Introduction

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'Excuse me!
Ladies and gentlemen,
forgive me for appearing alone.
I am the Prologue'.

R. Leoncavallo, I Pagliacci, 1892

Stress tests are quantitative tools used by banking supervisors and central banks for assessing the soundness of financial systems in the event of extreme, but still plausible, shocks (macroeconomic stress tests). They are also an important management instrument for banks since they provide financial institutions with useful indications on the reliability of the internal systems designed for the measurement of risks (microeconomic or prudential stress tests). Under the new Basel Accord on banks' capital adequacy the presence of sound stress-testing methodologies is a prerequisite for the adoption of the advanced methods for the quantification of minimum capital requirements.

Until the first half of 2007, interest in stress-testing had been circumscribed to practitioners, i.e., risk managers, central bankers and financial supervisors. Since then, the global financial system has been hit by deep turbulences and all major economies have been affected by high volatility in financial markets, deterioration of the value of portfolios, widespread repricing of risk and severe liquidity drying up. It has been pointed out that the severity of the crisis has been largely due to its unexpected nature and that a more extensive and rigorous use of stress-testing methodologies would have probably helped to alleviate the intensity and repercussions of the turmoil. In such a context, stress tests have become a key issue in policy discussions and a regular subject for newspapers' columnists.

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Just some examples show the importance of these issues in such a debate.

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. (L. Papademos, Conference on 'Simulating financial instability: stress-testing and financial crisis simulation exercises', European Central Bank, Frankfurt am Main, 2007).

Supervisors need to sharpen incentives for regulated institutions to improve risk management and stress testing practices and the adequacy of their capital and liquidity buffers. [They] need to sharpen firms' focus on tail risks and enhance stress testing regimes in order to identify and mitigate the build-up of excessive risk exposures and concentration risks. (Financial Stability Forum, Interim Report to the G7 Finance Ministers and Central Bank Governors, 2008).

The regulator should conduct system-wide stress tests of those scenarios most likely to produce systemic stress – such as a 40 per cent drop in house prices. Fears of a meltdown in global house prices were not rare before the crisis. These tests will probably underestimate spillover effects, but the information gleaned from them could help regulators estimate these effects and consider mitigating action. (J. Eatwell and A. Persaud, *Financial Times*, 25 August, 2008).

Indeed, in 2009 US supervisory agencies have carried out a comprehensive stress-testing exercise for determining the financial health of the major banks and defining their capital needs. Notwithstanding the importance of the topic, books covering the different facets of macroeconomic stress-testing are missing so far. While many articles have been published on specific issues and some textbooks deal with prudential stress tests, a systematic survey of methodologies and applications of macroeconomic stress-testing is not available. This book aims at filling this gap, by providing practitioners and academics with a comprehensive and updated discussion of the theoretical underpinnings as well as the practical aspects of the implementation of such exercises. Prudential stress tests carried out by banks are not analysed in the book, even though it is not always practicable (and sensible) to distinguish them from macroeconomic stress tests.

The book builds on the experience gained by the economists of many national and international financial authorities in their day-to-day surveillance activity. All the contributors have an extensive expertise in financial stability issues and stress-testing methodologies. Obviously, due to space

constraints, some potentially interesting applications may have been omitted. Nevertheless, the book – while not exhaustive – is wide-ranging and includes outstanding presentations of the most significant approaches as well as an inner description of the state-of-the-art in this field.

While tailored for an expert readership, the book has the ambition to remain accessible to other readers, thanks to its plain language, clear explanation of the different issues and recurrent use of examples. Readers can either pick specific chapters of interest or easily move from simple to more complex topics as they progress through the text.

The book is organised in two parts. The first part (Chapters 1–7) introduces the fundamentals of macroeconomic stress-testing; the second part (Chapters 8–16) reviews some of the most significant applications and experiences.

Chapter 1 introduces the concept of financial stability and serves the purpose of setting the stage for the whole book. While Chapter 2 illustrates the basic definitions and examines the main components of these exercises, Chapter 3 reviews the most significant statistical and econometric techniques that can be used for stress-testing banking risks and offers a rich menu to disentangle the empirical issues arising from the development and implementation of such techniques. Chapters 4 and 5 conclude the description of the methodologies, discussing scenario calibration and risk integration.

Chapter 6 illustrates the information needed for carrying out macroeconomic stress tests; after a general overview of the data needs for running any stress test, it concentrates on credit risk. The first part of the book ends with a discussion on the possible uses of stress tests (Chapter 7); in particular, it describes how the output of such exercises can be employed to communicate with the public, identify weaknesses in the financial system that authorities can address in normal times and inform the policy response at times of stress.

The second part of the volume illustrates several applications. Chapters 8, 9 and 11 deal with selected national experiences on stress tests for specific banking risks, namely credit risk in Italy, market risk in the United States and interbank risk in the Netherlands, whereas Chapters 10 and 12 describe the approaches developed in the United Kingdom and Austria respectively for integrating different types of risk. Chapter 13 analyses the methodologies developed in France and shows how macroeconomic stress tests can be linked to microprudential supervision.

