the possible negative impact on the host countries of their actions. The legal amendments could be modelled on the Trans-Tasman agreement mentioned above (see DeSoudry, 2006).
- Global banks should not get away with limited liability for subsidiaries that are operated as branches. This would not imply a full roll-back of international banking. But since political and economic risk matters with regard to how banks enter a new market, they should simply be asked to bring the legal form more in line with the business structure. A firmer position on this issue would in my view simplify our home-host discussions a great deal.<sup>15</sup>
- And finally, large and complex banking groups should be required to hold capital commensurate with the potential negative effects of an institution-specific financial crisis. It is a paradox, in my view, that many large and complex cross-border financial institutions will get large capital reductions under the new Basel 2 regime, while we are increasingly concerned about the possible highly negative impact that could follow from a disorderly failure of such a bank, should it happen. This seems to me to be a clear case of negative externalities where the correct response should be to “get the prices right”. In this case, global banks need to be confronted with the “right” prices reflecting the calamity of a possible (although not very probable) failure, which really is synonymous with some form of extra capital (perhaps under Basel 2). This will not be an easy dialogue, as it addresses very fundamental issues of risk shifting and sharing between the public sector (us) and the private sector (the banks).

## 8 CONCLUSION

Let me conclude. We found the regional crisis simulation exercise to be very useful. A follow-up simulation exercise is planned for this fall. Together with our national exercises, the 2002 simulation exercise highlighted important

<sup>15</sup>See Cerutti et al. (2005). CEBS could for example facilitate a discussion on which core functions a local bank should retain in order to keep its banking licence as a subsidiary.

policy issues and triggered practical follow-up work. The challenge ahead is to create simple, realistic and useful crisis simulation exercises. But then some of the unresolved policy issues need to be addressed. A key challenge here is the home-host conundrum, i.e. the mismatch between global institutions and national regulations. The current EU approach has made quite some progress in this area, and with some adjustments (mentioned above) it could well lead us to the desired outcome: an efficient and stable financial sector in Europe. Along the way, crisis simulation exercises will continue to be important for testing new crisis management procedures and helping us all to be better prepared for the next crisis – when it comes.

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# INTERACTION BETWEEN THE AUSTRALIAN AND NEW ZEALAND AUTHORITIES

CHRIS RYAN<sup>1</sup>

## BACKGROUND: BANKING STRUCTURES AND INSTITUTIONAL ARRANGEMENTS

Compared with many other countries, the Australian banking system does not have a particularly large foreign presence – foreign-owned banks account for just under a quarter of the assets of the Australian system. Historically, foreign-owned banks have concentrated on providing financial services to large businesses, although in recent years there has been an increased interest in lending to small business and to households. Foreign-owned banks have also played an important role in increasing competition in the market for retail deposits.

Among the Australian-owned banks, there are four that account for more than 60% of the assets of the entire banking system in Australia. More than half the loans of these banks (and the other Australian-owned banks) are for housing and many of their loans to small and medium-sized businesses are secured against housing. The overseas activities of these banks are concentrated in New Zealand – of the 26% of their assets that are claims on non-residents, around half are claims on New Zealand residents, with the vast majority of these assets arising from New Zealand based operations, rather than cross-border lending. The structure of these banks' New Zealand assets is broadly similar to the structure of their Australian assets – there is a heavy exposure to housing.

By contrast to the Australian banking system, the New Zealand banking system has an extremely large foreign presence. Foreign-owned banks account for around 98% of the assets of the New Zealand banking system (with all but 2 of the 16 registered banks in New Zealand being foreign-owned); and the four largest Australian-owned banks account for around 90% of the assets of the

<b>Parent bank</b>	<b>NZ bank</b>	<b>NZ banks' share of NZ system assets</b>	<b>Share of parent banks' assets</b>
ANZ	ANZ National Bank	34	25
CBA	ASB Bank <sup>(a)</sup>	18	13
NAB	Bank of New Zealand	17	9
WBC	Westpac New Zealand <sup>(a)</sup>	20	15
<b>Total</b>		<b>88</b>	<b>15</b>

(a) Includes branch operations  
Sources: Banks' annual and interim reports, RBNZ.

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New Zealand banking system, with each of them holding at least 15% of all banking assets in New Zealand. Table 1 provides some relevant statistics.

In Australia, prudential regulation is the responsibility of the Australian Prudential Regulation Authority (APRA), which regulates all authorised deposit-taking institutions (ADIs – banks, building societies and credit unions), general insurers and re-insurers, life insurers, friendly societies, and most of the superannuation industry. In exercising its various functions, the APRA is required “to balance the objectives of financial safety and efficiency, competition, contestability and competitive neutrality”.

The main vehicle for coordination among the various regulatory agencies in Australia is the Council of Financial Regulators, which comprises senior officials from the APRA, the RBA (which is responsible for overall financial stability), the Australian Securities and Investments Commission (ASIC) and the Treasury, and is chaired by the RBA. One of the Council’s responsibilities is to coordinate crisis management arrangements.

In New Zealand, prudential regulation is the responsibility of the Reserve Bank of New Zealand (RBNZ). Currently, this responsibility is confined to the banking sector but in June the Government announced its intention to widen the scope of the RBNZ’s prudential functions to include non-bank deposit takers and insurers. The RBNZ’s prudential mandate is similar to the APRA’s – to promote a sound and efficient financial system and to avoid significant damage to the financial system.

The New Zealand equivalent of Australia’s Council is the Financial Regulators’ Co-ordination Group, comprising the RBNZ, the Securities Commission, the Government Actuary, the Ministry of Economic Development, the Takeovers Commission, the Serious Fraud Office and the Commerce Commission.

Neither Australia nor New Zealand has a depositor insurance system. There is, however, a difference in the legislative responsibilities of the APRA and the RBNZ when it comes to depositors – the APRA is required to exercise a number of its powers (particularly those relating to crisis management) for the protection of depositors, whereas no such requirement exists in New Zealand. Australia also has a system of depositor preference in the event of a wind-up. In particular, the Banking Act states: “If an ADI becomes unable to meet its obligations, or suspends payment, the assets of the ADI in Australia are available to meet that ADI’s deposit liabilities in Australia in priority to all other liabilities of the ADI”. By contrast, in New Zealand, depositors rank with other unsecured creditors.

Both the New Zealand and the Australian financial systems has been the subject of an IMF Financial System Stability Assessment, published in 2004 and 2006 respectively. Each Assessment concluded that the respective financial systems were in good shape but noted the importance of making further progress on cross-border crisis management arrangements.

## I RECENT CROSS-BORDER EFFORTS

It is widely accepted that foreign banks have brought benefits to New Zealand, including: economies of scale; expertise (technical and otherwise); and cheaper funding by virtue of the parent banks' high credit rating in global capital markets. But it is also acknowledged that such a high share of foreign ownership can complicate crisis management, and requires close cooperation between the authorities in Australia and New Zealand. Reflecting this, the work between the two countries has extended well beyond the usual home, country-host country agreements in place between many other countries, with the two countries involved in four important joint initiatives.

### (i) Establishment of a Trans-Tasman Council

The establishment of the Trans-Tasman Council on Banking Supervision (TTC) in February 2005 represents a high-level political commitment to the coordination of supervisory arrangements. The TTC comprises senior representatives of the Australian and New Zealand Treasuries, the Reserve Banks of Australia and New Zealand and the APRA. The terms of reference for the TTC require it to:

- Enhance cooperation on the supervision of trans-Tasman banks and information sharing between respective supervisors;
- Promote and review regularly trans-Tasman crisis response preparedness relating to events that involve banks that are common to both countries;
- Guide the development of policy advice to both governments, underpinned by the principles of policy harmonisation, mutual recognition and trans-Tasman co-ordination; and
- In the first instance, report to Ministers on legislative changes that may be required to ensure that the APRA and the RBNZ can support each other in the performance of their current regulatory responsibilities, at least where regulatory costs are concerned.

### (ii) Legislative changes

Reflecting these terms of reference, the TTC submitted its proposals on legislative changes to the Ministers in August 2005, with changes to the Banking Acts in both countries coming into force in December 2006. As a result of these legislative changes:

- Each bank regulator is required to support the statutory responsibilities of the other regulator relating to prudential regulation and financial system stability, and to the extent reasonably practicable, avoid any action that is likely to have a detrimental effect on financial system stability in the other country;
- Where reasonably practicable, regulators must consult each other before exercising a power that is likely to have a detrimental effect on financial system stability in the other country; and
- An administrator or statutory manager appointed to a bank must advise the regulator if a proposed action by them is likely to have a detrimental effect on financial system stability in the other country.

### **(iii) Closer cooperation in the development and implementation of supervisory policies**

There have been several secondments between the APRA and the RBNZ in respect of Basel II. Further secondments are planned in respect of other supervisory policies.

### **(iv) Joint participation in solvency assessment simulations**

Both the APRA and the RBNZ have scheduled various stress testing exercises and will participate in each other's exercises. In particular:

- The RBNZ (and the RBA) will participate in the APRA's solvency assessment desk-top exercise, scheduled for September 2007;
- The APRA will participate in the RBNZ's solvency assessment and systemic impact assessment desk-top exercise, tentatively scheduled for October 2007;
- The APRA will participate in the RBNZ's in-house crisis simulation exercise, tentatively scheduled for November 2007; and most importantly
- The APRA, the RBA and the RBNZ will hold a joint trans-Tasman crisis simulation designed to test the respective agencies' capacity to: identify problems, share information, assess the solvency status of a troubled bank; and manage internal and external communication and identify resolution options. It is expected that this exercise will take place in June 2008.

In addition, consideration is being given to a Memorandum of Understanding between the APRA, the RBA and the RBNZ setting out the responsibilities of each agency in a cross-border crisis and the broad principles of information exchange and coordination between the three agencies that would apply in a crisis.

## **2 OTHER EFFORTS TO IMPROVE CRISIS MANAGEMENT ARRANGEMENTS**

In addition to the above joint initiatives, authorities in Australia and New Zealand have spent considerable time in recent years examining various crisis management options.

In Australia, the work of the Council of Financial Regulators has focused on two issues.

### **(i) Closed resolution**

The first is the arrangements under which an institution would be closed. One difficulty that the Council identified was that, while the Banking Act gave depositors first claim over the assets of a failed authorised deposit-taking institution (ADI), it did not provide a mechanism to ensure that depositors were repaid in a timely fashion. The Council has therefore recommended to the Government that it introduce a Financial Claims Scheme, under which depositors of a closed ADI would be assured of receiving up to AUD 20,000



(USD 17,000 at end-June 2007 exchange rates) of their deposits with this amount available on a timely basis. The cap would be revised on occasion. The scheme would have first claim over the assets of the failed institution, and only in the extremely unlikely event that the proceeds of asset sales were insufficient to cover the payouts, would there be a levy on surviving banks. The liquidity to make the payouts to depositors under the scheme would come from the government or the RBA.

## **(ii) Open resolution**

The second issue that the Council has focused on is resolution options that do not involve the closure of an institution. In particular, the Council has been examining: possible changes in the legislation that would allow a broader range of options; the conditions under which, in extremis, some form of public-sector support might be appropriate; and how public sector support could be structured so as to avoid undermining market discipline, for example how it could be used to facilitate a private sector solution.

This work has been discussed in detail with the New Zealand authorities.

The New Zealand initiatives have, not surprisingly, focused on cross-border crisis management and hence have involved a particularly high degree of liaison with Australia. The following outlines the three main initiatives of the New Zealand authorities.

