



UNITED KINGDOM

FINANCIAL SECTOR ASSESSMENT PROGRAM

June 2016

THE BANK OF ENGLAND'S STRESS TESTING FRAMEWORK—TECHNICAL NOTE

This Technical Note on the Bank of England's Stress Testing Framework on the United Kingdom was prepared by a staff team of the International Monetary Fund. It is based on the information available at the time it was completed in March 2016.

Copies of this report are available to the public from

International Monetary Fund • Publication Services
PO Box 92780 • Washington, D.C. 20090
Telephone: (202) 623-7430 • Fax: (202) 623-7201
E-mail: publications@imf.org Web: <http://www.imf.org>
Price: \$18.00 per printed copy

International Monetary Fund
Washington, D.C.



INTERNATIONAL MONETARY FUND

UNITED KINGDOM

FINANCIAL SECTOR ASSESSMENT PROGRAM

March 2016

TECHNICAL NOTE

THE BANK OF ENGLAND'S STRESS TESTING FRAMEWORK

Prepared By
**Monetary and Capital Markets
Department**

This Technical Note was prepared in the context of an IMF Financial Sector Assessment Program (FSAP) in the United Kingdom in November 2015 and February 2016 led by Dimitri Demekas. It contains technical analysis and detailed information underpinning the FSAP findings and recommendations. Further information on the FSAP program can be found at <http://www.imf.org/external/np/fsap/fssa.aspx>

CONTENTS

Glossary	3
EXECUTIVE SUMMARY	4
OVERVIEW OF THE BOE'S STRESS TESTING PROGRAM	6
A FRAMEWORK FOR EVALUATING CONCURRENT STRESS TESTING PROGRAMS	9
A. Scope of Coverage	10
B. Scenario Design	14
C. Analytical Infrastructure, Models, and Processes	19
D. Disclosure	21
E. Governance	26
CONCLUSION	29
BOXES	
1. Minimum Capital and Buffer Framework	11
2. Stress Testing and the ICAAP in the United Kingdom	12
3. Disclosure on Impact by Asset Class or Geography	23
4. Disclosure of Profits	23
5. Disclosure of Trading Assets	25
FIGURES	
1. China and Hong Kong SAR—BoE 2015 Stress Scenario Variable Paths	15
2. United Kingdom—BoE 2015 Stress Scenario Variable Paths	16
3. 2015 Stress Test Results—Bank Level Capital Ratios	22
4. 2015 Stress Test Results—Impairments	24
5. Timeline of BoE's Concurrent Stress Tests	28
References	30

Glossary

APRA	Australian Prudential Regulation Authority
BoE	Bank of England
BRRD	Bank Recovery and Resolution Directive
CCAR	Comprehensive Capital Analysis and Review
CET1	Core Equity Tier 1
CRD IV	Capital Requirements Regulation
ECHR	European Convention on Human Rights
EBA	European Banking Authority
EU	European Union
FCA	Financial Conduct Authority
FDSF	Firm Data Submission Framework
FPC	Financial Policy Committee
FX	Foreign Exchange
GBP	British Pound
GDP	Gross Domestic Product
ICAAP	Internal Capital Adequacy Assessment Process
IHC	Intermediate Holding Company
MoU	Memorandum of Understanding
PRA	Prudential Regulation Authority
R&D	Research & Development
RAMSI	Risk Assessment Model of Systemic Institutions
RWA	Risk Weighted Assets
SREP	Supervisory Review and Evaluation Process

EXECUTIVE SUMMARY¹

The Bank of England (BoE) has two mandates: a macroprudential mandate through the financial policy committee (FPC) and a microprudential mandate through the Prudential Regulation Authority (PRA). The stress testing program provides insights into both mandates. In October 2015, the BoE released a policy paper describing their current approach (BoE, 2015a), which guides the discussion in this Technical Note. The PRA's expectations on stress testing for capital planning are additionally set out in SS31/15.

A range of capital buffers are the principal tools at the BoE's disposal to effectuate its policy objectives, and the stress testing program plays a significant role in helping to inform their setting. The U.K. countercyclical capital buffer, which affects all banks, is informed by results from the concurrent stress test. The FPC can also use information outside the concurrent stress test from the results of banks that run the annual cyclical scenario as part of their internal capital adequacy assessment process (ICAAPs) to help support it in setting the U.K. countercyclical capital buffer. The PRA prudential buffers are used to capture material bank-specific risks, for example, higher sensitivity to cyclical risks than for the sector as a whole, or material shortcomings in bank risk management practices. Both are sized at the discretion of the authorities and are informed by the results of the concurrent stress tests.

This note considers the BoE's stress testing program including both the concurrent stress test and the stress testing done by the banks through the ICAAP, though with a clear focus on the former. The ICAAP forms a core part of the supervisory review and evaluation process in the U.K. and covers a Pillar 2A assessment whereby firms quantify risks not addressed or only partially addressed by the international standards for Pillar 1; and a Pillar 2B assessment whereby firms assess their forward-looking capital needs under stress by applying a severe but plausible stress to their capital plans. The PRA carries out a PRA buffer assessment for all firms. To do so, the PRA considers:

- The maximum change in capital resources and requirements projected in the results of concurrent stress testing and other relevant stress tests, including those conducted by other supervisory authorities, and the firm based on their own stress scenarios; and
- Other factors that may influence the vulnerability of a firm to a stress, e.g., the leverage ratio, or the projected use of capital buffers under stress.

According to BoE (2015b, p. 11), “[t]he main purpose of the [concurrent] stress-testing framework is to provide a forward-looking, quantitative assessment of the capital adequacy of the U.K. banking system as a whole, and individual institutions within it. In doing so, it aims to support both the FPC and the PRA in meeting their statutory objectives.” Since the capital buffers are one of the principal tools used by the BoE to implement the conclusions drawn from stress testing, it is impossible to evaluate the concurrent stress testing exercise in isolation of the role played by the individual ICAAPs.

¹ Prepared by Til Schuermann, a Partner at Oliver Wyman, and external expert for the IMF. He would like to thank his colleagues for their support and input. This assessment is based on the BoE's stress testing regime as of February 2016.

The BoE's stress testing program is evaluated here along five dimensions:

- Scope of coverage: are the covered institutions, portfolios, assets and geographies sufficient?
- Scenario design: is the design of the scenarios appropriate?
- Analytical infrastructure: are the processes, models, and other tools that exist or are being built appropriate and sufficient?
- Disclosure: does the disclosure regime help to meet the stated objectives?
- Governance: is the governance framework at the BoE appropriate and sufficient?

