Nigel Jenkinson: Developing a framework for stress testing of financial stability risks

Comments by Mr Nigel Jenkinson, Executive Director, Financial Stability, Bank of England, at the ECB High Level Conference on "Simulating Financial Instability", Frankfurt am Main, 12-13 July 2007.

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1 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.

2 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 crossborder 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.[1]

3 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.

4 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 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:

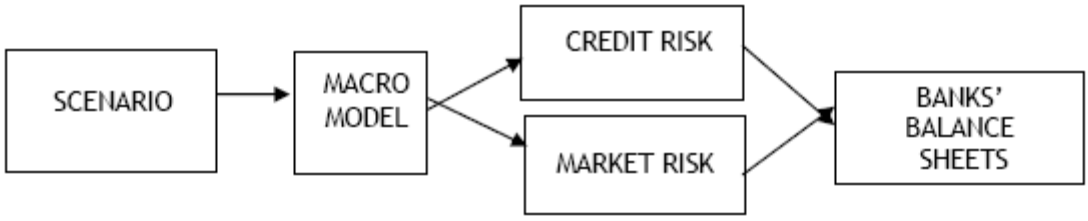
- To assess the vulnerability of the financial system to extreme but plausible shocks
- To improve the understanding of the transmission of shocks through the financial system (and, in a worst case, the potential propagation of financial crises)
- To identify "weak spots" in the financial system, to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

[1] *Systemic risk in modern financial systems: analytics and policy design* by Prasanna Gai, Nigel Jenkinson and Sujit Kapadia, *Journal of Risk Finance* Vol8, No2, 2007. Financial System Risks in the UK – Issues and Challenges (John Gieve) (July 2006) www.bankofengland.co.uk/publications/speeches/2006/speech280.pdf .

To deliver 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

5 So where is current practice against that ideal? A typical or traditional "macro" stress test has the stylised form set out in Chart A. 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; for example, 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).

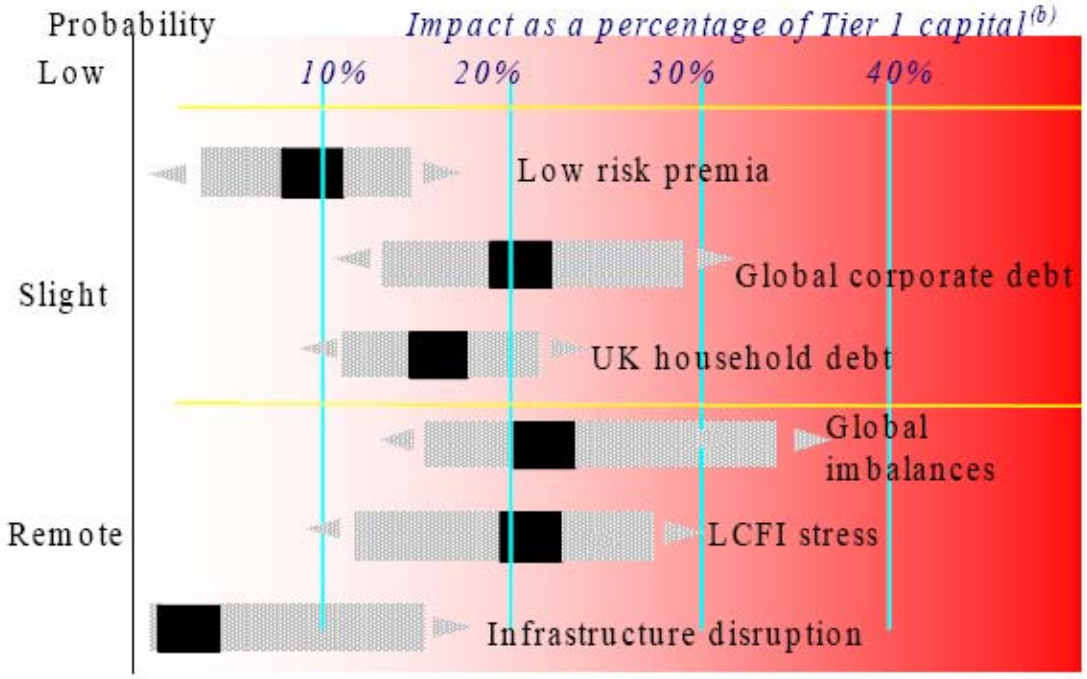
Chart A: Traditional macro-stress test



6 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 individually and in combination. Results have been published in recent Financial Stability Reports (see Chart B).[2]