## **(i) Local incorporation<sup>2</sup>**

The RBNZ has introduced a local incorporation policy intended to ensure that: the local operations of certain foreign banks are subject to the same prudential standards as the two domestically-owned banks, including capital requirements; and that they can be controlled by a statutory manager with greater legal certainty than otherwise. Other stated objectives of the policy are to make these entities: less vulnerable to stress within the parent bank, including the possibility that the parent bank would buy the local operation's assets for less than fair value; and less likely to put the interests of the parent bank ahead of the interests of the local entity. The RBNZ requires the local entity's constitution to ensure directors act in the best interests of the local entity, with self-reporting requirements placed upon directors that are very demanding by international standards.

The following banks are required to operate as a subsidiary rather than as a branch:

- Systemically important banks – that is, banks whose New Zealand liabilities, net of amounts due to related parties, exceed NZD 10 billion (around USD 7½ billion at end-June 2007 exchange rates);

<sup>2</sup> For further details, see Chetwin, W (2006), "The Reserve Bank's local-incorporation policy", *Reserve Bank of New Zealand Bulletin*, Vol. 69, No. 4.

- Banks which accept retail deposits and are otherwise incorporated in a country with depositor preference;
- Banks which accept retail deposits and do not provide adequate disclosures in their home jurisdiction; and
- Any other applicants that the RBNZ considers to be otherwise not subject to adequate supervisory arrangements and/or market discipline.

The four Australian-owned banks are covered by the first two requirements: each has New Zealand liabilities, net of amounts due to related parties, of at least NZD 25 billion; and Australian-incorporated banks are subject to depositor preference. (These two requirements do not, however, preclude the Australian banks from also operating *small* branch operations that focus on wholesale activities.) Accordingly, the only Australian-owned bank that had not locally incorporated has now done so.

### **(ii) Outsourcing policy<sup>3</sup>**

The second main initiative of the New Zealand authorities has been to introduce an “outsourcing policy” which seeks to ensure that the local entity has access to the people and systems (including customer records) that it needs to have access to in the event that its parent bank or any other service provider cannot provide such access. Particular emphasis is placed on the local entity’s ability to provide its customers – commercial or otherwise – with payments and transactions capabilities, reflecting the importance of this function in a crisis.

### **(iii) The Crisis Management Tool Kit**

The third initiative is ongoing: work on a “toolkit” that provides the Crisis Management Team with guidance on managing a bank crisis. In particular, the tool kit provides: a management framework and process for dealing with a crisis, such as the key priorities and actions that need to be considered; guidance (checklists) to assist management with problem identification, assessing the impact of a bank failure on the financial system, and making a solvency assessment of the failed bank; and options, and guidance on implementing options, for dealing with an insolvent bank.

One resolution option under consideration, which has been discussed with the Australian authorities, is the possible use of a Bank Creditor Recapitalisation, whereby a haircut would be applied equally to depositors and unsecured creditors.

## **3. OUTSTANDING ISSUES**

Despite the high degree of coordination, there are a number of outstanding issues on which discussions are ongoing. Three of these are raised below.

### *(i) The implications of different mandates and powers of statutory managers*

<sup>3</sup> See Ng, T (2007), “The Reserve Bank’s policy on outsourcing by banks”, *Reserve Bank of New Zealand Bulletin*, Vol. 70, No. 2.

- What are the implications of the fact that in Australia, a statutory manager is legally obliged to act in the interests of depositors, whereas in New Zealand this is not the case?
- What are the implications of any differences between the two countries in statutory managers’ powers to recapitalise a bank?

(ii) *The implications of different approaches to emergency liquidity assistance*

- Should there be any coordination of, for example, criteria for eligible collateral?
- Should the RBA adapt its collateral criteria in order to allow a parent to on-lend to a distressed subsidiary?
- Should, in this case, the APRA relax its related party lending limits?

(iii) *The implications of different resolution strategies being adopted in the two countries*

- Could Australia close a parent bank without this threatening the viability of the New Zealand subsidiary?

What, for example, would be the implications for the subsidiary’s external funding costs?

- What obligation, if any, would Australia have regarding the cost of any public sector recapitalisation of a New Zealand subsidiary?
- What would be the implications for the parent banks of any activation of New Zealand’s Bank Creditor Recapitalisation proposal? (e.g. cross default clauses)

Authorities in both countries are grappling with these and other questions and no doubt will be for some time yet. Hopefully, the cross-border stress test planned for next year will help provide answers.

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# CHALLENGES IN ARRANGING EU-WIDE CRISIS SIMULATION EXERCISES

GÖRAN LIND<sup>1</sup>

I have been allotted ten minutes for this presentation about challenges. This may be enough today, but would not have been sufficient a few years ago since at that time the consensus about crisis simulations was far weaker than at present. In fact, the very idea of conducting such exercises was seriously questioned by many. The simulation exercises were not seen as worthwhile and by some they were even seen as dangerous. By performing such exercises, we might scare the general public and the exercises were regarded as irrelevant since they could never exactly mirror the next crisis to come.

The consensus is now much broader, not least due to the increased activities of banks and financial groups across country borders. Authorities agree that problems in cross-border groups must be solved through discussions between agencies in different countries. There is also recognition that not only the central bank and the supervisory agencies have a role to play, but also the ministries of finance, since they might have to handle difficult political issues of burden sharing and solvency support.

In order for the communications and information sharing to work well in an acute crisis situation, preparations are needed. Bilateral and multilateral MoUs have been concluded, but need to be tested, and the formal and informal networks of the involved people in different countries need to learn how the other parties think and act. A lot can be achieved through bilateral and multilateral meetings and discussions, but there is no better way to make the policy-makers and their staff directly aware of the issues than a crisis simulation. Simulations often lead to the identification of weaknesses in the arrangements for problem resolution, e.g. conflicting approaches in different countries.

The EU- and Eurosystem-wide exercises conducted so far have been successful and have increased our level of understanding of the issues. But this is by necessity a gradual process and we are constructing exercises which are getting more and more complex in order to simulate a real-life crisis. The aim must be to finally arrive at an exercise which very closely mirrors what could happen in reality, not only in terms of scenario and data but also in terms of stresses on the participants, diverging interests and, maybe, open disagreements.

In the following I will point to some issues which it is important to address when preparing and conducting EU-wide crisis exercises. My Norwegian colleague has already mentioned the Nordic exercises and there are many similarities but also differences. For instance, there are features in both the Nordic and the EU context which facilitate crisis solutions, such as MoUs, but there is a wider dispersion in the EU of country policies, institutions and even legislation, which may make it

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more difficult to agree on solutions.

## WHAT SHOULD BE INCLUDED IN FUTURE SIMULATION EXERCISES?

As I noted, there is a high degree of consensus in Europe that crisis exercises are useful tools to identify weaknesses in existing frameworks and also to make people more acquainted with the process of crisis resolution at home and in other countries.

The main challenge lies now in moving further ahead in the scope, complexity and realism of the simulations. We need to challenge the present constraints on information sharing and cooperation. To start with, we need to identify more in detail what information and data the authorities must have to be able to fully assess the crisis situation. This will likely require confidential bank and market data, and this might seriously test the limits of countries' legislation on secrecy and on provision of information by MoUs. We need also to strike the right balance in a crisis between using old but reliable data and updated but uncertain data.

After having received the data, the authorities in the exercise will use them for an assessment of the liquidity and solvency situation, as well as to deem if the problem bank has systemic importance and also if the situation could endanger the stability of the financial system through contagion. Previous exercises have included all these aspects, but primarily on a country-by-country basis. What is now needed is a joint assessment by the involved authorities in all relevant countries. In addition to assessing the specific situation in the affected individual bank group entity, the assessment should cover the totality of the bank group – i.e. the parent bank and relevant subsidiaries and branches, and maybe even a holding company if one exists. In the joint assessment, the authorities should agree on a common view to what extent the various parts of the group have been affected and thus the involved countries. The assessment should also conclude on any potentially wider problem for the domestic and international financial system as a whole. Optimally, the assessment should arrive at a common view on sharing the financial burden of resolving the crisis.

I am fully aware that the policy-makers in the EU have not yet come this far in the MoUs. Nevertheless, I think that including such issues in the crisis exercises would be highly relevant and could act as invitation for further discussion. By actually performing such joint assessments and discussing burden sharing, we make the issues more concrete and understandable. Doing this in a simulation environment, where people realize that it is an exercise and not for real, is far easier than in an actual situation.

A less controversial issue might be to include the aspects of the different qualities of bank capital in future simulation exercises. As is currently being discussed in the EU, components of bank capital have varying characteristics which make them more or less useful in a crisis situation. For instance, some kinds of capital cannot be used to cover bank losses until the bank is declared insolvent. In crisis exercises so far, we always assumed that 8% of capital can be fully utilized, but

in future exercises we could introduce a more nuanced and realistic approach. Some EU countries apply stricter rules on capital than other countries.

Future exercises could also involve the issue of different qualities of bank collateral, e.g. for ELA borrowing. Which kinds of collateral might be accepted and under what terms? What is needed to assume other than traditional collateral – do we need to prepare legal drafts; and do we need new staff skills in central banks to handle new kinds of collateral? Should we agree in advance on any policies on haircuts and on penalty rates for ELA lending or should we improvise depending on the specific circumstances of each crisis? Or, perhaps, there could be a combination of principles and ad hoc solutions?

Speaking about ELA, future simulations need to include the EU provisions on state aid and the Eurosystem rules on liquidity support. In addition to the issues of substance, for which some constructive ambiguity must continue to exist, we need to test the procedures and the time it might take to get an answer from Brussels and Frankfurt.

The different characteristics of deposit insurance in different countries have not yet been fully included in crisis simulations. Widely differing coverage of the insurance or differing processes for intervention by the insurance fund could lead to problems in crisis solutions.

An interesting extension of our exercises could be to introduce not only cross-border, but also cross-sectoral financial groups. This would presumably identify many more aspects of potential obstacles to smooth problem resolution. We already have many such groups in Europe so the relevance of such an exercise is obvious. At the same time, I acknowledge the logistical difficulties in expanding our simulations further.

Providing adequate and timely information to the general public is an important and challenging issue and we should test this further in future exercises. Countries have widely differing traditions and approaches to external information and these differences may collide in a cross-border crisis. There are also differences between the financial sectors. For instance, the securities markets require immediate information in order to provide a correct basis for assessments of the values of financial instruments, but the bank supervisor may not wish to present sensitive information until more is known about the problem and until there is a degree of consensus on how to resolve it. Also, the coordination of the provision of information to the general public between the central bank and the ministry of finance is not always easy since they have partly different roles and responsibilities in a crisis.

Before concluding, I should note that several of the aspects I have just mentioned have to some extent been included in earlier exercises. This is fine. But my point today is that they have not been included in a systematic fashion and not all of them at the same time although they might occur simultaneously in a real-life crisis. It is the full complexity of a crisis that we should strive to simulate.

## CONCLUSIONS

The crisis exercises conducted so far have served us well. We have become aware of many issues which have provided an input to the political process for resolving them through various means, such as legislation, but also through softer approaches such as MoUs and other guidance.

