

# Stress Testing – An Overview of Global Best Practice and Areas for Future Improvement

By **Aziz Durrani**  
Senior Financial Sector Specialist  
Financial Stability and Supervision and  
Payment & Settlement Systems  
The SEACEN Centre

Stress testing has become one of the key prudential tools for Central Banks and Regulators following the financial crisis in the US, Europe and UK during 2007-2009. That period highlighted the inadequacy of regulatory reliance on Internal Ratings Based models that ultimately calculated Risk Weighted Asset requirements for setting capital buffers. Such models, which, amongst other things, were used to calculate the Probabilities of Default (PD's), the Loss Given Default (LGD) and the Exposure at Default (EAD) for Credit Risk and the Value at Risk for Market Risk based on historical experience, were open to mis-calibration and/or deliberate gaming by firms.

The crisis forced regulators in the affected countries to establish a new way of trying to assess the riskiness of banks' portfolios that would measure wider economic risks and interlinkages in the system, and also be forward looking in its approach. The result was a new system of regulatory stress testing that aimed to combine the macro-economic top-down assessment of the economic system, with the micro-economic bottom-up analysis of individual firms. It has since become **the** key tool in setting capital buffers for individual firms, whilst also being used to highlight model and data weaknesses and identify key risk issues for Supervisors to focus on. In addition, stress testing is now also used to support assessments of threats to financial stability and in testing out the impact of Central Banking policy changes across the wider markets. As such, it is important to understand how supervisory stress testing evolved from the recent financial crisis, and to take stock of the developments that have occurred over the last few years, during which stress testing has become a key part of the annual setting of capital buffers and supervisory strategies. This paper therefore aims to summarise the key elements of stress testing regulatory regimes that have been set up in the three major global centres that suffered most during the crisis, and to consider what has been learnt in the last few years of running these processes. It will also look at how this information can help those Central Banks and Regulators who are in the process of building up or improving their stress testing processes to develop their frameworks whilst taking into account the experiences of the three key regulators most affected by the crisis.

## 1. The Bank of England (BoE)

In the immediate aftermath of the financial crisis, stress tests were run by the Financial Services Authority - the FSA.<sup>1</sup> In similarity to other regulators, these focused on a bottom-up analysis of each bank's balance sheet to assess potential losses

to the bank and impact on capital from key risks areas, as this was the main on-going concern at that time. It involved looking at both solvency and liquidity risks and covered Credit Risk, Market Risk, Operational Risk and Liquidity Risk, thereby bringing in specialists with a variety of risk expertise from across the organisation. The stress tests were run on one bank at a time and methodologies for risk estimation were developed by a small team of Risk Specialists and supplemented by Asset Quality Reviews. These determined how accurate banks' risk grading models and provision estimations were, which subsequently drove assumptions in the loss estimation model.

Following the lessening of the immediate pressures in the aftermath of the crisis, the Bank of England (BoE) had the chance to take a more holistic view of how stress testing should be run, and what they should set out to achieve. Whilst this is still a work in progress, the key focus has been on understanding the interlinkages and inter-connectedness between banks, and their impact on financial stability as a whole. A key change that was introduced by the Bank of England was running a system wide, top-down, stress test, to sit alongside the more detailed bottom-up analysis of each firm that was already being run. These would include integrated liquidity and solvency stress tests. This followed the IMF's 2014 Review of the Financial Sector Assessment Program (FSAP) globally,<sup>2</sup> highlighted the need to strengthen the systemic focus of central banks' financial stability assessment, deepen the analytical treatment of interconnectedness, expand coverage of stress tests to non-bank financial sectors and enhance the systematic analysis of cross-border spill overs. The Basel Committee's Principles for Sound Stress Testing Practices and Supervision<sup>3</sup> also recommended that banks take into account system-wide interactions and feedback effects (principle 8), and consider interactions between funding and liquidity (principle 10).