[2] 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 B: Severe stress scenarios



7 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 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 focussed on capturing macroeconomic and financial sector feedbacks.

8 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 above in Chart B as a guide. These scenarios are constructed from risk transmission maps for each scenario based on the stylised model in Chart C. 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)[3]; and restrictions on lending (a

[3] Bank of England *Financial Stability Report July 2006* Box 5, Page 33.

"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.

Chart C: Risk transmission

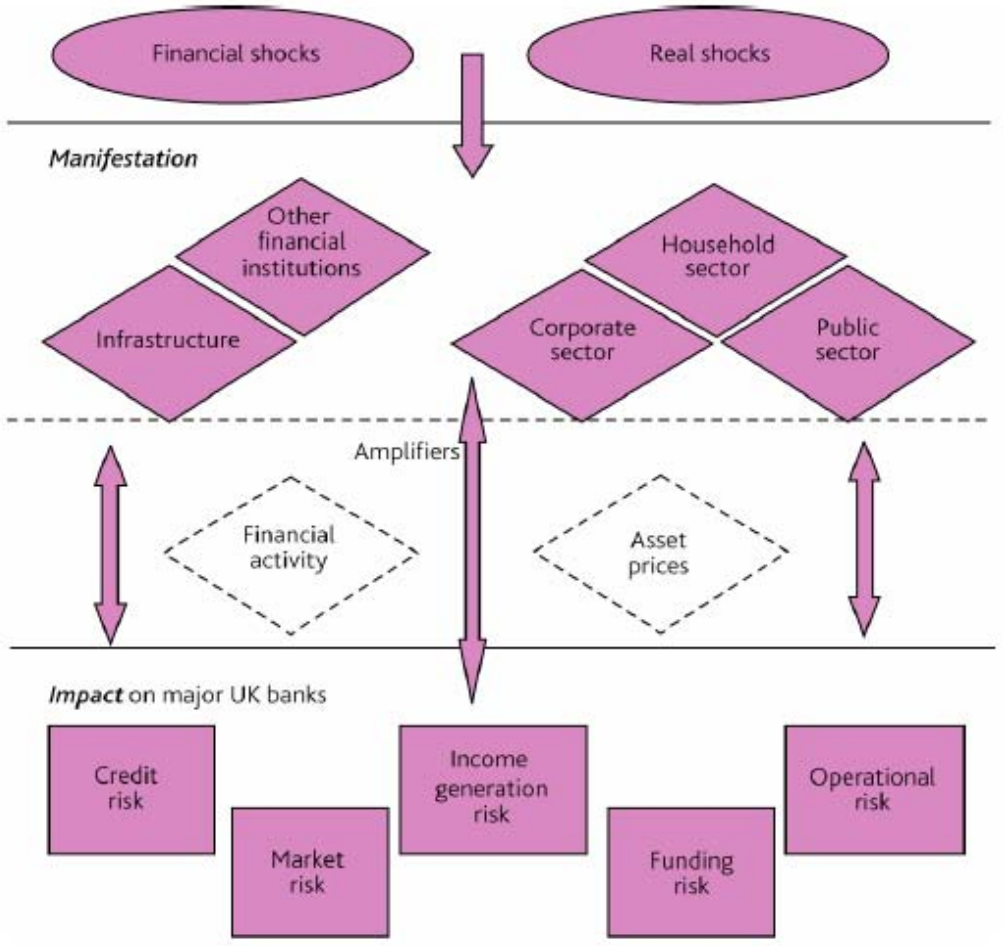


Table 1: Channels explicitly quantified in stress scenarios

	Low risk premia	Global imbalance	Global corporate debt	UK household debt	LCFI stres	Market infrastructur disruptio
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.