If I were to be bold enough to criticize anything in the exercises conducted so far, I would say that they have been a little bit too kind to and smooth for the participants. All the needed data have been served to the participants on a silver plate so there has been less uncertainty about the conclusions as to liquidity and solvency than in a real case. The participants have all arrived at the exercise in a good mood and have brought it to a successful ending. They have been very cooperative in their simulated negotiations with other countries during the exercise, sometimes even bending their mandate and domestic legislation. I am not totally convinced that we would get the same constructive results in a stressed situation involving a real crisis and real money. Therefore, I would find it useful to have future exercises under somewhat more stressful and realistic conditions. I also encourage the use of more unplanned “surprise exercises” such as the one held last year in Frankfurt and London to test that the organisations are prepared for contingencies, for instance that the deputies in various positions can assume their duties. An additional feature to make crisis simulations more realistic might be to have real bankers to play the role of themselves.

I have mentioned a range of proposals today, namely forcing exercise participants to ask for and to use obsolete and unrobust data; conducting and agreeing on joint assessments of the situation as to liquidity, solvency, systemic importance and potential contagion on a cross-border group basis – and, if possible, agreeing on burden sharing; widening the exercise to a cross-sectoral one; looking more in detail at the quality of banks’ capital and collateral; including the aspects of state aid and liquidity restrictions; taking account of the effects of deposit insurance; moving further ahead on the aspects of external information. If all these are introduced into future crisis simulations, we will achieve many positive results in identifying potential obstacles to smooth crisis resolution. This could then lead to discussions and actions aimed at reducing the impact of such obstacles.

The aspects of a cross-border crisis simulation exercise are in many ways very similar to those of a purely domestic exercise. However, there are some major differences which make problem solution, and hence also the cooperation and analysis, far more difficult. The main difference is of course that two or more countries’ interests are at stake, politically, financially and maybe in other ways.

In short, the main challenge in arranging an EU-wide crisis simulation is to make it so realistic that we cover what would happen in reality and also how the involved persons and authorities would react. We are getting there, slowly but surely.

# CROSS BORDER FINANCIAL CRISIS SIMULATION EXERCISES

## COMMENTS BY SVEIN ANDRESEN<sup>1</sup>

A serious cross-border banking problem has not been experienced for some time. But the challenges likely to arise in addressing such a problem are reasonably well known. To name but a few, difficulties can arise in establishing a common assessment among relevant authorities of the health of the whole or part of the bank, and of the wider implications of its problems. Complexities arise from the bank's legal and business structure, and from different national mandates and resolution frameworks in the countries where it is present. And there is uncertainty about the sharing of responsibilities amongst the authorities, and the lack of a shared responsibility for the group as a whole.

These challenges can lead to coordination gridlocks of various kinds, which can seriously worsen the initial problem. Difficulties are seen as likely to arise with emergency liquidity assistance – whether, who and when to provide it; the issue of national ring-fencing, which limits the transfer of assets between entities of the group; conflicts regarding the role of deposit insurance arrangements; uncertainty about permissible tools for addressing the problem; and a lack of ex ante agreement on how the fiscal costs of resolving a failed bank should be shared.

At the global level, not much headway has been made in addressing these challenges. However, the groups of countries from which we have heard during the conference have made serious efforts to make progress, through careful joint planning as well as the use of carefully constructed cross-border crisis simulation exercises.

In my comments, I will offer some thoughts on the value of cross-border crisis simulation exercises in making progress on crisis management arrangements; what we can and cannot learn from them; some issues that such exercises might look to try to incorporate in future; and some broader lessons for policy decisions about the quality of the cushions in the system that can be drawn from exercises to date.

## WHAT IS THE VALUE OF CROSS-BORDER CRISIS SIMULATION EXERCISES IN MOVING AHEAD ON THESE ISSUES?

Cross-border crisis simulation exercises can be a very valuable tool for generating an understanding of, and buy-in for, the hard work needed to make progress on difficult policy issues and enhance national and international preparedness.

First, cross-border crisis simulation exercises allow authorities to explore the policy reactions and strategic behaviours that are part and parcel of resolving a cross-border financial crisis where clear rules do not exist. Second, they can be used to assess whether the various national resolution policies in place and the

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cross-border procedures that the authorities may have agreed on in principle are appropriately joined up. In this way, a cross-border crisis simulation exercise can help us understand whether the pieces put in place are likely to have a chance of working in a crisis. Lastly, and this is important, cross-border crisis simulation exercises enable those that will have to resolve a real problem to get to know each other and to practice along some of the more challenging dimensions they would confront. Such personal and institutional interactions can make less abstract what are sometimes regarded as abstract problems, and are very important for establishing a climate for addressing these issues.

At the same time, there are limits to what we can learn from crisis simulation exercises. To paraphrase an oft-cited quote, they can take us into the known unknown and shrink that space, but not into the unknown unknown or the unknowable.

Some of the lessons about cross-border crisis simulation exercises that I have taken away from the presentations in this session are the following. First, cross-border crisis simulation exercises are part of a learning process – obviously, no single game can settle all issues and one should – as noted – be mindful of their limitations. Second, such exercises can and should be carefully designed and calibrated to accomplish specific objectives. For example, a simple tabletop exercise can expose a known unresolved issue and, by developing a better understanding of the problem, help in its resolution. A more complicated war game, which puts the process under more realistic strains of speed and uncertainty, seems better directed at generating an appreciation of the need to prepare well. But games that expose too many learning points and policy issues at once have greater difficulty finding traction and support at high levels. Another lesson seems to be that games that involve a small number of players with large but conflicting interests in the outcome are more valuable in the lessons they generate than very large games involving many but perhaps largely procedural coordination problems. Lastly, as confidence about the value of cross-border crisis simulation exercises is gained, and some of the important elements of cross-border crisis management arrangements come into place, successive crisis simulation exercises can and should be made increasingly realistic.

The lessons from crisis simulation exercises can be particularly valuable and lead to action points where they address a specific institution, scenario or risk that is recognised amongst authorities as a common issue. This argues for crisis simulation exercises to be part of the work of the small interest groups of countries with strong financial links which Sir John Gieve has recently discussed elsewhere.

## **WHERE SHOULD CROSS-BORDER CRISIS SIMULATION EXERCISES GO NEXT?**

In his paper, Thorvald Moe argues that crisis simulation exercises should be kept simple, while in his, Göran Lind urges that they be more complicated. I can see good arguments for both cases, depending on the circumstances. Göran Lind suggests increasing uncertainty about the information available to

participants; forcing participants to conduct and agree on a joint assessment of liquidity, solvency and the systemic impact of a problem; and taking account of real challenges, such as deposit insurance, constraints on assistance and communication to markets. I think these are very good suggestions.

An additional observation he might have made is that the crisis simulation exercises to date have been very bank-focused. But it is easy to imagine a wider capital market crisis that engulfs banks, non-banks and a range of markets, and that confronts authorities with serious shared challenges short of dealing with a failing institution. To Göran Lind's list, I would therefore consider adding how to deal with systemically important non-banks or conglomerates that are affected by a market crisis; securities market regulators and the constraints that securities regulation brings; and financial infrastructure problems with a non-EU dimension.

As I noted earlier, it is appropriate for exercises to be tailored to the particular scenarios and risks that authorities are likely to face, and to open issues that have been identified. Many of the lessons may be case- or country-specific. But it is not difficult to see how lessons learnt even in quite specific cases may be of relevance to authorities that have not participated in the game. These lessons might be about crisis management itself or about designing and running crisis simulation exercises. Given the costs of preparing and running crisis simulation exercises, especially cross-border ones, financial authorities should continue to find ways to share experiences of games amongst each other through workshops such as this.

Work to advance the state of the art of crisis simulation exercises in addressing these and other cross-border issues will necessarily be incremental. Perhaps some years down the road, it may be possible to run a crisis simulation exercise encompassing the range of relevant authorities in all the major centres. That is a long-term goal to keep in mind.

## **BROADER LESSONS FOR FINANCIAL POLICIES**

Now, what broader lessons can be drawn from the outcomes of cross-border crisis simulations about how the authorities need to position the financial systems to be able to address the challenges that global institutions pose in a setting of national regulators/authorities?

Thorvald Moe draws out some issues that are well worth reflecting on further. First, authorities should make it clear that responsibility for managing a crisis, in a cross-border group, including establishing and activating contingency arrangements, rests squarely with the managements of these institutions. Second, before giving way to pressure from firms to change rules so that they allow them to economise on capital and liquidity buffers, authorities should think carefully about the implications that these changes could have in times of crisis, and take supplementary action accordingly. For example, if constraints on trapped pools of liquidity are removed, authorities should insist that the parent be transparent

and explicit about the extent of its support for branches and subsidiaries in the group. In the same vein, authorities should carefully evaluate the consequences in a crisis before permitting different qualities and types of capital. And they should seriously consider raising capital requirements for large and complex financial institutions whose systemic footprint is large.

Mr Moe knows well that these broader issues cannot be tackled on the basis of lessons from crisis simulation exercises alone. However, a real crisis, in which firm managements and the authorities did all they could have done as well as it could have been done, yet failed to prevent a very bad outcome, could well prove the importance of the issues he has raised.





## **SESSION V**

### **SPECIFIC CHALLENGES FOR THE EU AND THE EURO AREA**

#### **CHALLENGES FOR EU-WIDE MACRO STRESS-TESTING**

*John Fell and Trevor Fitzpatrick*

#### **GETTING END-GAME EXPECTATIONS RIGHT**

*Peter Nyberg*

#### **EU FINANCIAL CRISIS MANAGEMENT ARRANGEMENTS FROM A CENTRAL BANKING PERSPECTIVE AND THE EUROSISTEM FINANCIAL CRISIS SIMULATION EXERCISE**

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#### **SPECIFIC CHALLENGES FOR THE EU AND THE EURO AREA**

Comments by *John Berrigan*

# CHALLENGES FOR EU-WIDE MACRO STRESS TESTING

JOHN FELL AND TREVOR FITZPATRICK<sup>1</sup>

## INTRODUCTION

Macro stress testing is a quantitative tool for assessing the resilience of financial systems to adverse events. In their practical implementation, macro stress tests essentially involve conducting “what if” exercises in order to gauge systemic risks. The stress events that are tested in these exercises are usually severe but plausible scenarios that nevertheless have a low probability of crystallising. The approach has become an integral part of the financial stability assessment work being carried out by many central banks around the world. For instance, Cihak (2006) found that of the around 50 central banks that were routinely publishing financial stability reports at the end of 2005, more than half of them were including the findings from macro stress tests in these publications.

Because macro stress testing typically involves the building of quantitative models of financial systems, the approach can provide a logical and internally consistent framework for financial stability assessment. This can help, for instance, in better understanding linkages between various parts of the financial system and, by extension, how shocks are likely to be transmitted within them. Macro stress testing cannot predict the likelihood of financial crises occurring but the approach can help in assessing which sources of risk and vulnerability are likely to pose the greatest threats, should they crystallise, to balance sheets and, ultimately, financial system stability. The potential that these frameworks offer for ranking different sources of risk by their relevance is particularly useful for policy-makers as it can help in identifying which of them warrants the closest attention and in assessing whether remedial action is needed. Some central banks have also found that publishing the findings from their macro stress tests can enhance their communication on vulnerabilities. To the extent that this ultimately influences private sector behaviour, this has the potential to enhance the contribution that central banks are already making to financial crisis prevention through the periodic issuing of financial stability reports.