The BoE was well placed to undertake this change, as its economists and policy makers were able to focus on such a system-wide approach to assess risks to wider financial stability that may not materially impact any one individual firms, whilst the BoE's Risk Specialists and Supervisors (housed within the Prudential Regulation Authority) could continue to focus on the bottom up analysis of each of the systemically important institutions in the UK. These were then brought together in an integrated assessment of risks across the system, to decide which banks' individually deserved higher capital buffers, further capital raising and limitations on dividend pay-outs, and/or which sectors of the system collectively required higher buffers to mitigate against systemic risks.

The BoE announced the first concurrent stress test of the UK banking system in 2014.<sup>4</sup> This followed a similar concurrent EU-wide exercise co-ordinated by the European Banking Authority in previous years. The process now involves seven firms (Barclays, HSBC, Lloyds Bank, Nationwide, RBS, Santander UK and Standard Chartered Bank) running a base and stress case scenarios using their own models over

a five year time horizon. The BoE also runs the scenarios on its own in-house models (both system wide and individual bottom-up loss projection models). The results of losses projected by the individual firms, as well as the results projected by BoE for each firm, are compared to highlight outliers and systemic impacts of the stress. Finally, Asset Quality Reviews (AQRs) are undertaken as part of both the stress testing, and the ongoing supervisory processes, to help calibrate the BoE's models and the assumptions and judgements made during the exercise.

The high level results and related commentary from the stress test is disclosed to the public. If the stress test results indicate that a bank does not have sufficient capital resources (i.e. does not meet the BoE's 'hurdle rate' for its capital ratio), the bank would have to take action to strengthen its capital position over an appropriate time frame. This is usually agreed and planned prior to the publication of results.

An additional objective of the Bank of England's stress-testing framework is to support a continued improvement in participant banks' own risk management and capital planning capabilities. As part of the annual stress test, the Bank of England's Risk Specialists conduct a review of participants' stress-testing practices. The findings of this qualitative review are then fed back to banks. Participants are expected to demonstrate sustained improvements in their capabilities over time, in particular in any areas of weakness identified in the review. If participants fall short of expectations in this area, the BoE may take action, including by using the findings of the qualitative review to inform the setting of required capital buffers for individual banks.

## 2. Lessons Learned - BoE

In June 2016, the IMF FSAP reviewed the Bank of England's stress testing framework,<sup>5</sup> and it is useful to consider their conclusions on the key areas for improvement:

1. Despite the investment and work undertaken to date, the IMF felt that the BOE's analytical infrastructure—data, models, processes— still required substantial efforts in order to be finalised. The IMF recommended that these should be completed as soon as practical, in order to allow for investment in the necessary infrastructure, both at the BoE and at the supervised banks.
2. The IMF further concluded that there should be additional investment and improvements in the Bank of England's actual models themselves, to ensure they properly capture the risks and interlinkages in the system.
3. Finally, the IMF also recommended that the BoE should include the largest subsidiaries of foreign investment banks in the concurrent stress test, given that they play such a key role in the UK's financial system.

Lessons learned from the 2014 and 2015 Concurrent Stress Tests, and following the IMF FSAP, were subsequently used to refine the stress testing approach from 2016 onwards.<sup>6</sup> The focus of the changes were:

- To develop an approach to stress testing that would be explicitly countercyclical, with the severity of the test, and associated regulatory capital buffers, varying systematically with the state of the financial cycle. As such:
  - ◆ Every year, the Bank will now design and run a scenario intended to assess the risks to the banking system emanating from the financial cycle — the **‘annual cyclical scenario’**.
  - ◆ Every other year, the annual cyclical scenario will be complemented by an additional scenario intended to probe the resilience of the system to risks that may not be neatly linked to the financial cycle — the **‘biennial exploratory scenario’**.
- To improve the consistency between the concurrent stress test and the overall capital framework, including ensuring global systemically important banks are held to higher standards. For example, Barclays, HSBC, RBS and Standard Chartered have been designated as Global Systemically Important Banks (G-SIBs), with associated G-SIB buffers ranging from 1% to 2.5% of Common Equity Tier 1 (CET1) capital. This will mean that banks in the stress test will face differing hurdle rates depending on whether they are a G-SIB or not.
- To enhance the Bank of England’s own modelling capabilities, whilst ensuring that participating banks were also improving their own stress testing methodology, framework and models.