The design of the concurrent stress test largely meets the objectives of the FPC and PRA, but the program is still young and not all dimensions of implementation are equally well-developed. Improvements can be made in the following areas, in order of priority:

- 1) **The analytical infrastructure—data, models, processes—appears to still be in the early stages of development and will require substantial efforts.** Stress testing is inherently an analytically intensive exercise, requiring a wide variety of data inputs and models. Data and models are used along the entire production chain: at the scenario design stage; evaluation, review, challenge and adjustment of bank submissions (microprudential); and aggregation of results and policymaking decisions. The specific recommendation for the medium term is to accelerate investments along two dimensions, with a view of implementing the attendant improvements no later than 2018, following the next review of the concurrent stress testing framework:
 - a) *Settling the core data model.* The data submission format, e.g., firm data submission framework (FDSF), and organization of other stress test relevant data elements, e.g., from firm ICAAP submissions, needs to be settled as soon as is practicable to allow for investment in infrastructure both at the BoE and at the supervised banks.
 - b) *Building out the supervisory model and analysis infrastructure.* To effectuate robust quality assurance of bank submissions, the BoE makes use of broadly three types of models in the overall stress testing process: (1) granular models using data submitted by the firms via the FDSF; (2) product or sector specific models using industry or other data sources; and (3) "system" models which examine interconnectedness, spillover effects, and so forth. Investment, especially in Type 1 and 2 models, should be accelerated.
- 2) **Coverage of the concurrent stress test may not be wide enough to sufficiently span the large banking organizations active in the U.K.** Coverage extends to banks and building societies representing over three-quarters of banking system assets. However, 8 of the 15 biggest U. K. banks (as measured by 2014 total assets) are foreign, mainly investment banks. While financial stability depends crucially on a stable banking system, given London's importance as a global financial center, the contribution of the stress testing exercise to the FPC's overall assessment of financial stability is likely hampered by leaving out large foreign investment banks, notwithstanding the fact that insights into these supervised entities would necessarily be partial. Including the largest subsidiaries in the concurrent stress test is a recommendation for the medium term.

OVERVIEW OF THE BOE'S STRESS TESTING PROGRAM

1. The stated objective of the BoE's stress test is to assess the capital adequacy of the U.K. banking system (macroprudential) and of the constituent institutions (microprudential).

The stress test is meant to generate information on potential vulnerabilities of the system to emerging and growing risks, both financial and in the real economy. Supervisors also gain (microprudential) insights into banks' stress testing practices, and thereby support an improvement of their risk and capital management capabilities to promote safe and sound banking practices. As a result, the PRA may decide to change a bank's PRA buffer. Finally, the disclosure of results is meant to enable better monitoring and market discipline of the banks, with the anticipated result of enhancing public confidence in the financial system and improving incentives for managers to consider risk in their decisions.

2. The scope of the BoE concurrent stress test covers all banks and building societies with total retail deposits greater than GBP 50 billion, which in 2015 covered seven institutions.²

Insurers, asset managers and funds—as well as nondomestic banking entities—are not covered.³ There is no explicit target level of system-wide asset or risk-weighted asset (RWA) coverage. The banks covered in the 2015 stress test accounted for about 80 percent of bank lending to the U.K. real economy (BoE, 2015b, p. 5). Within individual institutions, the scope of consolidation is the perimeter of the banking group as defined by the capital requirements directive (CRD IV),⁴ which includes investment banks but excludes insurance activities conducted inside covered banking organizations. The stress test methodology does not explicitly exclude any balance-sheet or profit-and-loss (P&L) items or risk types.

3. The BoE specifies three types of scenarios as part of the concurrent stress test; a baseline scenario; and two adverse scenarios—an annual cyclical scenario, and an exploratory scenario. The annual cyclical scenario is to be performed annually; with the exploratory scenario added every other year (the first time will be in 2017).

- The first annual scenario is intended to be explicitly countercyclical (the "annual cyclical scenario" (ACS), with the severity of the test and associated regulatory capital buffers varying systematically with the state of the financial cycle, meaning the extent of the shock compared to current conditions is greater in good times. The second adverse scenario is meant to be exploratory (the "Exploratory Scenario") to address a wide range of salient risks, not just cyclical,

² In 2015, the included institutions were Barclays plc, HSBC Holdings plc, the Lloyds Banking Group plc, Nationwide Building Society, the Royal Bank of Scotland Group plc, Santander U.K. plc, and Standard Chartered plc.

³ Note that nondomestic banking activities of the banks included in the stress test are considered. Moreover, in the wider U.K. supervisory framework an assessment of nondomestic entities' parent group support, and of the entities' resolution plans, is performed.

⁴ CRR/CRD IV (Capital Requirements Regulation and Directive) translates the Basel III capital standards into European Union (E.U.) law. It came into force on July 17, 2013.

which could pose a material threat to financial stability and individual banks; it will be run for the first time in 2017.

- This second adverse scenario need not be directly linked to the financial cycle and has the potential to examine a number of risks, and is thus designed to complement the annual countercyclical adverse scenario. The exploratory scenario may not be required of all banks covered under the annual scenario. Should some banks be excluded, there would be a concomitant reduction in the informational value derived from the second scenario.
- In 2015, the scenario covered 57 macro variable projections across all geographies plus 11 yield curve paths.⁵ A financial market shock was also included. The variable projections extend to a five-year horizon in quarterly time steps. The turnaround time from publication of the scenario (March 30, 2015) to publication of bank results (December 1, 2015) was eight months; but, when considering the bank data reference date (year-end 2014), the time to publication was 11 months.⁶

4. Banks are also required to conduct annual stress testing through their regular ICAAP.

These tests are in addition to concurrent stress testing. An important feature of the ICAAP is that banks are required to design their own stress scenarios that probe the unique and specific vulnerabilities of that bank.

5. The BoE's stress testing methodology generally allows banks to develop and use their own internal approaches to balance sheet and P&L projections.⁷ Notably, and in contrast to the European Banking Authority's (EBA) stress test, banks are not restricted to maintaining static balance sheets with assets and liabilities remaining constant in terms of both level and mix. This is a deliberate policy choice by the PRA to gain better insights into banks' stress testing capabilities. However, for concurrent stress testing the BoE imposes an overall lending growth assumption (in 2015, it was 9 percent over the five year horizon) to ensure that banks are adequately capitalized to support the real economy in a stress.

6. Banks can choose—and in some cases are mandated—to assume they will take a range of mitigating actions. These actions fall into three categories: (a) expected actions triggered by falls in banks' capital ratios (e.g., dividend restrictions); (b) business-as-usual actions that would be a natural response to weakening economic conditions (e.g., reducing staff bonuses); and (c) "strategic"

⁵ Brazil, China, Hong Kong SAR, Singapore, South Africa, and the United States had country-specific variables of varying granularity (United States had the most with eight variables, while Brazil and South Africa had only one real GDP). In addition, Europe's comprised two regions, and to capture a global picture, purchasing power parity (PPP) weighted world real GDP was provided.

⁶ Note that, unlike the macro scenario, the reference date for the trading shock is not end-year (for the 2015 exercise it was February 20) to account for the fact that end-year balance sheets may not be reflective of the positions held by banks over the course of the year.

⁷ More details on the BoE's methodology for the 2015 stress test can be found here: <http://www.bankofengland.co.uk/financialstability/Documents/stresstesting/2015/guidance.pdf>
<http://www.bankofengland.co.uk/financialstability/Documents/stresstesting/2015/tradedriskguidance.pdf>

management actions, in which decision-making would likely entail a more significant involvement from banks' boards (e.g., asset disposals). The BoE assesses whether the management actions proposed by banks are realistic under the scenario and requires banks to estimate results both with and without all accepted "strategic" management actions.