The case for carrying out EU-wide macro stress-testing exercises essentially rests on the fact that the process of financial integration, particularly intense within the euro area, is leading to a greater degree of inter-connectedness between national financial systems. This means that the implications of many of the stress scenarios that are routinely being tested at the national level cannot be fully and comprehensively assessed without taking account of the implications for neighbouring financial systems, especially the possibility of spill-over and externalities. This paper documents some progress that has been made towards building an EU-wide macro stress-testing framework and it highlights some of the most important challenges that remain to be addressed by future work. The

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rest of the paper is organised as follows. Section 1 discusses the main reasons why a euro area/EU-wide macro stress-testing framework is needed. Section 2 describes some of the progress that has been made towards building a euro area stress-testing framework. Section 3 outlines some of the main challenges facing macro stress testing and Section 4 concludes.

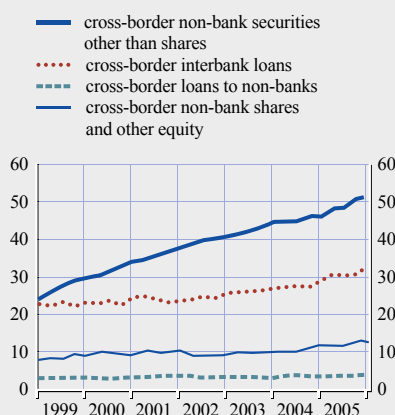
## I THE NEED FOR EURO AREA AND EU-WIDE STRESS TESTING

The extent of cross-border consolidation that has taken place across banking systems within the euro area and the EU over the past decade or so implies that large and complex banking groups (LCBGs) are facing greater diversity in the sources of risk they must manage compared to the past. Because of cross-border lending, investment in corporate bonds or participation in the credit risk transfer markets, the relevance of country-specific shocks to GDP in shaping their overall credit risk profile may be declining over time. At the same time, their exposure to common sources of risk has been growing. For instance, as banks lend and take on credit exposures to a broader geographical area than their own national markets, this increases the sensitivity of their balance sheets to the phase of the euro area business cycle. In addition, although the magnitude and composition of credit risk exposures may differ, banking systems in the euro area, to a large extent, face the same interest rate and foreign exchange risks arising from the single monetary policy. For macro stress testing, this means that a “what if” exercise involving a severe but plausible shock to, for instance, euro area GDP or to the level of euro area short-term interest rates will have implications for several financial systems simultaneously. If there are significant inter-linkages between any of these financial systems, then the findings from national stress tests will only be partial and incomplete.

As the EU financial system becomes increasingly integrated, this implies a greater degree of inter-connectedness between individual financial institutions within it (see Chart 1). This in turn creates more scope for cross-border contagion and counterparty credit risk. Several recent studies have attempted to assess the empirical relevance of cross-border banking activities by analysing either the “outward reach” (cross-border activities through foreign branches or subsidiaries) or the “inward attraction” (the extent of foreign bank presence in the host country) of banks. For instance, ECB (2006a) reported a sustained increase in internationalisation within the EU banking sector: between 2003 and

**Chart 1 Cross-border banking indicators in the euro area**

(percentages)



Sources: ECB.



2005, the average percentage of reporting banks' assets in branches and subsidiaries abroad (outward reach) relative to total assets rose from 24% to 38%. Using data on foreign assets, revenues and the number of employees of the 30 largest EU banking groups, Schoenmaker and Oosterloo (2005) reported similar findings. In addition to this, inward attraction has grown also. ECB (2006a) found that the average market share of foreign branches and subsidiaries in the EU as a whole stood at 26% at the end of 2005.

A key question is whether it naturally follows that increasing financial integration implies a higher likelihood of contagion spreading across the borders of member states. Several empirical studies have been carried out to examine this issue, many of them basing their analyses on correlation patterns of securities prices of individual financial institutions. This indirect approach to estimating cross-border contagion in the EU banking sector was followed by Hartmann et al. (2005) who examined interdependencies of extreme movements in bank equity prices to estimate spill-overs among them (i.e. contagion risk) and to assess their sensitivity to common shocks (i.e. systemic risk). The findings of their analysis suggest that cross-border contagion risk among EU banks exists but that it is lower than in the US due to weaker cross-border links in Europe. Gropp and Vesala (2004) indirectly measured cross-border contagion by estimating the interdependencies of banks' distances to default. They found cross-border contagion to be significant in a statistical sense but that domestic contagion among banks was more important. Gropp et al (2006) extended this study, also specifying the channel of contagion, and found an increase of contagion risk which they attributed to the integration of the euro area money market.

## 2 EURO AREA MACRO STRESS-TESTING WORK CARRIED OUT BY THE ECB

Having a vision of what an ideal or a complete macro stress-testing framework would comprise can serve to illustrate where the greatest challenges lie for euro area macro stress testing. Specific steps that would need to be taken in a complete macro stress test would include at least the following:<sup>2</sup>

- 1 **Identification of the source of risk underpinning a stress scenario.** This could be a shock to GDP or an unanticipated increase in wholesale market interest rates. The scenarios tested could be based on specific past events (e.g. the stock market correction of 1987, the bond market turmoil of 1994, etc), they could be drawn from the tails of empirical realisations of past data or they could be purely hypothetical.
- 2 **Quantify the impact of the shock or scenario on the macro-financial environment.** This step would primarily involve quantitatively assessing how key macroeconomic variables would respond to the initial shock. A key challenge to performing this step is to ensure consistent and sensible correlations in the responses of these variables.

<sup>2</sup> See, for instance, Bunn et al. (2005).

- 3 **Quantify the impact of deteriorated credit quality on loan loss rates and earnings of banks, as well as of adverse valuation changes on the banks' holdings of securities.** This step primarily involves mapping the macroeconomic scenario into the balance sheets of households, firms and banks in a way that allows the costs for banks' earnings and solvency to be estimated over the horizon of the stress test. A more challenging part of this assessment involves trying to assess the impact of mark to market valuation changes on banks' securities portfolios arising from the initial shock.
- 4 **Quantify the likelihood of bank failures and of potential domino effects.** It is important to note that examining the impact on the interbank markets in this way is quite different to stress tests which begin with a bank failure and then attempt to measure the impact of this failure on other banks and the system as a whole.
- 5 **Quantify feedback to the macro-financial environment.** If a stress event is sufficiently severe, it may lead to the erosion of capital buffers of banks to such a degree that it forces them to cut back on lending, thereby raising the possibility of a credit crunch. The findings from such an assessment are possibly the most interesting for policy-makers because the safeguarding of financial stability is primarily aimed at avoiding situations of systemic risk that lead to costs for the real economy in terms of foregone output or, possibly, higher fiscal imbalances. However, in practice, this step has been found to be particularly challenging to implement in practical macro stress testing.

In the event that such a complete macro stress-testing framework is developed, it would still need to be validated to ensure that it was capable of providing policy-makers with useful information. To do this, the framework could be validated by back-testing it against well-known historical episodes of financial instability, and comparing the predicted outcomes against the actual historical outcome. More ambitious validation exercises would involve changing some of the key inputs or parameters to measure the model's sensitivity and even challenging the output of this framework against alternative frameworks developed by other international institutions.

Work that has been carried out so far by the ECB on euro area macro stress testing has focused on the first three of the five steps outlined above.<sup>3</sup> It has built upon a modelling approach initially pioneered by the Oesterreichische Nationalbank, the Sveriges Riksbank and the IMF.<sup>4</sup> The main aim of the modelling approach is to quantify the first-round effects of macroeconomic shocks on banks balance sheets by linking a macroeconomic model with a credit risk model. In particular, this involves using a global vector autoregression (GVAR) macroeconomic model and an additional satellite model to generate shocks to corporate sector default probabilities (i.e. step 2 described above). These default probabilities are then fed into a modified version of a credit risk model (CR+). Given that the ECB only has access to publicly available data from banks through their quarterly and annual reports,

3 See, in particular, ECB (2007a) and ECB (2007b).

4 See, for instance, Sveriges Riksbank (2006) and Avesani et al (2006).

and no rating transition information on individual bank obligors within loan portfolios, the CreditRisk+™ model has an obvious appeal compared to some migration-based models. Additional inputs are provided by using aggregated loan exposures from banks' annual reports, combined with loss given default (LGD) and various sector default probability assumptions. The output from this step, which is step 3 described above, comprises loss distributions for each bank's credit risk at a given confidence interval.

VARs combined with measures of expected default have been used in other studies for assessing the impact of macroeconomic shocks on default frequencies. For example, Alves (2005) and Shahnazarian and Åsberg-Sommer (2007) combined macroeconomic VAR models and Moody's KMV expected default frequency (EDF) data, as well as other variables, into a co-integrated VAR model to analyse the interaction between EDFs and macroeconomic developments.<sup>5</sup> As an extension to the traditional VAR analysis, GVAR models take into account a large number of linkages across macroeconomic and financial variables. GVAR models consist of a set of individual VAR models for all countries included in the system. Each country is assigned its own set of "foreign" variables, depending on its own trade links. These country-specific foreign variables can be constructed using data on trade flows between the countries/regions. By providing a framework which is capable of accounting for both trade and financial transmission channels, the GVAR model is particularly suitable for analysing the transmission of real and financial shocks across countries and regions.<sup>6</sup>

By way of illustration, it is useful to show how the ECB approach, so far developed, has been used for macro stress testing. In this context, the GVAR model of Dees et al. (2007) can be linked to euro area corporate sector EDFs by using a satellite equation which, in effect, isolates the EDFs for various corporate sectors from the system of equations.<sup>7</sup> In this model, the conditioning variables are the macroeconomic risk factor changes that describe a particular macro scenario generated by the GVAR model. In the estimation, the GVAR framework is treated as an exogenous "state of the world" system within which the co-integration relationships are well established. The explanatory variables for the EDFs in the satellite model come from the GVAR model and are treated in first differences. In the satellite model, the left-hand side denotes the (logit transformed) EDF,  $\alpha$  and  $\beta$  denote the parameters, and  $GDP_t$ ,  $CPI_t$ ,  $EQ_t$ ,  $EP_t$  and  $IR_t$  stand for euro area real GDP, equity prices, the real euro/US dollar exchange rate, the short-term interest rate and consumer price inflation (CPI), respectively.

<sup>5</sup> See Alves (2005) who analyses corporate sector EDFs in a co-integrated macroeconomic model for the euro area; Aspachs et al (2006), who consider the links between banks' equity prices and default probabilities and output in the UK; and Shahnazarian and Åsberg-Sommer (2007), who find evidence of a long-term relationship between EDFs and macroeconomic variables in Sweden.

<sup>6</sup> For a full description of the model and data, see Dees et al (2007).

<sup>7</sup> See ECB (2007a) for a more complete description.

All variables are extracted from the euro area model of the GVAR:<sup>8</sup>

$$EDF = \alpha + \beta_1 \Delta GDP_t + \beta_2 \Delta CPI_t \\ + \beta_3 \Delta EQ_t + \beta_4 \Delta EP_t + \beta_5 \Delta IR_t$$

Once estimated, the satellite model is integrated into the GVAR model to form the Satellite GVAR model.

The second step is to use a credit risk model, in this case the CreditRisk+™ model, which calculates the losses over a fixed horizon for a given confidence interval.<sup>9</sup> The CreditRisk+™ developed by Credit Suisse Financial Products (CSFP) uses an actuarial approach, and purely focuses on default. In this model, default rates are not measured in absolute levels – such as 0.25% for a triple B-rated issuer – but are treated as continuous random variables. Given that most banks have large numbers of borrowers, some of these borrowers' default probabilities may be correlated. Moreover, since borrowers may be concentrated in certain economic sectors, it makes sense for a bank to take these factors into account when assessing the overall level of credit risk or potential losses in its loan portfolio.