### 3. The European Central Bank (ECB)

As Europe struggled with successive crises, its supervisory stress testing scenarios were seen by the market as being too optimistic. The 2010 exercise indicated that EU banks would remain sufficiently capitalized and resilient under adverse scenarios, yet weeks later Ireland requested a bailout from the ECB and IMF. Banks such as Dexia and Bankia passed the 2011 stress test, but later needed to be rescued. As a result, supervisory stress testing in Europe became increasingly focused on accurately assessing asset quality. When the ECB took over supervisory and stress testing responsibilities in 2014, it initiated a Comprehensive Assessment, which included an AQR of all banks it was to supervise, as a precursor to the annual stress test, in order to ensure balance sheets were correctly valued. By examining their asset valuations, a key input into a stress test, the AQR showed whether banks had/hadn’t the capital to withstand a crisis, and this helped to further strengthen the basis of results from the stress testing exercise.

The EU-wide stress test exercise<sup>7</sup> is carried out on a sample of banks covering broadly 70% of the national banking sector in the Eurozone, each non-Eurozone EU Member and Norway. To be included in the sample, banks have to have a minimum of EUR30bn in assets. The ECB provides two macroeconomic scenarios for the exercise - a baseline and an adverse scenario. The exercise and scenarios are run over a 3 year time horizon. The results are reported in terms of CET1 capital. In addition, the Tier 1 capital ratio and total capital ratio, as well as a leverage ratio, are also reported for each year of the stress test. Importantly, the ECB does not specify any hurdle rates or capital thresholds that firms need to 'pass'. Nevertheless, individual supervisors in their home countries are supposed to apply the stress test results as an input to the Supervisory Review and Evaluation Process (SREP) when reviewing the firm's Internal Capital Adequacy Assessment Process (ICAAP).

An important point to note is that the EU-wide stress test is conducted on the assumption of a static balance sheet. Assets and liabilities that mature within the time horizon of the exercise are assumed to be replaced with similar financial instruments in terms of type, credit quality, and original maturity as at the start of the exercise. No workout or cure of defaulted assets is assumed in the exercise. Furthermore, the ECB asks firms to maintain the same business mix and model (in terms of geographical range, product strategies and operations) throughout the time horizon. With respect to the P&L, revenue and costs, assumptions made by banks should be in line with the constraints of zero growth and a stable business mix. Banks frequently assert that this is not realistic and that in a stress they would change their business mix and business strategy. An equitable resolution to this issue has yet to be found, since if the banks had total freedom to change their business strategy, they may apply unrealistic assumptions in how quickly changes could be achieved. At the same time, central banks, in a stress, will want to continue the pressure on banks to keep lending to the real economy, and hence the argument is that the stress test should test to see if banks' are adequately capitalised to allow them to continue lending through a recession.

The stress test is primarily focused on the assessment of the impact of risk drivers on the solvency of firms. Firms are required to stress test the following common set of risks:

- Credit risk, including securitisations;
- Market risk, CCR and CVA;
- Operational risk, including conduct risk.

Firms are also requested to project the effect of the scenarios on Net Interest Income (NII) and to stress Profit and Loss and capital items not covered by other risk types.