9 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.

10 Addressing these limitations is an important priority for financial stability authorities, so that "practical" stress-testing meets the "ideal" objectives set out above. 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 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.[4] 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.[5]

11 A schematic for the planned suite of models is set out in Chart D 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

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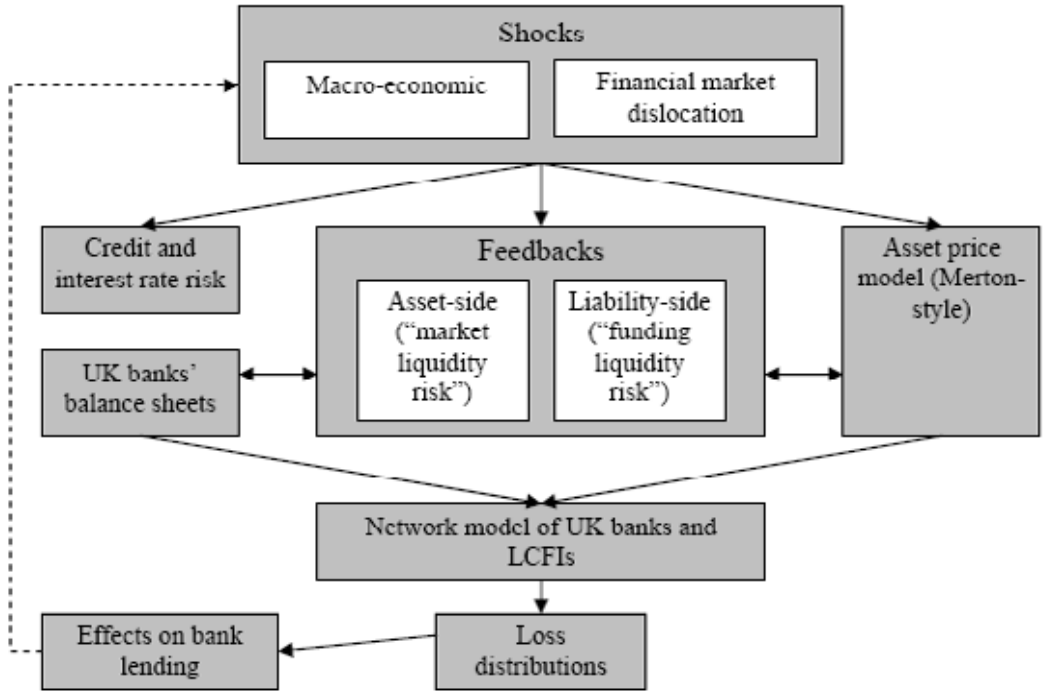
[4] *A new approach to assessing risks to financial stability* by Andrew Haldane, Simon Hall and Silvia Pezzini, Bank of England *Financial Stability Paper No 2* April 2007 for a fuller discussion.

[5] 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 Puhr, Martin Summer.