In CreditRisk+™, default correlations are not modelled with indicators for regional economic strength or industry-specific weakness, but with estimates of the volatility of the default rate. These estimates are produced by measuring the standard deviation of the default rate, and are designed to depict the uncertainty that observed default rates for credit ratings vary over time. This feature allows a better capturing of the effect of default correlations, and produces a long tail in the portfolio loss distribution because default correlations induced by external factors are difficult to observe and are unstable over time. The CreditRisk+™ model allows exposures to be allocated to industrial or geographical sectors as well as over varying default horizons. As inputs, data similar to those required by Basel II are used, while the effects of concentration are incorporated as credit risk drivers. The main advantage of this model is that it requires a relatively limited amount of data – an important consideration when using publicly available information.

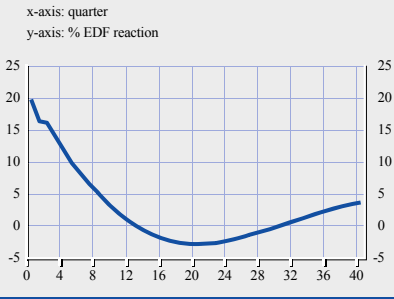
Various inputs are required for estimating portfolio credit risk models – including historical exposure data, default rates and their volatilities as well as recovery rates. This sample consists of data for the period 2003-2005 for 12 EU LCBGs drawn from their consolidated annual reports. While the data could be expected to refer in general to similar types of lending, these data are generally not harmonised as each bank has its own definition of various types of lending. Therefore, they were mapped to economic sectors to make the data comparable with the KMV data. A second necessary input is the set of default rates for the various economic sectors and their volatilities, as provided by Moody's KMV. Time series observations of default probabilities

<sup>8</sup> While the euro area block of the GVAR model is represented by six macroeconomic and financial time series (together with oil prices as a common variable to all economies), it was found preferable to restrict the number of variables to five to avoid estimating too many parameters. It is important to note, however, that although a factor is excluded from the satellite model, the effect of that particular factor is still represented through the impulse responses. For example, the effect of an oil price shock is transmitted to interest rates, GDP and consumer prices even if the oil price series is not explicitly included in the satellite equation.

<sup>9</sup> See ECB (2007b) for a more complete description.

**Chart 2 Impact on aggregate EDF of a negative real GDP shock**

(3 standard deviation shock)



Source: ECB calculations.

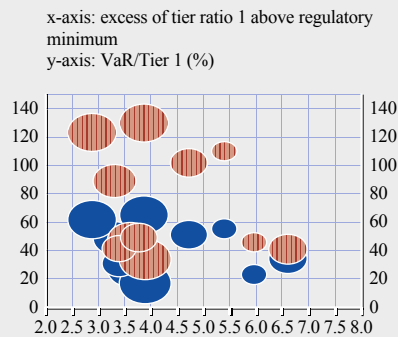
probabilities of the lower and higher credit quality portions of the portfolio were also adjusted to reflect differing credit qualities. The LGD values from LCBGs' annual reports were used when available. However, most institutions in the sample failed to publish suitable information. Therefore, PDs and LGDs based on the Basel II Capital Accord were used, taking into account the experience of practitioners in commercial banks. In addition, other studies were used as well due to the unavailability of recovery rates for each exposure type. As the majority of LGDs used for this stress test can be classified as stressed or "economic downturn" LGDs according to the fifth Basel II Quantitative Impact Study, the loss distributions for each bank's portfolio may be more extreme – implying higher VaR estimates – than those obtained using through-the-cycle LGDs.

One of the benefits of the VAR approach is that it makes it relatively straightforward to evaluate the impact of shocks to a variable on other variables, by picking up the dynamics of the model. For example, Chart 2 below shows how a 3 standard deviation shock to euro area real GDP impacts on the aggregate EDF for all corporate sectors. The shocked EDF values for a range of sub-sectors are used to shock the default probabilities for corporates and financial institutions, and the aggregate change is used to artificially shock the default probabilities for the household sector. It can be seen that the shock increases the EDF before dying out after 12 quarters. The impact of this extreme scenario is more pronounced for some banks in the sample, pushing their credit VaR measures to over 100% of their Tier 1 capital (see Chart 3).

for households were not available. In this case, default probabilities were used based on estimates of others – including estimates of the Basel Committee and individual banks' own estimates of probabilities of default for the household sector.

Following Shahnazarian and Åsberg-Sommer (2007), the portfolio was expanded in order to make it more granular by assuming 80% of the portfolio was of standard credit quality, with the remaining 20% of the portfolio split equally between higher and lower credit quality segments. The default

**Chart 3 Impact on credit risk of euro area large and complex banking groups**



Source: ECB calculations.

Notes: The size of the circles is proportional to the size of risk-weighted assets for individual banks in 2005. The green circles indicate the risk assessment before the shock and the yellow ones indicate the risk assessment after the shock.

### 3 PRACTICAL CHALLENGES FOR EU-WIDE STRESS TESTING

The work carried out so far by the ECB in the area of macro stress testing indicates that much is possible even when only publicly available data can be accessed by the practitioner. However, the work also serves to illustrate a number of practical challenges, many of which are common to other central banks where macro stress-testing frameworks are being built. These challenges centre around three broad areas, namely methodological issues, data and evolving financial systems.

Beginning with methodological issues, many of the challenges facing EU-wide macro stress testing are common to the frameworks being employed at the national level. In particular, an area where much progress needs to be made is the incorporation of second-round or feedback effects – step 5 of the ideal outlined in Section 3. As discussed in Fell and Schinasi (2005), if insufficient account of macro-financial interaction is taken, then it is probable that the overall impact of adverse events on the financial system will be underestimated. Moreover, it may not even be possible to gauge whether a particular stress scenario would warrant remedial action by policy-makers. The same can be said if the potential for contagion is not adequately modelled within a macro stress test since such effects are likely to have an important bearing on the second-round macro effects. This could be the case not only if contagion results in domino effects and bank failures but also if they result in higher funding costs in interbank markets which are subsequently passed on to non-financial sector borrowers. Proper assessment of this particular risk hinges crucially on having good information on cross-exposures between institutions that are active in the interbank markets. Other areas where methodological advances in macro stress testing could be made include broadening the scope of the quantitative framework to include non-bank financial institutions and conducting stress-testing exercises over several horizons.

As regards data issues, the ECB does not have access to supervisory data on individual euro area LCBGs and so it must depend on publicly available data. This is a challenge which is common to central banks that do not have supervisory responsibilities. While it often reflects issues of confidentiality, it is a significant drawback not least because experience has shown that the most progress in developing macro stress-testing frameworks has been made in central banks where stress tests can draw upon supervisory information. Apart from this, a comprehensive modelling framework of the euro area financial system has heavy data requirements, including sufficiently long runs of comparable data across countries for key macro-financial variables such as non-performing loans or loan impairment data for banking systems. To the extent that these data have been collected across euro area countries, and often they are not, they frequently lack comparability, making the building of euro area aggregates over sufficiently long time spans to estimate behavioural relations particularly challenging. An additional challenge is the paucity of micro data covering households and firms, which is essential for assessing the cross-sectional distribution of credit risk. Even if this type of data is collected, the collection frequency is often very low – such as every three years – and may not adequately cover the financial assets

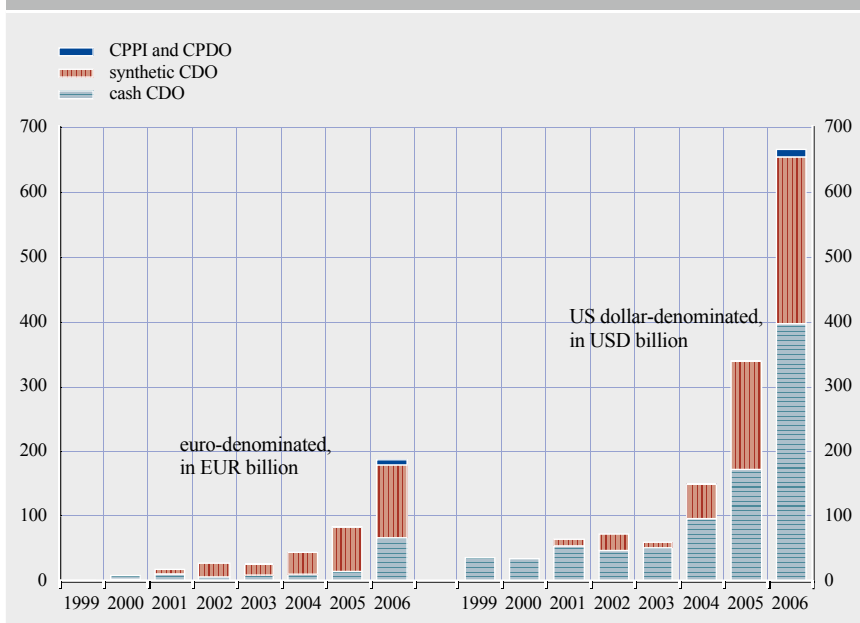
and liabilities of these sectors. Finally, publicly available micro data for banks, while having better coverage than such data for the non-financial sectors, often does not satisfy the requirements of practical macro stress testing.

The evolution of financial systems also poses challenges for macro stress testing. Changes in the type and relative importance of different participants in the system, changes in the traditional business models adopted by different participants as well as changes in the sources of risks are all making it more difficult to quantitatively assess the resilience of the financial system to adverse events. Concerning participants, consolidation within the EU financial sector is creating larger financial institutions that are operating in several member states simultaneously. While there is some evidence to suggest that larger institutions may be better diversified, thus increasing their resilience to shock, the growth in size may also increase operational risks due to the complexity involved in running pan-European or global banking groups (see ECB (2007c)). Outside of the banking sector, the emergence and growth of new market participants, such as hedge funds and other pools of private capital, may be creating systemically relevant institutions which are not part of the regulated banking system. This means that macro stress-testing frameworks that focus only on the banking sector may be missing increasingly important sources of risk.

As for the traditional business models adopted by different participants, the shift from the traditional “buy and hold” banking business model towards widespread adoption of the “originate to distribute” model is entailing a shifting of credit risk off-balance sheet or the transfer of credit risk to other parts of the financial system. This process of repackaging and wider dispersal of credit risk through the financial system, evidenced for instance by the surge of issuance of structured credit products (see Chart 4), has facilitated a lowering of risk concentrations among individual institutions. However, it has also made it more difficult to isolate where risks are located and to assess how well they are being managed – especially when they have moved to more lightly regulated financial institutions. From a broader financial stability perspective, the originate to distribute model is vulnerable to impairment in the functioning of the distribution leg of the model. For instance, if it becomes difficult to issue structured credit products to investors, this can cause problems with the origination leg, thus threatening a credit crunch in the wider economy. At present, most macro stress-testing frameworks are incapable of taking such vulnerabilities or shock transmission channels into account. An additional challenge for macro stress testing of the spreading of risk across the financial system is that many euro area and EU large and complex banking groups are actively involved in various ways in the credit risk transfer markets. However, it is often difficult on the basis of the information they disclose to make accurate inferences on how they would be affected in the event of a disruption in these markets.