The banks themselves run the bottom-up stress tests using their own models. They need to adhere to the scenario, assumptions around the static balance sheet and

other PD and LGD benchmarks, as well as caps and floors for PDs, LGDs, and NII etc. provided by the ECB. Each bank supervisor in the relevant country then carries out a quality assurance process on the bottom-up results. This includes validating banks' data and stress test results based on their own bottom-up calculations, as well as reviewing the stress testing models applied by firms. The ECB will then review the output from these and carry out its own top-down analysis of results, peer reviews and benchmarking across the Eurozone. High level results from the stress test are then disclosed to the public.

In practice, it is very difficult to co-ordinate each country's regulators and banks to run the test as prescribed, and ensuring they all apply the same level of oversight. Moreover, as the stress test has to cater for so many different institutions, it has sometimes been criticised as being too high level. Nevertheless, probably the most important action the ECB has undertaken is to publicly release a lot of the underlying stress testing data related to individual firms. This enabled the market to carry out its own analysis of each banks' capital adequacy and reflect the outcome in the share price.

#### 4. Lessons Learned – ECB

An IMF FSAP of the EU was carried out in 2013<sup>8</sup> which made some recommendations on the EU's stress testing programme, a number of which were since implemented by the ECB when it took over supervisory responsibilities formally. The review mentioned that the June 2011 stress tests failed to signal some subsequent bank failures and that the recapitalization exercise in June 2012 was more effective, leading to substantial infusions of capital into EU banks (albeit the report also pointed out that some banks enhanced their capital positions through risk weight optimization). Hence, the IMF's recommendations should be viewed in the light of what had taken place in the stress tests of 2011 and 2012, and it is therefore not surprising that they focus on the importance of obtaining full transparency about banks' data, preferably through an asset quality review. The review also stated that further bank failures after passing a stress test would substantially damage the credibility of the stress testing programme and so it was important to avoid this happening. They made the following additional recommendations to prevent such an outturn occurring:

1. The ECB should implement standardised definitions of NPLs, loan classifications, provisioning etc. while initiating a review of input asset quality data.<sup>9</sup>
2. The ECB should continue to publish a wide range of detailed information on banks being stress tested.
3. Banks should be encouraged to incorporate, as far as possible, their funding and capitalization plans in their stress test projections, and further efforts could be made to assess the sensitivity of results to likely changes in balance sheet composition.

4. The ECB should ensure the consistency and quality of tests run by national supervisors against its own ones, and also run tests on relatively neglected topics such as structural issues and funding vulnerabilities. The ECB should develop further liquidity stress testing, and run stress tests to incorporate longer-term and cross-sector factors.

## 5. The Federal Reserve Banks (Fed)

During the financial crisis in the US, in a similar manner to the UK and Europe, the usefulness of stress testing in assessing the capital needs of, and restoring confidence in, banks, resulted in stress testing becoming a required and regular feature of large firm prudential regulation. As a result, the Dodd-Frank Act Stress Test (DFAST) was introduced, and it has since been integrated into the Fed's Comprehensive Capital Analysis and Review (CCAR) process.

The CCAR process evaluates the capital planning and capital adequacy of the largest U.S. based bank holding companies, including the firms' planned capital actions such as dividend payments and share buybacks and issuances. The stress tests cover 13 of the largest and most complex bank holding companies, which are subject to both a quantitative evaluation of their capital adequacy, and a qualitative evaluation of their capital planning capabilities.

Banks are required to submit the results for a total of 5 scenarios: 3 Supervisory ones (Baseline, Adverse and Severely Adverse – provided by the Fed); and 2 Bank scenarios (Baseline and Stress – to be formulated by each bank). The banks must also provide the Federal Reserve with detailed and significantly standardized data on their loans, securities holdings, trading positions, counterparty exposures, revenue, expenses, and balance sheets. The Fed then inputs the data from the firms into its own supervisory models to project each firm's losses, revenues, and capital over a nine-quarter planning horizon under the specified scenarios. The results of the exercise, including the capital positions of the firms following the hypothesized stress scenarios, are disclosed to the public.