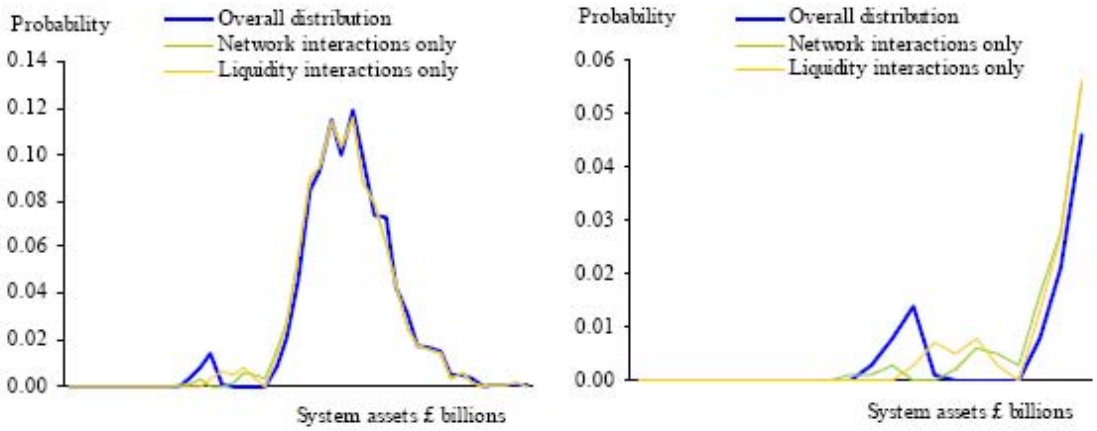
assets and off-balance sheet exposures, the asset price approach can serve as a useful cross-check to the outputs of the more structural model.

Chart D: The planned suite of models



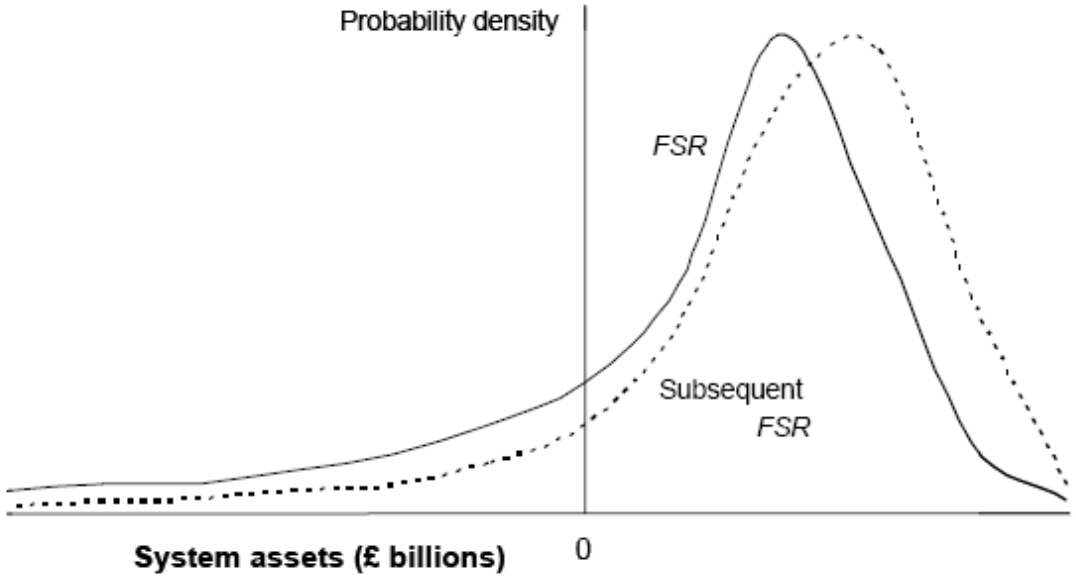
12 The distinguishing feature of the model suite is the emphasis placed on the feedback effects induced by market liquidity risk and funding liquidity risk and their interactions in a network context. In addition, the potential feedback to the macro economy from the behavioural responses of banks individually and collectively to an impairment of their balance sheet position (eg, 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 E shows an illustrative distribution of future UK bank 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 firesale 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 E: The distribution of banking system assets



13 Chart F 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 F: Distribution of banking system assets over time



14 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.

15 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 of 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.[6] 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.

16 To conclude, there is a major programme of inherently difficult and challenging modelling work ahead for the public authorities and for financial firms. But this 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.

[6] De Nederlandsche Bank (2006), Financial Stability: is the Dutch financial sector stress-resistant? Quarterly Bulletin, December.