Finally, with financial systems becoming more market-based or more market-sensitive, this can also pose challenges for macro stress testing. Almost a decade ago, against a background of significant growth in euro area securities markets, Davis (2000) pointed to the need for greater focus in the euro area on risks posed by asset market volatility, collapses in market liquidity and challenges

**Chart 4 Issuance of euro and US dollar-denominated structured credit products**



Source: ECB calculations based on various sources.

to securities issuance. Moreover, as credit risk is being increasingly traded in credit risk transfer markets, this calls for a greater focus on the interaction between credit and market risk. Additionally, in this environment, macro stress-testing frameworks will need to take better account of counterparty and market liquidity risks.

#### 4 CONCLUDING REMARKS

The case for carrying out EU-wide macro stress-testing exercises essentially rests on the fact that the process of financial integration, particularly intense within the euro area, is leading to a greater degree of inter-connectedness between national financial systems. To the extent that this is leading to greater risks of contagion, this means that the implications of many of the stress scenarios that are routinely being tested at the national level cannot be fully and comprehensively assessed without taking account of the implications for neighbouring financial systems, especially the possibility of spill-over and externalities. While scope remains for methodological progress to be made across several dimensions, the greatest challenge facing EU-wide stress testing is data. This means that to build a framework that is capable of quantitatively assessing the relevance of different sources of risk and vulnerability for financial stability, investment needs to be made in building micro data sets. In addition, efforts need to be made to overcome institutional barriers to information sharing, especially given the way in which financial systems are evolving through consolidation and the growing pervasiveness of the originate to distribute model.



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## GETTING END-GAME EXPECTATIONS RIGHT

PETER NYBERG<sup>1</sup>

One of the major problems in crisis simulation is the existence of a definite end date known by the participants. While necessary for a number of practical reasons, the end date may affect participants' expectations and thus actions during the simulation itself, in particular if the general objective of the simulation is also known (testing liquidity or solvency problems).

By definition, the artificiality of a simulation exercise can never be fully compensated for. In its most general form the worry that exercises are not "realistic enough" is therefore irrelevant. However, a number of things may be done to increase realism in an exercise without necessarily having to wait for the real thing.

### THE EU-WIDE CRISIS EXERCISE IN 2005 – SOME REMARKS

In April 2005, the EBC hosted a EU-wide crisis management exercise with participants from virtually all EU banking supervisory bodies, central banks and ministries of finance. Working out the scenario was the responsibility of a working group which I had the honour to chair and the scenario was concretely put together by an operational subgroup headed by Mr Andrew Gracie of the Bank of England. Because the same exercise was conducted in three different "streams" it was possible to compare how differences in participants affected outcomes. Since the exercise is, thus far, probably the largest of its kind in many ways, it may be interesting to look at what it taught us in terms of organising such events.

First, cooperation between the participants was surprisingly good. One major reason could have been that they all, as previously agreed after some heated debates, represented imaginary authorities. Therefore, there was no historical, legal or institutional ballast and, in addition, no budgetary constraints. Despite this marked lack of realism, participants nevertheless operated in a reasonably realistic manner and tended to reach workable compromises.

Second, there was a very great variation in the assessment and resolution in various parts of the exercise. There was no common way of assessing which disturbance could be classified as "systematic". There were few clear procedures used to address common problems. Crisis management and resolution thus proceeded quite differently in each stream, highlighting the obvious fact that when inputs vary, so do outputs.

Third, ongoing and reliable monitoring of what was going on proved to be vital to the post-exercise evaluation. Within hours after the exercise finished, participants

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held widely different views on what actually had happened in their respective streams and even “countries”. However, since records were available it proved quite feasible for the working group to draw clear conclusions.

Fourth, it appeared that participants fairly early in the exercise formed a general view on the future type of problems to be put before them. As the exercise proceeded, expectations of a solvency crisis, its timing and an accompanying end game became quite prevalent. There appeared to be (fulfilled) expectations of a structured scenario, where each type of authority would have its moment of glory and otherwise play a supporting role.

## **REAL FINANCIAL CRISES – SOME FEATURES**

By contrast, what could one expect to face in a real crisis as compared with an exercise? Based on some personal experience, there are, indeed major differences.

First, a real crisis arrives as a surprise. Almost by definition, serious problems arise at a time when the situation, at least the authorities’ view of it, appears to be fine. Aberrations that have been dismissed for years with variations of “it is different this time” suddenly reveal themselves as problems. The problems are initially considered minor, later temporary and thereafter manageable. Only well into the crisis does there tend to develop an appreciation of the true depth and nature of the disturbance. Asset prices and confidence tend to change rapidly and by more than believed warranted by fundamentals. It becomes difficult for authorities to judge the relevance of information received. In short, uncertainty tends to reign regarding the nature and path of the crisis, and only ex post will a reliable assessment be possible.

Second, the actions of the authorities will strongly affect the path of a real crisis. Even at an early stage the crisis will feed off and influence public confidence. Anything the authorities do or fail to do is likely to affect confidence in some manner, particularly in a world of active public media. Clear, consistent and specific communication with the public is obviously important to avoid sudden loss of confidence in the authorities’ ability to contain the crisis. Of particular importance, but even more difficult, is avoid reassuring statements that could prove disastrously inaccurate at a later stage. All this indicates that it is absolutely vital for all authorities involved to agree, at a very early stage, on the common message to deliver at any one point in time.

Third, political and civil service careers are on the line in a real crisis. Since the values at risk are so large, the problems so intricate and the information so difficult to assess, authorities tend to cooperate more easily than in normal times (at least in my own experience). They also tend to be less brave. In short, authorities do not wish to carry such responsibilities alone. Furthermore, some decisions that are very difficult for civil servants may have to be taken. Administrative procedures may have to be sidestepped. Situations may require that officials take legal risks to contain problems. Politicians both in and out of

government need to be mobilised. All such actions are more difficult or even impossible if authorities do not use a single (analytical) language.

Fourth, it remains unclear for quite some time at what point a real-life crisis is over. Even then, the acute phase of the crisis is followed by the aftermath in which politicians and the public take stock of what they have lost. By this time, sacrificial lambs have already left the scene and at least two issues dominate. If joint costs have been high, their distribution and payment is an issue for debate and lobbying. Bad assets, if accumulated, have to be disposed of, somehow. Also, everybody involved will have learnt his or her own lesson, implying that the financial market place may be a very different place from before. It is partly the responsibility of the authorities to make sure that this temporary change, quite usually for the better, among market participants and institutions remains permanent.

## CONCLUSIONS

Exercises are, by necessity, much more orderly than real-life crises. Importantly, they also tend to concentrate participants' minds on a supposedly preordained path with a defined end point and some acceptable resolution alternatives. Particularly the volatile and vital nature of public communication tends, for practical reasons, to be significantly downplayed in exercises. Furthermore, the exercises never really assess what has changed as a result of the crisis; what to do with bad assets, how economic policy should adapt, the results of changed market expectations, etc.

While being the only viable way of preparing for the management of a real crisis, exercises nevertheless need to and can be developed to avoid some of these features. There are, in my opinion, some obvious improvements that could be made fairly easily. I list them in subjective order of priority.

Most obviously, participation should always be comprehensive. All relevant authorities should always be potentially involved. This would mean the end of the "just for us" exercises where already the participation loudly announces what kind of problems are going to be addressed. Those not invited to participate or opposed to participating should at least be played.

Timing should be very flexible and high-level participants should accept that they need to adapt to that. This may seem excessive in normal times, but may seem less onerous if considered a reasonable preparation for a career make-or-break contingency. Ideally, both the start and the end points of an exercise should be left open and participation should be mandatory for responsible officials of a reasonably high level. At the very least, more time should be reserved for an exercise than will actually be required.

Authorities should stay at home and play themselves. Institutional, legal and political issues in different countries are features important in the EU reality and they should play a role in the exercise as well. This will uncover unsuspected and unexpected legal peculiarities that affect authorities' ability to act. Authorities

should be free to meet in whatever forum they wish, but need to be continually monitored for accurate reporting.

Finally, the dynamic elements of the scenarios should be strengthened. For instance, confused or incoherent communication in the exercise should affect markets by way of shaken confidence. Insufficient agreement between authorities in different countries, resulting in uncoordinated action, should result in penalties by way of market reactions or political ostracism. This requires a lot of outside players and, consequently, much more work for the organisers and planners of the exercise. Of course, one could also consider the option of keeping the planning process to a minimum and running an exercise essentially off the cuff. In real life, crises do not have a detailed script except ex post – could our exercises maybe do with less ex ante as well?

If it were possible to carry through at least a few of the above suggestions, such exercises could prove even more useful than today. This is because each suggestion would, in my view, tend to reduce the risk of having an exercise inadvertently structured in a way that creates the illusion that in a crisis situation, the end game is known early on. In reality, of course, the end game is always in doubt.

# EU FINANCIAL CRISIS MANAGEMENT ARRANGEMENTS FROM A CENTRAL BANKING PERSPECTIVE AND THE EUROSISTEM FINANCIAL CRISIS SIMULATION EXERCISE

PANAGIOTIS STROUZAS<sup>1</sup>

## INTRODUCTION

The increasing degree of financial integration in the EU, particularly in the euro area following the introduction of the euro on 1 January 1999, at the level of markets and market infrastructures, the growing number of large banking and other financial groups and the diversification of financial activities have significantly improved the liquidity and efficiency of financial markets.<sup>2</sup> The Eurosystem has a keen interest in financial integration as it is of key importance for the smooth and effective implementation of the monetary policy throughout the euro area. Also, financial integration contributes to the stability of the financial system and thus is of high relevance to the Eurosystem's task of safeguarding financial stability. Furthermore, financial integration is fundamental for the Eurosystem's task of promoting the smooth operation of payment systems. At the same time, in a more integrated financial system the likelihood that financial market disturbances propagate across borders, potentially hindering the smooth functioning of financial systems in more than one Member State, may increase.

The paper is structured as follows: Section 1 gives a brief overview of the EU financial crisis management framework. Section 2 deals with the specific Eurosystem arrangements in the area of crisis management. Section 3 provides an insight into the Eurosystem financial simulation exercises, including their main features and the outcome.

## I THE EU FINANCIAL CRISIS MANAGEMENT ARRANGEMENTS

As a response to the challenges stemming from the enhanced pace of financial integration and the growing number of cross-border banking and other financial groups, arrangements for managing financial crises at the EU level between the authorities responsible for safeguarding financial stability have been enhanced over the past years.

The enhancements, which are of relevance and importance for the Eurosystem, include legislative initiatives, the adoption of non-binding voluntary agreements on cooperation between authorities (Memoranda of Understanding - MoUs), and the improvement of the practical arrangements (e.g. reports including

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<sup>2</sup> "Financial integration in Europe", ECB, March 2007.

recommendations endorsed by the competent EU committees) for managing a cross-border financial crisis situation. Also, financial crisis simulation exercises have been conducted at Eurosystem and EU level with a view to testing the efficacy of the present arrangements for financial crisis management.<sup>3</sup>

The table below provides a brief overview of the arrangements for financial crisis management:

	Authorities responsible for financial stability		
	Central banks	Banking supervisors	Finance ministries
Regulatory arrangements	Capital Requirements Directive (CRD)		
	Financial Conglomerates Directive (FCD)*		
Voluntary cooperation arrangements	2005 MoU on crisis management		
	2003 MoU on crisis management		
	2001 MoU on payment systems		
	Regional MoUs **		
	National MoUs **		
Central banking arrangements	Eurosystem		
EU committees	BSC and CEBS		FSC
	EFC		EFC
Tools for practical implementation	Financial crisis simulation exercises		
	Development of practices by EU committees		

\* The exchange of information between supervisory authorities and finance ministries regarding the regulated entities of a financial conglomerate is subject to the sectoral rules in EU legislation for credit institutions, insurance companies and securities firms.