Banks must also submit a capital plan which should sufficiently detail the Bank's capital planning process and the process for deriving stress test estimates as well as planned capital distributions. If the Fed objects to a plan, it means the bank in question cannot undertake its planned capital distributions. The Fed can object to the plan on either a quantitative or a qualitative basis. The quantitative assessment involves the Fed using its supervisory models to assess whether a bank is capable of continuing to meet minimum capital requirements and that it meets a minimum Tier 1 ratio of 5% through the stress period. The qualitative assessment involves a review of the comprehensiveness of the capital plan, the suitability of scenarios the bank has chosen and the extent that all risks are captured. It will also look at the reasonableness of the assumptions made and the overall robustness of the capital plan. If the Fed is not satisfied with its findings, it may object in whole or in part to the proposed capital actions in the plan.

## 6. Lessons Learned - Federal Reserve

The IMF reviewed the CCAR stress testing framework in their FSAP review in 2015<sup>10</sup> and made some suggestions for improvement, many of which have since been adopted (see below). One of their key recommendations was for the Fed to try to link liquidity, solvency and network analysis into a systemic risk stress testing framework. The IMF pointed to the example of the Bank of Canada's Macro Financial Risk Assessment Framework, which captures the various sources of risk (solvency, liquidity and spill-over effects) within a single stress testing framework. Another key suggestion they made was that the Fed should try to conduct more intensive monitoring of systemic financial sector risks, including the use of market-based solvency and shortfall measures. Their recommendations included:

1. The Fed should increase the coverage of the tests, and should start to include the largest Savings and Loan Holding Companies in the supervisory stress tests once they start performing company-run stress tests (from 2017).
2. Establishing a regular liquidity stress testing framework for banks. The IMF stated that the announced Comprehensive Liquidity Analysis and Review (CLAR) is a step in the right direction and will complement the solvency testing under Dodd-Frank.
3. The IMF observed that improvements were necessary in relation to modeling network contagion. They stated that the Fed should try and expand their data on interbank exposures to include a richer set of dynamics and a broader range of counterparties.
4. In insurance, the IMF report stated that the focus should be on developing and performing insurance stress tests on a consolidated, group-level basis. This was deemed to be particularly important for groups that are (i) designated as systemically important; (ii) engaged in material group-internal risk transfer, e.g., via captives; or (iii) exposed to non-linear market risks through the sale of products which include guarantees or optionalities, e.g., variable annuities.
5. The IMF also recommended that regular system-focused liquidity risk analysis for the mutual fund industry should be undertaken on a regular basis. The report observed that at present a considerable range of bottom-up analyses is performed by the industry. The Fed was encouraged to further clarify the guidance to the industry on liquidity risk analysis, and to start conducting regular top-down analysis to provide a more holistic picture of the industry's contribution to systemic risk.
6. The IMF encouraged the Fed to conduct more intensive monitoring of systemic financial sector risks, including the use of market-based solvency

and shortfall measures. As market-price based stress tests employ forward-looking, higher-frequency, market consensus information, they can add value to traditional stress tests by providing a useful “cross-check” to corroborate the findings of other stress tests. They can also be readily extended to assess the safety and soundness of sectors which are not traditionally subject to bank-like supervisory oversight.

In a speech delivered in September 2016,<sup>11</sup> Governor Daniel Tarullo of the Federal Reserve indicated a number of improvements that were to be made to the Fed’s stress testing programme. These included the following:

- The integration of CCAR into the year round Supervisory program.
- The introduction of a Stress Capital Buffer (SCB) for the largest banks which would replace the 2.5% Counter-Cyclical Buffer already in place for G-SIBs, and would be risk-sensitive and vary across firms. It would be set equal to the maximum decline in a firm’s common equity tier 1 capital ratio under the severely adverse scenario of the supervisory stress test, before the inclusion of the firm’s planned capital distributions, but with a floor of 2.5%.
- The Stress Capital Buffer approach would also have the effect of requiring a firm to hold capital to meet its stress losses *and* fund its planned dividends over the following year.
- Instead of trying to forecast how banks will continue to lend during a stress, the Fed will now follow the ECB’s approach and assume that balance sheets and risk-weighted assets remain constant over the severely adverse scenario horizon.
- To build out the macro-prudential elements of the stress testing program, i.e. to also stress the indirect risks to bank capital through channels such as market-wide funding and liquidity disruptions, fire sales, counterparty failure and so on.
- Banks with less than \$250 billion in assets that do not have significant international or nonbank activity will no longer be included in the annual CCAR qualitative review. As a result, 21 firms with less complex operations will no longer be subject to the qualitative portion of CCAR.

The Fed’s new approach would appear to convert the CCAR stress test into an additional risk-based capital requirement, in which the new Stress Capital Buffer would substitute for the capital conservation buffer. Under that requirement, a bank would need to maintain CET1 capital equal to the sum of (i) 4.5 percent, (ii) its SCB, and (iii) its GSIB surcharge, if applicable. The SCB would be the greater of (i) 2.5 percent or (ii) the maximum decline in the bank’s CET1 ratio under the CCAR severely adverse scenario.<sup>12</sup>

## 7. Implementing a Robust Stress Testing Framework

Regulators globally have started to implement many of the stress testing practices detailed above. In some cases they have also put in places more stringent requirements, taking into account the lessons learned from earlier practices in the UK, Europe and US. Nevertheless, the majority of regulators outside of the UK, Europe and US have not been forced to develop stress testing processes as robustly as Western peers, whose banks have suffered/have been suffering direct losses that have necessitated much more formal stress testing. Regulators therefore have a unique opportunity to learn the lessons from these countries, and supervisors should use the opportunity to revamp their stress testing regimes to help strengthen their financial systems before the next crisis emerges. There are several key practices that regulators should take note of, when developing or enhancing their stress testing frameworks.<sup>13; 14</sup>

The experience of the Bank of England, the European Central Bank and the Federal Reserve has demonstrated that to be credible, stress tests really need to push banks in assessing a severe loss scenario. This not only means that the macroeconomic stress scenario has to be robust and pose an appropriately challenging situation, but also that the assumptions and methodologies banks use need to be sufficiently challenged by the regulator. This includes the models used for stress testing, the assumptions made in calibrating such models, and the adequacy of the stress testing methodology and governance processes.

Arguably an even more important factor is for the regulator to undertake sufficient asset quality reviews to determine the quality of the underlying portfolios being stressed. Some regulatory authorities have often omitted this aspect (whether in relation to stress testing, or in their more general day-to-day supervisory functions), arguing that this is something for the banks' management and auditors to be responsible for. Unfortunately, experience in the UK, Europe and the US has shown time and time again that there have been significant issues with the quality of lending portfolios that neither the banks' senior management, nor their auditors, have openly identified. This includes a range of issues from poorly structured facilities, incorrect identification of risk drivers, inappropriate risk grading or improper application of models, documentation weaknesses, failure to identify high-risk or non-performing loans, and insufficient provisions against non-performing loans once identified. Auditors have been at fault for focusing more on whether correct processes and procedures have been followed, rather than carrying out a more comprehensive risk assessment. A key conclusion from the recent financial crisis, and experiences at the regulators most affected by bank losses resulting from it, is that an in-house team of risk reviewers /specialists, with previous banking credit risk assessment skills, are critical in allowing the Regulatory Authority to properly carry out a stress testing programme. Such asset quality reviews can then help identify weaknesses in valuations or provisions, which can then be properly reflected in the stress test and thereby increase its credibility and the accuracy of results.