7. The BoE employs a suite of models to challenge the banks' concurrent stress testing results and to assess uncertainties and sensitivities around the outcomes. In addition to bank projections (viewed individually and aggregated for system level analysis), the BoE's models use data from supervisory reviews of banks' balance sheets, portfolio level models of key books, sectoral asset class risk reviews, and so forth. The use of these models for quality assurance in the concurrent stress test has been limited to informing judgment on individual bank projections, with the stress test disclosure being based on banks' results adjusted for BoE judgements. The BoE intends to build up its modelling capabilities as it aims to move towards generating its own, supervisory estimates more comprehensively. This is meant to enable the BoE to increase coverage and scope and incorporate system-wide dynamics into the analysis. Given the central role of models in all aspects of stress testing, strict quality standards and model risk-management practices should remain a high priority.

8. In addition to the quantitative challenge, the BoE undertakes a qualitative review of banks' stress testing framework and, with that, their risk and capital management practices. This assessment includes a review of banks' policies and procedures around their own models, the quality of data, and the governance and controls relating to stress-testing processes. Banks are required to submit documentation and supporting analysis to aid in this assessment. This is designed to support a continued improvement in banks' own risk-management and capital-planning capabilities.

9. Stress tests contribute to the FPC's ability to fulfil its statutory responsibility to identify, monitor, and take action to remove or reduce systemic risks with a view to protecting and enhancing the resilience of the U.K. financial system, as well as the PRA's ability to promote the safety and soundness of the firms it regulates. The concurrent stress test results and the supporting qualitative analysis, together with the information derived from the ICAAP exercise, support the policy response of adjusting regulatory capital buffers—including the countercyclical capital buffer—sectoral capital requirements, and the PRA buffer. However, results are not "mechanically linked" to policy response. Box 1 presents the BoE's minimum capital and buffer framework.

10. The BoE's concurrent stress testing framework is meant to be transparent to the public. In 2014 and 2015, the BoE disclosed information on the scenario, the impact of the stress test on the U.K. banks in aggregate, and post-stress minimum capital ratios (with and without "strategic" management actions) at the individual bank level. The BoE has made it clear that the information and results that are disclosed to the public at the conclusion of the exercise could change over time as the framework evolves and to reflect the risks explored by that year's scenario.

A FRAMEWORK FOR EVALUATING CONCURRENT STRESS TESTING PROGRAMS

11. Given the stated objectives to be achieved by the concurrent stress test, this section outlines a framework for assessing the concurrent stress test along five dimensions. To appropriately assess the stress testing regime of the BoE, one first needs to establish the criteria to determine if the regime, both as designed and as implemented, is able to meet those stated objectives. This section outlines a framework for assessing the concurrent stress test along five dimensions:

- Scope of coverage: Are the covered institutions, portfolios, assets, and geographies sufficient?
- Scenario design: Since the actual scenario is at the core of a stress testing exercise, is the design of the scenarios appropriate?
- Process and models: Are the processes, models, and other tools that exist or are being built appropriate and sufficient?
- Disclosure: Does the disclosure regime help to meet the stated objectives?
- Governance: Is the governance framework appropriate and sufficient?

12. A well-designed crisis exercise has five components. While the criteria or ingredients for a successful “wartime” or crisis stress testing exercise are, by now, well agreed (Hirtle, Schuermann, and Stiroh, 2009; Ong and Pazarbasioglu, 2013), there is less guidance for its effective “peacetime” application. A well designed crisis exercise has the following components:

- Scope of coverage: The included banks should cover enough of the banking system to ensure proper assessment of financial stability.
- The scenario needs to be severe enough, and the post-stress capital hurdles need to be sufficiently high, to be a credible worst case.
- The translation of the scenario to the outcomes (e.g., losses, profitability, and capital impact) needs to be appropriately conservative.
- The disclosure regime has to be sufficiently detailed to allow verification of process and results.
- A credible capital backstop by the government in case banks, judged to be viable, who need to raise capital, cannot do so forth their own in a timely manner.

All except the last component map readily to “peacetime” stress testing. In meeting its financial stability mandate, the BoE’s stress testing framework enables the identification and monitoring of risks as manifested concretely in the chosen scenarios, both countercyclical and exploratory; and it is able to take actions to mitigate those risks through the capital buffer framework.

13. All stress testing regimes seem to have both macro- and microprudential objectives, including that of the BoE. Stress testing lends itself naturally as a tool for gaining insights into

both.⁸ On the microprudential side, the quantitative assessment of capital adequacy under a pre-specified stress scenario results in specific answers for a given bank. Along the way the supervisor gains rich qualitative insights into risk and capital management practices, both on a relative basis by directly comparing banks, and on an absolute basis by judging bank practices against supervisory expectations of desired standards. In short, stress testing can be an excellent tool to help supervisors answer some of the basic questions they have always asked of banks: do they have enough capital to support their risk taking activities, and are their risk- and capital-management practices “good enough”?

14. On the macroprudential side, stress testing can provide rich insights into the resilience of the financial system as a whole to shocks. “Stress tests therefore contribute to the FPC’s statutory objective to protect and enhance the stability of the U.K. financial system.” (BoE, 2015a, p. 5). It should be noted that this macroprudential objective covers the broader financial, and not just the banking system (the scope of coverage is discussed below). Concurrent supervisory stress tests are complemented with results from the banks’ ICAAPs and other relevant information, to help inform the PRA and the FPC on how to size the different capital buffers, the principal (but not the only) mechanism for impacting banks (see Box 2). The stress test results are used as an input to the sizing and calibration of the capital buffers banks are expected to hold above and beyond the minimum requirements (see Box 1).

A. Scope of Coverage

15. The scope of coverage for concurrent stress testing is limited to PRA-regulated banks and building societies with total retail deposits greater than GBP 50 billion.⁹ As of this writing, this criterion captures seven banking organizations (see footnote 2). This scope of coverage could be expanded along three dimensions: (1) more banks and building societies by reducing the size cut-off; (2) other banking organizations, such as U.K. subsidiaries of foreign owned investment banks; and (3) other financial institutions such as insurers, asset managers, and pension funds. In determining the scope of coverage, a regulator faces the trade-off between comprehensive coverage of the financial system and the effort required to execute the stress test, both by the regulator and the participating financial institutions.

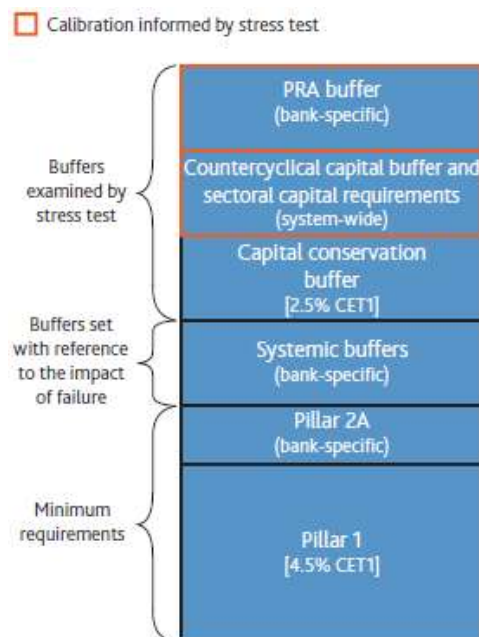
⁸ Greenlaw et al. (2012) provide a framework for evaluating stress testing exercise by contrasting the macro -vs. microprudential principles. For a more recent treatment especially on macroprudential principles, see Demekas (2015); and Hirtle and Lehnert (2014) for a more microprudential focus.