\*\* Regional and national memoranda of understanding (MoUs) may involve different sets of authorities, including either or both central banks and banking supervisors. In some Member States, finance ministries are also party to MoUs.

Source: ECB Monthly Bulletin article entitled “The EU arrangements for financial crisis management”, February 2007.

At EU level, the following enhancements to financial crisis management may be mentioned:

## 1.1 REGULATORY ARRANGEMENTS

Provisions for enhancing cooperation and information sharing between competent authorities under normal conditions and in emergency situations are set out in the Capital Requirements Directive (CRD)<sup>4</sup> and the Financial Conglomerates Directive (FCD).<sup>5</sup>

<sup>3</sup> Exercises have been conducted also at national and regional level and are not covered in this paper.

<sup>4</sup> The CRD encompassing Directive 2006/48/EC and Directive 2006/49/EC was published in the Journal of the European Union on 30 June 2006 (L 177/1-200).

<sup>5</sup> Directive 2002/87/EC of the European Parliament and of the Council of 16 December 2002 on the supplementary supervision of credit institutions, insurance undertakings and investment firms in a financial conglomerate, amending Council Directives 73/239/EEC, 79/267/EEC, 92/49/EEC, 92/96/EEC, 93/6/EEC and 93/22/EEC, and Directives 98/78/EC and 2000/12/EC of the European Parliament and of the Council.



The CRD sets out requirements (in Articles 129 to 132) for cooperation and information exchange between the authority responsible for the consolidated supervision of the banking group and the other competent supervisory authorities in going concern and emergency situations. Also, Article 130 of the CRD provides for the competent authority responsible for supervision on a consolidated basis to alert as soon as practicable other competent authorities (central banks, finance ministries) in cases where an emergency situation arises within a banking group which potentially jeopardises the stability of the financial system in any of the Member States where entities of the group have been authorised.

It is important to note some recent initiatives under way with a view to assessing possible enhancements of the current regulatory framework. In this context, at its October 2007 meeting, the ECOFIN Council endorsed conclusions on EU arrangements for financial stability whereby, inter alia, the Commission is invited to propose ways to clarify cooperation obligations, including possible amendments to EU banking legislation. In that context, the Commission has been asked to clarify the existing obligations for supervisory authorities, central banks and finance ministers to exchange information and cooperate in a crisis situation, to increase the information rights and involvement of host countries and clarify the role of consolidating supervisors and to facilitate the timely involvement of relevant parties in a crisis situation and examine whether legislative initiatives are needed, including the reinforcement of legal requirements for supervisory collaboration and information sharing. A proposal by the Commission is envisaged by end-2008 and adoption by the European Parliament and the Council by end-2009.

The FCD contains a number of provisions of relevance to crisis management. In particular, the tasks to be carried out by the coordinating supervisor<sup>6</sup> include the coordination of the gathering and dissemination of relevant or essential information in normal times and in emergency situations (Article 11). Furthermore, as in the CRD provisions mentioned above, the authorities responsible for the supervision of regulated entities in a financial conglomerate have to cooperate closely with one another (Article 12). This entails, among other things: (i) the gathering and the exchange of information with regard to adverse developments in regulated entities or in other entities of a financial conglomerate which could seriously affect the regulated entities; and (ii) the sharing of information with central banks, the European System of Central Banks (ESCB) and the European Central Bank as may be needed for the performance of their respective tasks.

## **1.2 MOUS ON CRISIS MANAGEMENT:**

There are currently two EU-wide MoUs on crisis management and one on payment systems oversight which includes provisions of relevance to crisis management.

<sup>6</sup> The FCD provides for the identification of the coordinating supervisor, which coordinates the supplementary supervision of the financial conglomerate and manages the information sharing and cooperation among the supervisors of the regulated entities in the financial conglomerate.

The first MoU on crisis management between EU banking supervisors and central banks was signed in 2003.<sup>7</sup> It contains high-level principles for cooperation in relation to crises with a potential cross-border impact. In particular, appropriate information-sharing procedures could promote timely interaction between relevant authorities.

The second MoU on crisis management between EU banking supervisors, central banks and finance ministers was agreed in 2005.<sup>8</sup> It aims at supporting and promoting cooperation in crisis situations between the aforementioned authorities.

Also, an MoU between the EU banking supervisors and central banks was signed in 2001,<sup>9</sup> aimed at promoting cooperation and information sharing between central banks in their capacity as payment systems overseers and banking supervisors in relation to large-value interbank funds transfer systems, including in crisis situations.

The aforementioned MoUs are designed to provide basic principles and practical arrangements for cross-border cooperation and information sharing between authorities in the event of disturbances which may give rise to cross-border systemic implications. In particular, the envisaged procedures will support the sharing of information on emerging financial disturbances, the assessment of potential systemic implications, and the coordination, if deemed necessary, of policy actions between central banks, as well as between central banks and other authorities.

*Recent developments:* The ECOFIN Council at its 9 October 2007 meeting endorsed Council conclusions on enhancing EU arrangements for financial stability. In that context, the ECOFIN Council invited the Economic and Financial Committee to prepare, for spring 2008, an extended MoU that would build on the 2005 MoU on crisis management between heads of competent banking supervisory authorities, central bank governors and finance ministers in the EU. The MoU will include: (a) common principles developed by a specific Ad Hoc Working Group on Financial Stability Arrangements; (b) a common analytical framework for the assessment of the systemic implications of a potential crisis with the aim of ensuring common terminology and facilitating decision making among authorities in a crisis situation; and (c) common practical guidelines for crisis management to reflect steps and procedures that need to be taken and followed in a cross-border crisis situation. In addition, authorities in different Member States that share financial stability concerns are encouraged to develop voluntary cooperation agreements consistent with the aforementioned extended MoU.

### 1.3 PRACTICAL ARRANGEMENTS

Practical arrangements at EU level are further enhanced by central banks and supervisory authorities, mainly as a response to the outcome of the financial crisis simulation exercises. The aim is to intensify and improve cross-border cooperation and information sharing to respond to a financial crisis.

<sup>7</sup> Available at: [http://www.ecb.int/press/pr/date/2003/html/pr030310\\_3.en.html](http://www.ecb.int/press/pr/date/2003/html/pr030310_3.en.html).

<sup>8</sup> Available at: [http://www.ecb.int/press/pr/date/2005/html/pr050518\\_1.en.html](http://www.ecb.int/press/pr/date/2005/html/pr050518_1.en.html).

<sup>9</sup> Available at: <http://www.ecb.int/press/pr/date/2001/html/pr010402.en.html>.

In this context, two initiatives may deserve to be mentioned:

*First*, the Banking Supervision Committee (BSC) and the Committee of European Banking Supervisors (CEBS) have jointly developed recommendations to assist EU central banks and banking supervisors in making their own preparations for and responding to cross-border crises. The recommendations build upon the aforementioned EU MoUs on crisis management. Their underpinning principle is that the primary responsibility for the management of the crisis remains with the credit institution and its shareholders. The recommendations, inter alia, offer practical considerations for central banks and banking supervisors on how to enhance preparedness and contingency planning in case of a financial crisis. As a practical tool the report recommends relying on networks composed of relevant home-host central banks and banking supervisors. A brief overview of these recommendations can be found in the CEBS Annual Report 2006 (Section 2.4.4. on crisis management).<sup>10</sup>

*Second*, as a response to the Economic and Finance Committee's financial simulation exercise, a report is under preparation by the BSC in cooperation with CEBS on developing an analytical framework for assessing systemic implications of a financial crisis. The framework, due in autumn this year, would aim at serving as a "common language" between authorities for assessing the systemic impact of a cross-border financial crisis on their domestic financial system.

#### **1.4 FINANCIAL SIMULATION EXERCISES**

At the EU level, two financial crisis simulation exercises have been organised to test the effectiveness of the overall financial stability arrangements.

*The first exercise* took place in September 2003 under the aegis of the BSC (including the then EU15 banking supervisors and central banks, i.e. 31 participants, at the premises of Sveriges Riksbank) and was aimed at testing the provisions of the 2003 MoU on crisis management. The exercise provided useful insights into the different aspects of cross-border cooperation between banking supervisors and NCBs in the event of a systemic financial crisis.

*The second EU-wide financial crisis management simulation exercise* took place in April 2006 at the premises of the ECB under the aegis of the EFC and was aimed at testing the 2005 MoU on crisis management between central banks, supervisors and finance ministers. The exercise was centralised (EU25 banking supervisors, central banks and finance ministries – 76 participants). On the basis of the findings of the exercise, the ECOFIN Council agreed on further work to enhance cooperation among Member State authorities responsible for financial market stability.

*The two Eurosystem financial crisis simulation exercises are dealt with in Section 3.*

<sup>10</sup> Available at: [http://www.c-ebs.org/documents/AnnualReport2006\\_000.pdf](http://www.c-ebs.org/documents/AnnualReport2006_000.pdf)

## 2 THE EUROSISTEM ARRANGEMENTS FOR CRISIS MANAGEMENT

Within the Eurosystem, the necessary mechanisms are in place to tackle a financial crisis, if and when one occurs.

*First*, the Eurosystem has set up the appropriate operational procedures to contain, within the scope of its functions, the potential systemic effects of a financial disturbance. This includes procedures for the conduct of monetary policy operations, the operation of TARGET, the oversight of payment systems (also considering potential consequences for the functioning of market infrastructures), the conduct of foreign exchange operations (e.g. with foreign central banks), and the safeguarding of financial stability. For the latter, Article 105(5) of the Treaty establishing the European Community requires the Eurosystem to contribute to the smooth conduct of policies pursued by the competent authorities in the areas of prudential supervision and financial stability, which may include the field of crisis management.

The Eurosystem has taken action using some of its tools. More specifically, following the events of 11 September 2001, a swap was conducted between the ECB and the Federal Reserve, which supported financial markets in terms of dollar liquidity. This agreement was communicated via a press release<sup>11</sup>. Also, the Eurosystem issued communications<sup>12, 13</sup> declaring that it would support the normal functioning of the markets and it would provide liquidity, if need be. The Eurosystem also confirmed the smooth functioning of the TARGET system. These communications aimed at establishing a certain degree of market confidence in the stability of the financial system.

*Second*, the Eurosystem/ESCB committees, established to provide assistance and advice to the Eurosystem's decision-making bodies, also provide the necessary technical infrastructure for managing the implications of a potential disturbance across the euro area.<sup>14</sup>

*Third*, the Eurosystem has procedures in place regarding the provision of emergency liquidity assistance (ELA) by the individual Eurosystem NCBs. The main guiding principle is that the competent NCB takes the decision to grant ELA to an institution operating in its jurisdiction. This would take place under the responsibility and at the cost of the NCB in question. The Eurosystem procedures ensure an adequate flow of information so that any potential liquidity impact can be managed in a manner consistent with the maintenance of the appropriate single monetary policy stance.<sup>15</sup>

<sup>11</sup> Available at: [http://www.ecb.int/press/pr/date/2001/html/pr010913\\_1.en.html](http://www.ecb.int/press/pr/date/2001/html/pr010913_1.en.html)

<sup>12</sup> Available at: <http://www.ecb.int/press/pr/date/2001/html/pr010911.en.html>

<sup>13</sup> Available at: <http://www.ecb.int/press/pr/date/2001/html/pr010912.en.html>

<sup>14</sup> Among the committees assisting the ECB decision-making bodies in their work, the Banking Supervision Committee (BSC) of the ESCB, the Market Operations Committee (MOC) and the Payment and Settlement Systems Committee (PSSC) are those which could be most directly involved in financial crisis management.