Stress tests also need to be embedded by the bank into their everyday processes. Under Basel II, banks must link together planning, risk appetite and performance. In practice, they have struggled to do this. The risk appetite statement, set by senior management, has often failed to be communicated to front line staff in its entirety, and loans and other credit has often been extended outside of the stated risk appetite. Similarly, whilst stress tests are also part of the ICAAP process, banks often run them primarily for the purposes of the regulator rather than as part of a strategic planning tool. As such, they would fail the regulatory ‘use’ test. Regulatory Authorities, by using the output from stress tests to set capital planning buffers and also the supervisory agenda, can help to encourage firms to embed the stress test into their business as usual planning cycle.

Taking this a step further, regulators can further enhance the importance of stress testing by making use of stress test data in reaching policy decisions. For example, stress tests can show the potential impact of raising interest rates or of falls in house prices. Some of the key variables used in the stress test can also be monitored to provide early warnings against forthcoming downturns in the economy.

A final point to note is that the actual result from any stress test is not really the key purpose behind stress testing. Clearly, neither the Regulatory Authority nor the banks can accurately predict the response to any economic shock or crisis. The most important element the stress testing process contributes to, apart from indicating a range of possible outcomes, is the wider light that it helps shine upon the banks’ myriad operations, as well as highlighting areas where potential losses or problems for the bank could develop and putting in place contingency plans. Where data is made public, then there is further benefit in the market being able to come to its own conclusions on the solvency of particular banks. A properly run stress test exercise will underscore the quality of a bank’s risk data and models, how effective and well trained its staff are, how strong the Risk function is vis-à-vis the front line, how robust its sources of liquidity are, how well Board members understand the nature of the risks being taken by the bank, and the effectiveness of the overall governance and control processes within the bank. As such, these can greatly aid risk based supervision in helping Supervisors to focus their limited time and resources on the key issues of risk and concern within the bank. Ultimately this will improve both the level of regulatory oversight of the bank, and ensure the bank’s senior management are equally aware of, and focused on, such issues.

## 8. Issues relevant to Emerging Market Economies

There are a number of points that are pertinent to consider, particularly for emerging market countries, when implementing a stress testing programme. Some of these are discussed below.

1. There may be a lack of sufficient historic stressed losses in particular markets. An example may be Commercial Real Estate (CRE) and residential property in Hong Kong. During both the Asian Financial Crisis and the more recent global financial crisis, this part of the market was relatively unaffected and did not see the heavy losses and write-offs experienced in the CRE and residential property markets in the US, UK and Europe. Banks being stress tested in Hong Kong, and associated regions, may therefore draw on such historic data in the calibration of their own stress testing models. Hence, even if the scenario were to stipulate large falls in property prices, the models would not forecast particularly heavy losses. The banks would support this by stating that in previous periods of significant stress they did not experience heavy losses and so there would be no reason to expect such losses to crystallise during periods of future stress. There is certainly some merit in this argument, since homeowners in these countries prioritised repaying their mortgages, and corporates were able to take advantage from other income streams to keep their CRE interest payments up to date. Furthermore, we should note that even significant falls in CRE prices do not necessarily lead to losses, as long as customers have sufficient cash flow to cover their interest payments. Similarly, steep falls in GDP over one or two years would again not lead to corporates defaulting on their loan repayments, particularly if they are larger companies who can weather more difficult conditions and can draw on reserves or income from other business lines or markets. Nevertheless, the purpose of a stress test is to test the hypothetical question of just how severe would the impact be on the bank if such companies were to default on their payments. Therefore Regulators / Central Banks should guide the banks to use historical data drawn from other regions where heavy losses were experienced, or create hypothetical scenarios which generate more significant levels of losses than those experienced historically in the home country. In this respect, it is important for the Regulator / Central Bank to describe the details of the scenario they are proposing, and the potential impacts they would expect to see resulting from it, so that there is a clarity of expectations on assumptions that should be made during the stress testing process.
2. In many economies, a number of the companies banks lend to are conglomerates, with multiple and significant lines of business that are inter-connected across industries. Careful thought therefore needs to be given as to how the stress scenario would play out for them. This would include assessing how much of their business function falls into particular asset classes or industry sectors, so that stress factors appropriate to the scenario can be applied. For example, how much of the underlying conglomerate's business is related to the CRE sector, how much

to manufacturing businesses, how much to non-bank financial activities and so on. There may also be additional contagion risks that could arise from threats in a sector that they are not at first sight directly connected to via their primary lines of business, but which could still end up having a material effect on their ultimate performance. Regulators need to ensure that all such risks are fully explored and appropriately accounted for.