⁹ All firms supervised by the PRA undertake stress testing for capital planning as part of their ICAAPs.

Box 1. Minimum Capital and Buffer Framework

The BoE's capital framework for banks, building societies, and investment firms brings together and operationalizes the macro- and microprudential aspects of the stress testing program. To aid the discussion, Figure 2 from BoE (2015a) is reproduced below. The requirements and buffers fall into three categories, as noted in the figure by braces.

- The minimum requirements: These are a combination of the Pillar 1 minimum (4.5 percent core equity tier 1 (CET1) and Pillar 2A requirements, which are designed to account for risks not otherwise (or adequately) captured in Pillar 1 such as pension risk, concentration risk and interest rate risk, in the banking book.
- The systemically important financial institutions (SIFI) buffer: for banks that are deemed to be systemically important, an extra capital buffer requirement is imposed to lower their likelihood of failure. The size of the buffer is bank specific and not impacted by the stress test results.
- Buffers examined by the stress test: there are three sets of buffers that are examined through the stress test, two of which are calibrated using information from the stress test and other relevant information. All three buffers are available for loss absorption during the stress test.
 - Capital conservation buffer: This buffer of 2.5 percent CET1 is meant to be built up during good times to be available for loss absorption during stressful times.
 - Countercyclical capital buffer and sectoral capital requirements: The purpose of this buffer, which can be used, and may be released in a stress, is to offer additional protection against the build-up of systemic risk relating to the financial cycle.
 - PRA buffer: This prudential buffer is used to capture material bank-specific risks, for example, higher sensitivity to cyclical risks than for the sector as a whole, or material shortcomings in bank risk management practices.



Countercyclical capital buffer and sectoral capital requirements: This buffer is system-wide. The size of the U.K. countercyclical buffer rate will be informed by the results of the stress test.¹ Sectoral requirements may be introduced to account for rising risks in particular asset classes.

PRA buffer: The PRA carries out a PRA buffer assessment for all firms. In doing so, the PRA considers:

- The maximum change in capital resources and requirements from the stress testing results (from concurrent stress testing or the firm's own stress scenarios); and
- Other factors that may influence the vulnerability of a firm to a stress, e.g., the leverage ratio, or the projected use of capital buffers under a stress

The PRA buffer is bank specific and is intended to capture material bank-specific risks, for example, higher sensitivity to cyclical risks than the sector as a whole, or material shortcomings in bank risk management practices. The size of the buffer is left to supervisory discretion by the PRA.

The setting of the regulatory buffers is informed by the institution-level and system-wide stress test results. In a similar vein, the stress test results can lead to bank-level supervisory actions. For example, following the 2014 stress test the PRA Board required The Co-Operative Bank to submit a revised capital plan. Alongside other relevant information, the results of the stress test also inform supervisory decisions on issues such as remuneration and dividends.

¹The U.K. CCyB rate has now been set at a positive rate:

<http://www.bankofengland.co.uk/financialstability/Pages/fpc/ccbrates.aspx>. The countercyclical capital buffer is rapidly being implemented around the world. For example, Sweden, an early mover, announced in September 2015 an increase in their countercyclical buffer from 1 percent to 1.5 percent, effective June 2016; Finansinspektionen (2015). This decision was informed in part by the Swedish Financial Supervisory Authority's (FSA) stress testing program.

Box 2. Stress Testing and the ICAAP in the United Kingdom

Banks in the U.K. are subject to multiple stress testing regimes: the “concurrent stress test,” which is the primary focus of this technical note, is a simultaneous stress test with the same scenario and approach across all institutions in the sample, the results of which are published together; and the EBA stress test (for those U.K. banks included in the EBA sample), which is similar in nature if different in detail to the concurrent stress test, at a European level; in addition all firms conduct stress testing as part of their ICAAP. All firms regulated by the PRA under CRD IV are required to document and update their ICAAP annually. This latter requirement is important context to an assessment of the overall stress testing regime.

The ICAAP in the U.K. forms a core part of the supervisory review and evaluation process, and covers (a) a firm-specific Pillar 2A capital assessment, under which firms quantify their exposure to risks not addressed or not adequately addressed by the international standards of Pillar 1; and (b) a Pillar 2B capital assessment, under which firms stress test their capital plans.¹ Stress testing within the ICAAP requires firms to develop a range of firm-wide scenarios, which should be relevant to the circumstances of the firm, including its business model and the markets in which it operates. The PRA publishes a macroeconomic scenario to serve as a guide, and where relevant, as a severity benchmark for firms designing their own scenarios. From 2016 onwards, this macroeconomic scenario will be the annual cyclical scenario used in the current year’s concurrent stress test.² Firms are also required to complete a “reverse stress test” identifying scenarios that would test their business plan to failure. The ICAAP submission is reviewed and challenged in detail by the PRA, and forms a central part of the firm’s capital requirements and planning.

Many of the BoE’s objectives for its stress testing regime are arguably already achieved by the ICAAP submission. Microprudentially, the ICAAP helps set capital levels for individual institutions, tests the vulnerabilities of those institutions (in a more individually tailored way than the concurrent stress test), and provides insights into the risk- and capital- management of individual institutions. Macroprudentially, the use of a common scenario provides insight into the vulnerabilities of the system to that common scenario, with a wider set of institutions included than the concurrent stress test, albeit not conducted simultaneously.

The value added by the concurrent stress test is three-fold: (a) it is run at the same time for all institutions in the sample, whereas individual firms complete their ICAAPs at different times during the year, making like-for-like comparison much more difficult;³ (b) the results are made public, adding transparency for market participants; and (c) the scenarios specified by the BoE may be more focused and topical than those included for the ICAAP. The concurrence of the exercise leverages one of the few informational advantages that the supervisor has over the banks: the ability to compare exposures, vulnerabilities, models, practices and resilience to shocks across the firms. This ability to compare is critical also in the quality assurance process on any one bank’s results, especially bearing in mind BoE’s evaluation starts with the banks’ own calculations. The publication of the results with accompanying description of the process provides both firm specific and system-wide information on bank and banking system resilience and enhances the Bank’s accountability.

¹ Supervisory considerations under Pillar 2B are now captured by the PRA buffer. See Box 1.

² <http://www.bankofengland.co.uk/pr/Pages/supervision/activities/stresstestscenario.aspx>.

³ For small firms with relatively stable balance sheets (such as building societies), the value of running the test concurrently is likely reduced as their balance sheet composition does not change quickly.