<sup>15</sup> See ECB Annual Report 1999, page 98.

### 3 THE EUROSISTEM'S FINANCIAL CRISIS SIMULATION EXERCISES

In the context of the Eurosystem arrangements to safeguard financial stability, the Eurosystem central banks have carried out exercises to assess the ability of the Eurosystem to address effectively a complex financial crisis with the potential for systemic implications across several countries in the euro area.

*The first Eurosystem crisis management simulation exercise* took place in April 2005 (13 Eurosystem central banks – 65 participants) at the premises of the ECB.

*The second Eurosystem crisis management simulation exercise* was held in May 2006 in a decentralised fashion. 150 participants from the 13 Eurosystem central banks located at their respective central banks were involved in the exercise. Following the positive experience with the first Eurosystem stress-testing exercise, the overall objective of the second exercise was to achieve a more realistic environment in the crisis simulation.

#### 3.1 AIM OF THE EXERCISES

The exercises aimed specifically at testing the financial crisis management arrangements in place within the Eurosystem and identifying possible areas for enhancement. To this end, the objective of the exercises was to replicate, to the extent possible, crisis scenarios that would help national central banks understand how the arrangements assist in practice the management of a real-life crisis situation.

The Eurosystem simulation exercises involved all the relevant central banking functions, including the conduct of monetary policy, the operation of TARGET, the oversight of payment systems (also considering potential consequences for the functioning of other market infrastructures), and the safeguarding of financial stability. The performance of the Eurosystem functions under conditions of stress was tested focusing on the ability of the Eurosystem to address a succession of both general and idiosyncratic shocks and their impact on institutions, markets and market infrastructures, including payment and settlement systems.

#### 3.2 THE NATURE OF THE FINANCIAL CRISIS SCENARIOS

The financial crisis scenarios considered in the Eurosystem exercises acknowledged the high degree of financial integration within the euro area. Hence, the scenarios placed particular emphasis on the systemic interlinkages and channels for contagion, both on a national and cross-border basis. The aim was not to address current vulnerabilities or specific concerns regarding the resilience of the euro area's financial system to shocks, but to enhance understanding of how various shocks – of a global and/or specific nature – would propagate throughout the euro area's financial system. In this context, the scenarios were based on hypothetical institutions, which were designed to reflect the main features of European cross-border banking structures, interacting through the interbank market with domestic banking institutions.

As to the features of the Eurosystem simulation exercises, and in particular the second exercise, the following may be worth mentioning:

- The adoption of a decentralised logistical setting, according to which the decision-making bodies of the Eurosystem and managers and staff of the ECB and the twelve Eurosystem central banks participated in the exercise from their respective workplace. The communication during the exercise was based on the existing Eurosystem infrastructure, which includes dedicated teleconference systems, e-mail systems and other related facilities. The simulation was run through a website, which was developed specifically for the stress-testing exercise.
- The simulation was based on real-time financial market developments, which were disseminated to the participants in the exercise. The financial market indicators included money market rates, bond yields, credit default swap spreads, stock prices, implied stock market volatilities and exchange rate developments. The design of the second Eurosystem simulation exercise allowed for the indicators to be updated in real time, thus reflecting the decisions made by the participants throughout the exercise (e.g. money market rates reacted to communications and operations). In addition, although the simulation was not based on real data, the features of the banks, markets and market infrastructures mirrored real entities.
- The scenario put emphasis also on public communication during a financial crisis. The design of the simulation exercises rendered necessary the conduct of public communication at the national, bilateral and Eurosystem/EU levels.

### **3.3 OUTCOME OF THE EUROSYSTEM SIMULATION EXERCISES**

The simulation exercises provided reassurance regarding the preparedness of the Eurosystem to respond efficiently and effectively to a financial crisis situation with potential systemic implications across the euro area.

In that context, the following can be mentioned:

- overall the Eurosystem crisis management framework was assessed as effective and efficient.
- communication within the Eurosystem took place in an efficient manner, benefiting from the framework defined in internal operational procedures, the established communication infrastructure, as well as the EU-wide MoUs on financial crisis management.
- in a crisis situation the Eurosystem has a wealth of information potentially available for the assessment of systemic implications, notably stemming from the performance of the Eurosystem central banking functions
- the central banks of the Eurosystem took particular care in ensuring timely,

consistent and coordinated public communication.

Overall, the conduct of the exercises provided useful insights on the information flows, assessments and decision-making processes of the Eurosystem and thus of its involvement in dealing with potentially systemic events that affect the euro area's financial system. In addition, useful elements were drawn from the planning phase of the exercise, which allowed a better understanding of the transmission channels of liquidity shocks and subsequent spillovers across the euro area's financial system.

### **3.4 FUTURE INITIATIVES**

With a view to ensuring preparedness, the Eurosystem will continue to carry out simulation exercises to further test and, if need be, to enhance the effectiveness of its arrangements for financial stability in coping with potential shocks to the euro area financial system.

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## SPECIFIC CHALLENGES FOR THE EU AND THE EURO AREA

### COMMENTS BY JOHN BERRIGAN<sup>1</sup>

The challenges in safeguarding stability within a globalised financial system have been discussed at length in earlier sessions of the conference. The main conclusion reached was that growing interlinkages between national financial systems necessitate the introduction of a cross-border dimension in the conduct of crisis prevention, management and resolution. Introducing a cross-border dimension in these processes, in turn, raises issues relating to cooperation among relevant national authorities and the appropriate level at which actions should be taken. In this conference session, such issues are explored in the specific context of the EU financial integration process.

In general, the challenges in managing financial stability are similar at both the EU and global levels. An EU-specific dimension can be found, however, in the greater scale and urgency of such challenges due to the particular context in which financial integration is proceeding. EU Member States have set themselves the highly ambitious objective of creating a single or unified financial market. Meanwhile, for reasons entirely unrelated to financial integration, they have decided to retain segregated national tax bases. The result of these two decisions is an inconsistency between the incentives facing private-sector actors and public authorities within the financial integration process.

Several factors contribute to encouraging private sector actors to “think cross-border” in their financial activities within the EU. First, financial integration has been an explicit policy objective of the EU almost from the outset and certainly since the mid-1980s. In this way, integration is actively promoted and not just accommodated. Second, the introduction of the euro in 1999 eliminated currency risk on the bulk of cross-border financial flows within the EU. The euro also sent a powerful signal that the EU is serious about market integration in general and financial market integration in particular. Third, the implementation of the Financial Services Action Plan is progressively putting in place the main elements of a common regulatory framework for the EU financial system.

By contrast, public authorities have strong reasons to continue to “think national” in their financial sector activities. A set of cross-border rights and obligations have been established among these authorities, either by EU law or in the softer form of Memoranda of Understanding. However, these rights and obligations exist in the context of a decentralised fiscal policy framework, which is a fundamental feature of the EU and, if anything, has been reinforced in the construction of Economic and Monetary Union. Of course, segregation of tax bases implied by this decentralised fiscal policy framework mean that the fiduciary responsibilities of national authorities in crisis management and resolution remain strongly rooted at the national level.

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An unfortunate – but understandable – outcome of this inconsistency in the incentives facing private sector actors and public authorities is a growing disconnection between financial market reality and arrangements for financial stability within the EU. This disconnection is set to widen further unless ambitious steps are taken to better align incentives. Otherwise, there is a risk that integration will result in EU financial markets that are more efficient in terms of their contribution to cost effectiveness and competition, but dangerously inefficient in terms of their contribution to instability. There are clear echoes of this theme of inconsistent incentives in the three presentations made in this session.

John Fell has reported on the impressive work of the Banking Supervisors Committee on EU-level macro-stress testing. He makes a convincing case for stress testing in general. He also makes a convincing case for stress testing at the supranational level in the EU, based on banks' exposure to common market risks and the increased interconnectedness of financial systems. In this context, the key question seems to be whether there is a need to pool information and present one centralised assessment of stability or whether one can rely on the considerable number of national financial stability assessments to adequately capture elements of cross-border risk. I suspect the answer is no. The degree of aggregation in the typical central bank financial stability report is already such that the all-important tail risks cannot be readily identified. Relying on some consolidation of many national financial stability reports would simply aggravate this problem at the EU level.

Needless to say, a centralised assessment of financial stability requires the transfer of data and the challenges identified by John Fell in the area of data provision raise some EU-specific issues. In particular, there is a need for clarity on the nature of legal and confidentiality constraints on the cross-border exchange of data among Member State authorities and between those authorities and the ECB. To the extent that such constraints exist, I suspect that the rationale for their existence can be traced back to the national fiduciary responsibility of Member State authorities.

Peter Nyberg has described the problems of cooperation among Member State authorities, which emerged in the April 2006 cross-border financial crisis simulation exercise. Many of these problems related to the very basic processes in crisis management, such as information sharing, decision-making, and even how to assess the systemic nature of a crisis. In listening to his presentation, several possible explanations for these problems came to mind. Perhaps they can be attributed to the specific design of the exercise (e.g. the use of multi-national teams) or they may simply reflect the EU's inexperience with such cross-border crisis simulations. On the other hand, it is difficult to dismiss the possibility that much of the uncertainty in cooperation and collective decision-making related to the implied distribution of fiscal costs arising from the simulated crisis. Once again, we find the national fiduciary responsibility of Member State authorities at the source of the problems.

Panagiotis Strouzas provided a more reassuring message in his presentation on the Eurosystem liquidity crisis simulation, even though decentralised

management of ELA within the Eurosystem is a unique challenge. Although central bank outsiders like me know next to nothing about the mysteries of ELA arrangements within the Eurosystem, it is possible to identify some factors contributing to this favourable result. In this respect, I would highlight the well-defined procedures within the Eurosystem and the strong co-ordination role of the ECB – two features that were patently absent in the crisis simulation exercise discussed by Peter. Nevertheless, even the Eurosystem exercise was not perfect. Panagiotis identified problems with collateral transfer and sovereign guarantees, which can again be traced to the national fiduciary responsibilities of Member State authorities.

In conclusion, these three excellent presentations provide clear evidence that the EU has major challenges in safeguarding stability within an integrated financial system. I suspect that these challenges cannot be traced only to technical aspects, but also reflect the inconsistent incentives facing private sector actors and public authorities in the financial integration process. While the private sector actively pursues profitable opportunities in cross-border activity, cooperation among Member State authorities is heavily conditioned by their national fiduciary responsibilities. If EU financial integration is to proceed on an efficient basis, it is essential to align incentives more closely. A prerequisite to achieve such alignment of incentives is through a political commitment to cross-border burden sharing – a subject that is far too complex and politically sensitive to discuss in this comment. Suffice to say that the issue of burden sharing cannot be taboo, if we are to make real progress in resolving the problems in safeguarding EU financial stability that have been highlighted in this session.



## **ANNEXES**

- CONTRIBUTORS**
- LIST OF PARTICIPANTS**

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