3. Linked to this is the question of cross-border inter-connectedness within corporates, and indeed across banking groups themselves. Banks may be lending to conglomerates that operate across numerous countries, whilst the bank itself may also be operating across a number of global locations. Hence, a stress situation may not arise in the company or bank's 'home' country, but ultimately would impact the home market and therefore have to be resolved by the home regulator. Such an impact would therefore need to be considered in a stress test. Conversely, a stress situation in the home country may actually end up impacting a host jurisdiction much more severely than the home country. All such issues need to be considered as part of a comprehensive stress testing programme, and contingency planning around this needs to take place. The results from the stress test should then also contribute to recovery and resolution planning, and be discussed further at supervisory colleges and other similar meetings.
4. Whilst it is reasonable to assume that individual Central Banks and Regulators will still want to run their own country specific stress tests, given the issues raised above there is also a benefit in co-ordinating a stress test across regions. Such a region wide stress test (similar to that run by the ECB) may provide a useful benefit in harmonizing scenarios, assumptions, credit assessments and management actions, as well as reducing the scope for banks to engage in regulatory arbitrage by providing contradictory rationales and assumptions to different regulators. An added benefit would be to increase co-ordination and co-operation amongst Regulators, enabling them to use resources more effectively. Banks being stressed would also benefit in not having to run multiple similar scenarios, allowing them to invest in one common data request platform and thereby also enabling them to better focus and manage their own resources.

## Endnotes

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1. Subsequently split into the Prudential Regulation Authority (within the Bank of England) focusing on Prudential Risk, and the Financial Conduct Authority, focusing on Conduct Risk.
2. Review of the Financial Sector Assessment Program: Further Adaptation to the Post Crisis Era, prepared by IMF staff and completed on August 18, 2014.
3. Principles for sound stress testing practices and supervision, May 2009, Bank for International Settlements.
4. Stress Testing the UK Banking System: 2014 results, Bank of England, December 2014.
5. IMF United Kingdom FSAP – Financial System Stability Assessment, June 2016.
6. The Bank of England's Approach to Stress Testing the UK Banking System, Bank of England, October 2015; Stress Testing the UK Banking System: 2016 results, Bank of England, November 2016.
7. EU Wide Stress Test – Methodological Note, European Banking Authority, 24 February 2016.
8. IMF EU FSAP – Financial System Stability Assessment, February 2013.
9. The ECB, on 20 March 2017, published its final guidance to banks on non-performing loans. This can be found here: [https://www.bankingsupervision.europa.eu/ecb/pub/pdf/guidance\\_on\\_npl.en.pdf?b2b48eefa9972f0ca983c8b164b859ac](https://www.bankingsupervision.europa.eu/ecb/pub/pdf/guidance_on_npl.en.pdf?b2b48eefa9972f0ca983c8b164b859ac)
10. IMF US FSAP – Stress Testing: Technical Note, July 2015.
11. Next Steps in the Evolution of Stress Testing, Governor Daniel K. Tarullo, Board of Governors of the Federal Reserve System, 26 September 2016.
12. The speech was not clear on whether and how the stress capital buffer would apply to existing CCAR post-stress risk-based minimum capital requirements other than the CET1 requirement, and so this will need to be worked out in due course
13. Some of the points are expanded from Oliver Wyman's 2015 Review of Stress Testing in Asia.
14. How Well Do You Know Your Banks – The case for supervisory stress testing development in Asia, Oliver Wyman, 2015.