16. The stated statutory objective of the FPC is “to protect and enhance the stability of the U.K. financial system.” If the focus on the banking system is judged to be sufficient to meet the FPC’s statutory objective, it is unlikely that there would be significant gains achieved by descending the size distribution below GBP 50 billion in retail deposits; the smallest bank included in the 2015 stress test, Nationwide Building Society had a balance sheet of GBP 189 billion at year-end 2014. However, the narrow focus on retail deposits is important and different from stress testing regimes in other countries, which use assets as the size criterion. For example, in the U.S., the Dodd-Frank Act stipulated semi-annual (annual) stress tests for all banks with assets of at least USD 50 billion (USD 10 billion).¹⁰ The EBA’s stress test exercise is carried out on a sample of banks covering broadly 70 percent of the national banking sector in the Euro area, each E.U. member state and Norway. To be included in the sample, banks have to have a minimum of EUR 30 billion of total assets at the highest level of consolidation to be included in its 2016 stress test.¹¹

17. The focus on deposits, and more narrowly retail deposits, excludes banks whose business model is not dependent on retail deposits yet can grow to be systemically significant. Examples of such business models include investment banks and trust/custody banks. Because large U.K. domiciled banks have a broad portfolio of business activities—there are no large stand-alone investment or custody banks—it so happens that the GBP 50 billion in retail deposit criterion captures the largest domestic banking organizations.¹²

18. A sizable omission is U.K.’s subsidiaries of foreign investment banks, hence, it is the largest of these which should be included in the exercise in the medium-term. Eight of the 15 biggest U.K. bank legal entities, as measured by 2014 total assets, are foreign (mainly investment banks). These institutions are captured in their host country stress testing programs, where they exist, and the PRA aims to work with those supervisors in assessing the resilience of the group-wide entity and its U.K. subsidiary to stressful conditions. It is noteworthy that foreign (from the U.K. perspective) subsidiaries face the same ICAAP requirements as their U.K. domestic peers, and stress testing features prominently in those capital adequacy assessments with buffers set as required; the largest subsidiaries also submit FDSF data templates. In addition, the PRA makes use of the domestically (i.e., U.K.) focused resolution regime to effectively provide a backstop to the subsidiary’s financial fragility. Consequently, the PRA places significant emphasis on its review of these firms’ solvent wind down plans, which outline how a firm would wind-down parts—or all of its balance sheet—in either a business-as-usual or recovery and resolution context, including in stress. These plans can therefore be thought of as a form of stress test. This approach is different from that in the U.S., where the Federal Reserve’s intermediate holding company (IHC) requirement places large U.S.

¹⁰ This is about GBP 35 billion and GBP 7 billion, respectively.

¹¹ See <http://www.eba.europa.eu/documents/10180/1259315/DRAFT+2016+E.U.-wide+ST+methodological+note.pdf>

¹² Note that the data requirements, analytical tools and models that are developed as part of the BoE’s concurrent stress testing regime will be both useful and used for individual firm assessments, such as ICAAP exercises, for firms outside the scope of the concurrent stress test. See also discussion in Section C.

subsidiaries of foreign (from the U.S. perspective) banking organizations under the same going concern stress testing regimes as equally large U.S. banks.

19. To be sure, any conclusion of the financial resilience of a U.K. subsidiary of a foreign bank, especially an investment bank, will be based on a partial picture. These large firms are global institutions with a global business model. They have a flexible booking model, which makes balance sheet coherence at a legal entity level difficult. These entities are slices of global businesses with which they are highly interconnected because they transact with a global client base, fund themselves, transact in global capital markets, and centralize risk-management globally or regionally. This leads to significant flows of cash, collateral, funding, and risk around these groups. As such, they may not be viable businesses that could stand alone from the parent. A stress test only on the U.K. entity would, for instance, not include activity undertaken in branches of global firms based either in the home country or the EU, which can be larger than the subsidiaries. The ICAAP is therefore also likely to generate more limited quantitative information, even while still providing rich qualitative insights into the firm's risk management capabilities and control practices. Consequently, there is a risk that the U.K. entities that pass the stress test are brought down by failure of the parent.

20. Because a complete perspective on their resilience to shocks can really only be gleaned from a group-wide stress test (one conducted by or for the home supervisor), a rich information exchange between home and host supervisors is essential. Close engagement and strong relationships with home-state regulators will also be necessary to implement the agreed single point of entry (SPE) approach to resolving such highly interconnected entities. Efforts to further "ring fence" the U.K. investment banking entities—e.g., by stress testing them on a stand-alone basis—has the risk of running counter to the BoE's aim to strengthen international cooperation. Still, given London's importance as a global financial center, especially in the capital markets, inference on current financial stability might well be hampered by leaving out large foreign investment banks. This will be particularly the case if: (1) The PRA is not provided with information on global group stress tests from home-state regulators; and (2) global investment banking fragments regionally, increasing the chance that U.K. offices of the major firms could operate as viable stand-alone entities.

B. Scenario Design

21. The choice of scenario is central to any stress testing exercise. Because the concurrent stress test is used explicitly to inform the setting of some of the capital buffers, its importance in the BoE's regime is especially high. In addition, every other year the BoE plans to add a second stress scenario to its concurrent stress test (the "Exploratory Scenario") to probe vulnerabilities facing the banking system at the time and that may not be captured by the countercyclical scenario (the "Annual Cyclical Scenario").

22. There are several choices the supervisor faces in the scenario design. What are the relevant risk factors to focus on, and how many are needed to sufficiently cover the exposures or vulnerabilities of the banks? How severe should the scenario be, and severe for whom; what shape

(e.g., a sharp decline followed by gradual recovery, or a gradual decline and no recovery); how long is the horizon; at what frequency or time steps (quarterly or annual)? For example, the U.S. stress testing program has grown from just 3 risk factors in 2009 (all domestic: GDP growth, unemployment rate, and a residential house price index) to 16 domestic variables and 12 variables covering different regions outside the United States. Now by comparison, the 2015 BoE concurrent stress testing scenario comprised 57 macro variable projections across multiple geographies plus 11 yield curve paths.¹³

23. The 2015 stress scenario focussed on exploring foreign risk factors. Recognizing emerging risks in East Asia in 2015, a region where several large U.K. banks have significant exposures, the BoE 2015 stress scenario included risk factors specific to that region. For instance, house prices were projected to drop by 35 percent in mainland China and by 40 percent in Hong Kong SAR (Figure 1).¹⁴

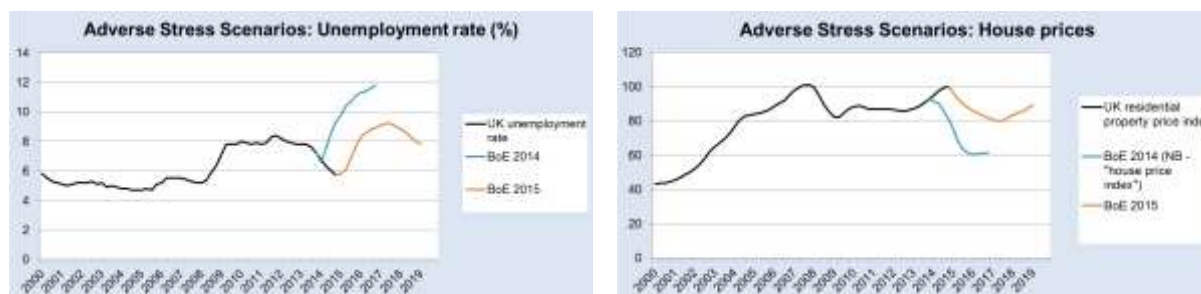


¹³ Note that there is a balance to be struck between specifying more variables to ensure that banks test their vulnerabilities against the key risks that the supervisor would want as part of the scenario, and testing banks' own capabilities to design and expand scenarios by leaving some variables unspecified.