Chapter 14 presents the experience of the EU new member states, analysing the peculiarities of the financial systems of these countries and highlighting

the challenges for the development of appropriate stress-testing methodologies where data typically deserve special attention. Chapter 15 turns to the issue of stress-testing in a cross-border dimension, examining the challenges in terms of modelling strategies and data availability in the European Union. Finally, Chapter 16 focuses on the experience with stress-testing gained in the Financial Sector Assessment Programs (FSAPs) by the International Monetary Fund, a leading authority in this field.

Part I

Fundamentals

1 A framework for assessing financial stability

Maurizio Trapanese*

1.1 Introduction

In recent years, policy-makers and banking supervisory authorities reinforced their efforts aimed at ensuring financial stability, considering it as a relevant policy objective, autonomous with respect to both monetary and microeconomic stability (see Schinasi, 2003). Many central banks regularly publish reports in which they disclose their assessment of the factors that may threaten financial stability. Ad hoc fora have been established in order to discuss the implications for financial stability of globalisation, financial innovation and macroeconomic fluctuations. Major financial institutions also devote a large part of their activity to the analysis of the vulnerabilities of financial systems.

However, as pointed out by Schinasi (2005), 'compared with the analysis of monetary and macroeconomic stability, the analysis of financial stability is still in its infancy. As anyone who has tried to define financial stability knows, there is as yet no widely accepted model or analytical framework for assessing or measuring it.'

The definition of financial stability itself is difficult to provide. Padoa-Schioppa (2003) considers financial stability as: 'a condition whereby the financial system is able to withstand shocks without giving way to cumulative processes, which impair the allocation of savings to investment opportunities and the processing of payments in the economy'. Financial stability does not necessarily imply that all components of the financial system operate at or near peak at all times, but a stable financial system has the ability to limit and resolve existing imbalances (Schinasi, 2005).[1]

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[1] For a survey of possible definitions, see Houben *et al.* (2004).

Financial instabilities have the potential to jeopardise the correct functioning of one or more components of the financial system, which – in turn – can have a substantial impact on the real economy and imply 'second-round effects' to the financial system. The extent of the impact greatly depends on the underlying vulnerabilities in the financial system and on the possibility that this is able to absorb or withstand the shock and continue to perform its key functions. Another key factor, which is likely to have substantial consequences on the behaviour of public authorities, is the speed of propagation of the instability within the financial system (Hoggarth and Saporta, 2001).

Because of the multifaceted nature of financial stability, the main challenge for policy-makers is the definition of an effective framework for assessing the state of health of the financial system. Such an assessment is a composite and, to some extent, iterative process; it is the result of quantitative measures and qualitative intuition. It relies on predefined rules and some degree of discretionary judgment.

It is worth underlining that the goal of the assessment is not necessarily to prevent problems from materialising; rather it is to protect the stability of the financial system and, at the same time, minimise the potential harmful economic impacts of the crises. In other words, the efficient functioning of the financial system requires that authorities, while not pursuing a zero-failure regime, try to prevent potential weaknesses from becoming systemic.

For the purposes of this chapter a systemic crisis can be defined as an event that leads to the failure of a relevant number of financial institutions, or has a substantial impact on the functioning of financial markets or infrastructures, thereby undermining the main functions of a financial system and having an impact on the real economy. Systemic crises imply two key elements: shocks and contagion channels. Shocks can be idiosyncratic or systemic depending on whether they affect a single financial institution, the price of a single asset or a relevant part of the financial system. The contagion channel is the mechanism through which shocks are transmitted from one financial institution or market to the other.

The goal of public authorities is to build a framework through which the likelihood that such a crisis occurs and the severity of its impact on the real economy can be identified as early as possible. Any analytical framework for assessing financial stability does not define *ex-ante* quantitative benchmarks for qualifying instabilities as systemic, but it assumes that *ex-ante* the public authorities are aware of the potential channels through which a systemic crisis may appear. In that respect, stress tests provide a very powerful and eclectic tool for carrying out such an assessment.

This chapter provides a brief overview of these issues and sets the stage for the following parts of the volume. It is organised as follows. Section 1.2 sketches the main building blocks of a framework for financial stability in modern economies; section 1.3 introduces the tools that can be used to carry out the assessment and section 1.4 offers some inputs from a policy perspective.

1.2 Building the framework

Financial stability analysis aims at understanding whether the financial system is exposed to shocks and quantifying the possible repercussions of a crisis should the shock occur. Therefore, any framework for assessing financial stability should focus on three main elements: the risks and vulnerabilities that make the financial system weak, the shock that can trigger those vulnerabilities and the propagation mechanisms that amplify the impact of the crisis.