¹⁴ <http://www.bankofengland.co.U.K./financialstability/Documents/stresstesting/2015/variablepaths2015.xlsx>.

24. Reflecting the source of the shock, the U.K. domestic component saw less severe stresses than in the 2014 concurrent stress test. For example, both the unemployment rise and the home price drop were less severe than in 2014. Unemployment rose 3.5 percentage points (from 5.7 percent to 9.2 percent) vs. 4.6 percentage points (from 7.2 percent to 11.8 percent), and home prices dropped 20 percent vs. 35 percent in the 2014 scenario (Figure 2). As a result, banks with mostly domestic exposures experienced only a modest capital depletion in the 2015 stress test. Nationwide’s CET1 capital ratio, for example, declined by less than 1 percentage point (from 19.8 percent to 19.1 percent) against an average CET1 decline (ex-Nationwide) of 3.9 percent before ‘strategic’ management actions and 3.6 percent after (Figure 3).

Figure 2. United Kingdom—BoE 2015 Stress Scenario Variable Paths



Source: BoE 2015 stress test variable paths.

25. The quarterly macroeconomic variables specified for the concurrent stress test are used to describe the general economic environment needed to produce credit losses, profitability, and balance-sheet dynamics. Banks with significant capital markets activities (sales and trading, investment banking) that are subject to mark-to-market face market and corresponding counterparty credit risks at much higher frequency (daily). For them, a separate financial market shock is needed to probe their particular vulnerabilities. The market shock is designed to be consistent with the macro scenario. The 2015 BoE concurrent stress test also included such a trading shock with approximately 450 parameters specified.¹⁵ The 2014 exercise in the EU had approximately 950 parameters plus about 580 sovereign haircuts (by country and maturity), while the Federal Reserve specified about 24,000 parameters across about 20 categories—such as equities, FX, rates, energy, and commodities, securitized products, credit correlation and so forth—for comprehensive capital analysis and review (CCAR) 2015.¹⁶ Taken together, the task of designing a coherent and complete scenario is indeed daunting.¹⁷

¹⁵ For more details see:

<http://www.bankofengland.co.uk/financialstability/Documents/stresstesting/2015/tradedrisk2015.xlsx>.

¹⁶ CCAR: Comprehensive Capital Analysis and Review; the Federal Reserve’s capital plan evaluation and stress testing program.

¹⁷ Kapinos and Mitnik (2015) have proposed a dimension reduction approach to top-down stress testing, at least for the macroeconomic variable set.

26. In considering these design choices, an important backdrop is the general economic and financial environment. Generating the appropriate supervisory scenarios is difficult, especially during benign times, when it is particularly hard to pinpoint a narrow set of risks to explore. Note that it is not enough to have a view on the broad risk profile of the macroeconomic and financial market situation; one also needs to have a good view into the vulnerabilities faced by the banking system and combine these information items to generate an appropriate set of scenarios. In the face of uncertainty on both fronts, the choice of scenarios is not obvious.

27. The design problem may be somewhat easier in bad times, once a crisis manifests. At this stage, there is less uncertainty about what to stress and by how much, what shape that scenario should take, and the length of the stress horizon: examples are housing prices in the U.S. in 2009 and in Spain in 2012. To be sure, one should not underplay the difficulty of designing an appropriate scenario even during a crisis, but it seems safe to say that one may need fewer scenarios to comfortably span the relevant region in the risk factor space than in benign times.

28. The design problem—the choice of a specific scenario—is especially hard in good times, when the financial system and the economy seem robust, growth is strong, no obvious threats are on the horizon, and no obvious vulnerabilities in the banks. Kahneman (2011) points out that “hindsight bias makes surprises vanish,” a poignant reminder of how hard it is to design an effective stress scenario ex ante. Arguably, a good example is the period immediately prior to the onset of the recent financial crisis, around 2005–06. Most economies were growing strongly, risk premia were low (as measured, for instance, by credit spreads and equity volatility), and banks were highly profitable. Indeed, this is one of the underlying motivations for the Annual Cyclical Scenario framework as discussed in BoE (2015a, p12).

29. Whether a crisis can already be clearly seen on the horizon or not, this discussion points to the need to have the flexibility to run many different scenarios. One has to span a very wide space to probe for vulnerabilities, implying many scenarios, where the scenarios should be quite heterogeneous, one from the other. The heterogeneity should be in many dimensions: choice of risk factors, severity, shape, length, etc. At present, the BoE’s concurrent stress testing regime is contemplating one countercyclical scenario run annually and one alternative, more exploratory scenario run every other year. This risk is in part mitigated by the requirement that banks run multiple scenarios as part of their ICAAP, and through reverse stress testing.

30. Flexibility to run scenarios has profound implications for the design of the stress testing regime. Executing stress tests, translating a given scenario into the micro-outcomes at a bank—the losses, profitability, balance-sheet evolution, and thus capital position—is costly. The higher the desired degree of precision in that translation with the concomitant quality assurance and process control, the more difficult it is to run multiple scenarios. The resource demands are high both from the banks, who have to generate and review the results, and from the supervisor who has to evaluate them; this evaluation may require a parallel and independent generation of results.

31. In this way, the supervisor is faced with a stark choice: higher precision from running few (one or two) stress scenarios, or lower precision from running many scenarios. High

precision has clear microprudential benefits; it can uncover many qualitative shortcomings in a bank's risk- and capital-management practices as well as their governance and control processes through careful and detailed work expected from the execution of a given scenario. The price paid for few scenarios translated with higher precision is more macroprudential: one may miss entirely the relevant set of threats facing the banks because they were simply not captured by that one or those few scenarios. However, the ICAAP process helps to mitigate this risk.

32. This trade-off has implications for the design and priorities of the data and analytical apparatus developed at the BoE. Is it more important to check with great detail the calculations of banks at a very granular level, or would one prefer to be able to calculate the impact of a wide range of scenarios at lower granularity subjected to a less time-intensive review process? A robust and nimble data and modeling infrastructure at the supervisor can and should do both. There are clear macroprudential benefits as the supervisor can run many scenarios at different times without needing to resort to the banks to generate outcomes. This capability itself could provide insights into the vulnerabilities of the banking system, narrowing the range of scenarios the banks would then need to run.

33. The length of the horizon is another important design variable. The BoE has chosen a five-year horizon in order to allow for possible slow realization of losses.¹⁸ That puts the BoE at the long end when compared with other stress testing regimes—EBA is three years, the Federal Reserve asks for a nine quarter projection—but it is not alone, as APRA also imposes a five-year horizon.¹⁹ Closely coupled is the question of the frequency of calculation: are results generated at quarterly frequency to match the scenario, or at a lower frequency, e.g., annual, to conserve on modeling complexity? Given how quickly banks can fall into insolvency following a shock and the uneven timing of loss realizations across asset classes, as well as profitability dynamics, the more granular or higher frequency approach is likely to better uncover vulnerabilities. With the BoE's interest in capturing long range or slow loss emergence profiles, it has decided to use lower frequency (annual) to allow for a longer projection horizon without, in their view, unduly increasing execution burden.

34. The solution may be a hybrid. The annual scenario can serve the microprudential objectives when, in good times (meaning high uncertainty about the nature of risks), the supervisory emphasis can be on the process of translation, generating qualitative insights into bank practices, rather than information value of the quantitative answers per se. This can be complemented by many alternative scenarios run privately by the supervisor using the analytical infrastructure being built today. While this scattergun approach will be less accurate and comprehensive for any given bank, it will yield insights into the vulnerabilities actually facing the banking system, allowing a

¹⁸ Note that the BoE's guidance on ICAAP capital planning horizon is three to five years, BoE—PRA (2015).

¹⁹ Seeking strength in adversity: Lessons from APRA's 2014 stress test on Australia's largest banks, Byres (2014). <http://www.apra.gov.au/Speeches/Documents/Byres%20-%20ABF%20Randstad%20Leaders%20Lecture%20Series%202014%20-%207%20November%202014%20%282%29.pdf>.

narrowing of scenarios subsequently. Over time the information and beliefs about those vulnerabilities may become diffuse again, motivating more and more heterogeneous scenarios.

C. Analytical Infrastructure, Models, and Processes

35. The BoE is making increasing use of internally developed models to evaluate and assess the banks' concurrent stress testing submissions. Over the next three years, the BoE has plans to more substantially develop this internal analytical infrastructure.²⁰

36. The impact of the concurrent stress test scenario on banks' capital adequacy is estimated by the banks' own models, and is then quality assured, challenged and adjusted by the BoE. The BoE intends to use/build dedicated stress testing models for three purposes:

- Ensuring consistency in projections across banks.
- Producing their own estimates of institution level capital impact of the stress.
- Producing their own estimates of system level capital impact of the stress, including feedbacks and amplification mechanisms.

37. To meet these objectives, the BoE has a number of models in place and under development. There are broadly three types of models used by the BoE in the concurrent stress testing process: (1) granular models using data submitted by the firms via the FDSF (firm data submission framework); (2) product or sector-specific models, using industry or other data sources; and (3) "system" models that examine interconnectedness, spillover effects, etc.

38. The models using granular data from the FDSF allow the BoE to build relatively granular models to project losses (e.g., residential mortgage impairment). They serve primarily as a quality-assurance tool for the bank submissions for the concurrent stress test.

39. Complementing the granular models is a set of product or sector models which make use of alternative data sources. These models are useful for sector analysis where exposure could extend beyond banks (or covered banks), as well as providing an alternative perspective on results produced by the granular models. For instance, average projections coming from granular mortgage impairment models could be compared to industry level projections built on aggregate data.

40. Finally, there is an active Research & Development (R&D) program at the BoE to develop "system" models, which examine interconnectedness between financial institutions, spillover effects into and back from the real economy. Within the context of the concurrent stress test, these models can serve to estimate amplifier effects on bank losses, as well as yet another set of challenger results at the very aggregate level. A notable example is the risk assessment model of systemic institutions (RAMSI); Burrows, Learmonth and McKeown (2012).

²⁰ See BoE 2015b, pp. 36.

RAMSI, which has been under development for several years, is a large-scale model of the U.K. banking sector, potentially well suited for system-level stress testing.

41. Type 1 and type 2 models have both micro- and macroprudential applications. On the microprudential side, these models—and especially the granular type 1 models—serve an important quality assurance role on the bank submissions. On the macroprudential side, they can be used in the scenario design process to quickly sift through a range of candidate scenarios such that the chosen scenario indeed probes the vulnerabilities of the banking system. While surely useful for the specific design of the annual countercyclical scenario, this process would be especially useful in designing the biannual exploratory scenario. To operationalize efficient scenario generation, models are needed to generate quick-impact results of a candidate scenario. Indeed, the existing model architecture is already used for this purpose. Finally, the same architecture can be used by the BoE to do quick “off-line” stress tests outside of regular cycle without burdening the banks and/or unduly alarming the public with creative scenarios. Given the variety of uses relevant to core activities of banks, returns on investment in type- 1 and -2 models seem high.

42. The FDSF is not the only source of regularly submitted firm risk and stress testing data. As part of the ICAAP submission, firms also submit data with supporting documentation that is used by the PRA, among other things, to inform the Pillar 2A capital charge. There is work underway at the BoE to set up a more consistent database to allow for more flexible analysis. These data are already used in the concurrent stress test process to help form a view on a given firm’s stress test results.

43. A robust analytical infrastructure is at the core of an effective stress testing program. It serves as effective quality assurance of the bank generated projections. This is especially important since the BoE uses the banks’ own projections as the starting point for its assessment, subject to challenge and possible adjustments. Given the powerful incentives for banks to refrain from generating conservative projections, supervisory models allow for an independent view of bank-generated results.

44. Implementing a stable data model and architecture is a necessary condition to build out a robust analytical infrastructure. Building a robust model infrastructure requires substantial planning and investment in modeling resources, not just for the initial build but also for subsequent model maintenance. This, in turn, requires a robust and relatively stable data model and data architecture. With these in place, internal data modeling can become more predictable allowing for planning and longer-term investment in analytics. Moreover, banks are then able to invest in robust systems to populate the templates that feed the data model.

45. The specific recommendation for the medium term is to accelerate investments along two dimensions:

- *Settling the core data model.* The data submission format, e.g., FDSF and organization of other stress test relevant data elements, e.g., from firm ICAAP submissions, need to be settled as soon

as is practicable to allow for investment in infrastructure both at the BoE and at the supervised banks;

- *Building out the supervisory model and analysis infrastructure.* To effectuate robust quality assurance of bank submissions, the BoE has broadly three types of models used in the overall stress testing process: (1) granular models using data submitted by the firms via the FDSF (firm data submission framework); (2) product or sector specific models using industry or other data sources; and (3) “system” models that examine interconnectedness, spillover effects, etc. Investment should be accelerated, especially in type 1 and 2 models.

D. Disclosure

46. The disclosure regime balances two needs: information dissemination and information protection: the need to be sufficiently detailed to allow verification of process and results (information dissemination) without being so granular as to invite gaming and risk revealing information that the firms may reasonably view as proprietary and market sensitive (information protection). Generous disclosure on both process and results is particularly important in a crisis when a key objective is to restore confidence in the banking system, meaning both the banks and the banking supervisors.

47. The disclosure regime of the BoE’s concurrent stress test represents a good balance between these benefits and some of the costs observed by Goldstein and Sapra (2013). They point out, among other things, that the signal from the regulator, now (post-crisis) highly credible, may drown out signals from the banks’ own disclosures of risk-relevant information, both hampering market discipline and inducing strategic behavior in bank disclosures. Moreover, as the disclosure becomes more granular, it risks revealing information that the firm may reasonably view as proprietary and market sensitive.

48. Judgment about the severity of a stress test can be made both at the front end, the scenario, and the back end, the impact on the banks’ financials. Disclosure on bank-level and more aggregate results serve this purpose. Indeed, the translation from the scenario to outcomes is what determines any action at the bank (or system) level, which is why some description of this process is needed to support that it was done rigorously.

49. The entire process, from release of the scenario (late March), to publication of results (beginning of December) takes eight months. Bearing in mind that the balance sheet cut-off date is the prior year-end; by the time the results are disclosed, they represent bank resilience from 11 months ago; see also the discussion below in Section E and Figure 7 for a complete timeline.