This requires systematic monitoring of individual parts of the financial system as well as the real economy (households, firms, the public sector). The analysis should also consider cross-sector and cross-border linkages, because imbalances are often caused by a combination of weaknesses from different sources.

While it is clear that both the shock that triggers the crisis and the contagion channels that propagate it across intermediaries and markets play a role in determining financial instability, the significance of each of these elements is disputed. As an example, in the study of the pattern of financial instability episodes, Davis (1999) distinguishes between primary shocks or 'displacements', which act as propagation mechanisms of financial fragility, and secondary shocks, which actually trigger the episode of financial instability. Since the aim of any framework for assessing financial stability is to detect early signals of distress, the focus is on the propagation mechanisms, that is, on the leading indicators of the crises. According to Borio (2003), 'the triggering shock is, in fact, the least interesting aspect of the story' and it would be detected too late to be a leading indicator.

Therefore, the crucial point in defining and making operational a framework for financial stability is the analysis of potential sources of fragility. This analysis should be as comprehensive as possible, trying to include all the underlying factors that can have an impact on the functioning of the system. The assessment should ideally end up with a categorisation of the existing vulnerabilities according to their intensity, scope and potential threat to

financial stability and the definition of the policy responses that are deemed adequate.

A useful contribution to the design of such a framework could derive from the distinction of financial vulnerabilities according to their impact on the main elements of the financial system, namely financial institutions, financial markets and market infrastructures. A special focus should be assigned to the analysis of the contagion channels across borders and sectors. Indeed, both those elements have gained relevance, given the increased pace of financial integration in the global financial system. In addition, as highlighted by the 2007–8 financial crisis, the vulnerability of the financial system increases when shocks hit portfolios that are not liquid, hedged or diversified enough; furthermore, the interaction among different types of risks may magnify the impact of any shock. All these factors should thus be taken into account when ranking different risks.

In the assessment, one should ideally distinguish the risks that may arise within the financial system and those that may originate outside the financial system – for example from the real economy – and still have an impact on the functioning of the financial system itself. These different sources of risk have important consequences in terms of the choice of the more adequate policy responses: endogenous vulnerabilities can be offset by preventive policies in terms of regulation and supervision and their effects can be alleviated by appropriate crisis management tools; conversely, the impact of external imbalances on the financial system can only be mitigated by the policy responses of the authorities.

As far as the triggering event is concerned, it is up to the analyst to determine the most plausible shocks and identify the institutions that are more likely to be affected. The following chapters show that this is not an easy task and therefore the assessment should be based on statistical methods and human judgment.

Finally, the interconnections across markets and intermediaries increase the probability that the shocks are transmitted among the major components of the financial system, thus exacerbating the crisis. Because of this propagation mechanism, an idiosyncratic shock at, for example, one or a few banks may result in a systemic crisis where many institutions or markets are in turn affected through their linkages with these banks.

Two main channels exist through which such contagion risks can occur, namely the exposure channel and the information channel. The former refers to the knock-on effects on other institutions or markets through real exposures (via wholesale payment systems or the interbank market). The latter

refers to contagious actions by depositors/investors (through deposit withdrawals, asset sales) who are imperfectly informed about the shocks hitting the financial system. Hence, the risk of bank runs and systemic crises are interlinked with the public's confidence in the stability of the financial system.

1.3 The use of macroprudential analysis for assessing financial stability

Macroprudential analysis is the tool that public authorities use for assessing financial stability. According to the IMF (2001), macroprudential analysis is 'a methodological tool that helps to quantify and qualify the soundness and vulnerabilities of financial systems'. The perspective of macroprudential analysis is clearly focused on overall financial stability, whereas (traditional) microprudential analysis concentrates on single financial institutions. Indeed, the main goal of such a tool is to reduce the likelihood of the failure of significant parts of the financial system and the relative costs; the failure of individual intermediaries is a matter of indifference if it does not have systemic effects on financial markets.

The importance of macro-prudential analysis for assessing financial stability is witnessed by the speech that Andrew Crockett (2000) made before the Eleventh International Conference of Banking Supervisors:

> Where will the journey take us? In sketching the challenges ahead in the 21st century, as befits today's theme, I would like to share with you some personal reflections on a possible future direction. I shall argue that in order to build most productively on past achievements in the pursuit of financial stability, we should strive for a better marriage between the microprudential and macroprudential dimensions of the task. We should, in other words, consolidate a shift in perspective that is already taking place, complementing the microprudential perspective with increased awareness of, and attention to, the macroprudential facet.

Macroprudential analysis clearly requires the systematic use of a huge set of information in order to capture early signals of fragility in the financial system as a whole.[2] The integrated use of micro and macroeconomic information, the development of stress-testing exercises and the analysis of the structural and institutional framework are increasingly regarded as useful tools to identify the determinants of financial instability.

[2] Evans *et al.* (2000).