50. Bank-specific results are largely limited to summary measures like post-stress test ratios and thereby capital depletion due to the stress scenario. Banks are allowed to take some mitigating actions, and their impact is reflected in the disclosures. Importantly, the capital impact is shown with and without “strategic” management actions such as expense reductions attributable to cuts in staff costs, to allow the public to judge how much or how little flexibility for maneuver a bank would have in the face of a stressful market and economic environment. This disclosure also allows

for evaluation of the degree of conservatism or discipline the supervisor has exercised over the banks on whose calculations these results are based. Table 2 in BoE (2015b) is reproduced below as Figure 3 for illustration.

Figure 3. United Kingdom: 2015 Stress Test Results—Bank Level Capital Ratios

Table 2 Projected CET1 capital ratios and Tier 1 leverage ratios in the stress scenario^{(a)(b)}

Per cent	Actual (end-2014)	Minimum stressed ratio (before the impact of 'strategic' management actions or AT1 conversion) ^(c)	Minimum stressed ratio (after the impact of 'strategic' management actions and before AT1 conversion) ^(c)	Minimum stressed ratio (after the impact of 'strategic' management actions and conversion of AT1) ^(c)	Actual (2015 Q3)
CET1 ratios					
Barclays	10.2	6.8	7.3	7.3	11.1
HSBC	10.9	7.0	7.7	7.7	11.8
Lloyds Banking Group	12.8	9.5	9.5	9.5	13.7
Nationwide ^(d)	19.8	19.1	19.1	19.1	21.9
The Royal Bank of Scotland Group	11.1	5.9	6.1	6.1	12.7
Santander UK	11.9	9.5	9.8	9.8	11.7
Standard Chartered	10.5	5.1	5.4	5.4	11.4
Aggregate ^(e)	11.2	7.2	7.6	7.6	12.2
Leverage ratios					
Barclays	3.7	3.2	3.3	3.3	4.2
HSBC	4.8	3.5	3.7	3.7	5.0
Lloyds Banking Group	4.9	3.9	3.9	3.9	5.0
Nationwide ^(d)	4.1	4.1	4.1	4.1	4.2
The Royal Bank of Scotland Group	4.2	2.9	3.0	3.0	5.0
Santander UK	3.8	3.3	3.4	3.4	4.1
Standard Chartered	4.5	2.8	3.0	3.0	4.8
Aggregate ^(e)	4.4	3.4	3.5	3.5	4.7

Sources: Participating banks' published accounts and FDSF data submissions, Bank analysis and calculations.

(a) The CET1 capital ratio is defined as CET1 capital expressed as a percentage of risk-weighted assets, where these are defined in line with the UK implementation of the CRR via the PRA Rulebook.

(b) The end-point Tier 1 leverage ratio as defined in the FPC's leverage ratio review, taking into account the European Commission Delegated Act on the leverage ratio.

(c) The minimum CET1 ratios and leverage ratios shown in the table do not necessarily occur in the same year of the stress scenario for all banks.

(d) For Nationwide the stress tests are based on an estimated 4 April 2015 balance sheet, rather than end-2014. See Annex 1 for more details.

(e) Aggregate CET1 ratios are calculated by dividing aggregate CET1 capital by aggregate risk-weighted assets. Aggregate leverage ratios are calculated by dividing aggregate Tier 1 capital by aggregate exposure measure.

Source: BoE (2015b).

51. Bank-level results are complemented by more aggregated disclosures, which lend insight into asset quality and profit-generation capacity. With information about portfolio composition for a given bank, market participants can make inference about that bank's projected loss profile from the aggregate level results. Consider the following examples from the 2015 exercise:

- Disclosure on impact by asset class or geography. The asset-class-level results can give hints about the impact of the scenario on nonparticipating banks since some information about portfolio composition is usually available. For an example, see Box 3.
- Disclosure of profits. Profit generation capacity in a stressful environment provides important insights into bank resilience. For an example see Box 4.
- Disclosure of impact on *trading*. Some banks have significant capital markets activities, so the stress test must accommodate those business models and probe their vulnerabilities. For points to consider see Box 5.

Box 3. Disclosure on Impact by Asset Class or Geography

In this example (Figure 4), loss impairment is shown graphically in three ways: first (labeled “Chart 12”) by borrower category (individuals, nonfinancial businesses) and U.K./non-U.K. across banks; second (labeled “Chart 13”) by bank for a given borrower category (in this case lending to individuals) split between mortgage and nonmortgage; and third (labeled “Chart A”) which shows impairments by major region aggregated across both individuals and (nonfinancial) businesses.

Starting with “Chart 12”, both absolute (GBP) and relative (percent) impairments were higher from overseas exposures than from the U.K. Some of that may be driven by a harsher scenario in non-U.K. geographies, especially East Asia, and some by differences in portfolio risk characteristics. An observer might be able to tease apart some of these effects by careful consideration of the different relative macro shocks by region, but an unambiguous attribution is not possible without knowing more about portfolio composition by bank.

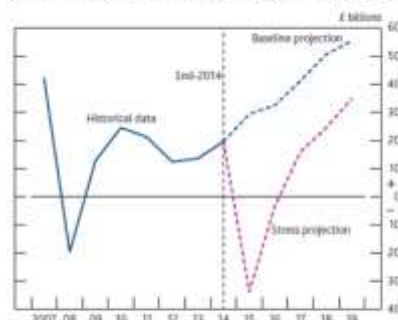
A similar conclusion can be drawn from “Chart 13” that shows bank-level results just for U.K. retail exposures, split between mortgage and nonmortgage. In absolute terms, impairments from nonmortgage lending swamp mortgage losses. Some of this is surely driven by the size of the house price shock which, at -20 percent, was milder than the -35 percent in the 2014 stress test; see also above. But it is harder to pin down what is driving the non-mortgage results since it is a mixture of different products (auto, personal loans, etc.) with rather different risk characteristics. Barring serious concern about this asset class or mix, this level of granularity in disclosure may well be sufficient.

One of the biggest differences in disclosure between the 2014 and 2015 Results documents is the addition of major non-U.K. regions, motivating presenting impairment results by geography. “Chart A” gives both a sense of scale of exposure (the bars showing impairment in GBP) and an indication of relative riskiness (the diamonds show the impairment rate). To allow observers to judge if the stress test was applied with sufficient rigor and conservatism, both the baseline and stress results are displayed. Note that these are impairment rates averaged across retail and commercial portfolios. So for instance, when comparing the impairment rates for the U.K. with China and Hong Kong SAR, baseline to stress was just under two and just over three times, respectively. Behind those outcomes are different scenarios. For instance, U.K. home prices dropped just 20 percent while China’s dropped 35 percent and Hong Kong 40 percent. Of course other risk factors are also at play.

Box 4. Disclosure of Profits

Consider profitability projections under baseline and stress, as well as impairment projection by major geographic region in. Profitability modeling under stress is not yet as well developed as credit and market risk stress loss modeling but can have a big impact on the final results, so focusing some attention in the disclosures is worthwhile. The difference between the baseline case, effectively the expected performance, and the stress case is dramatic. It helps to assure observers that a rather stressful scenario also resulted in profitability that is projected to be even worse than observed during the financial crisis.

Chart 4 Projections for aggregate profits before tax, after the impact of ‘strategic’ management actions^{(a)(b)}



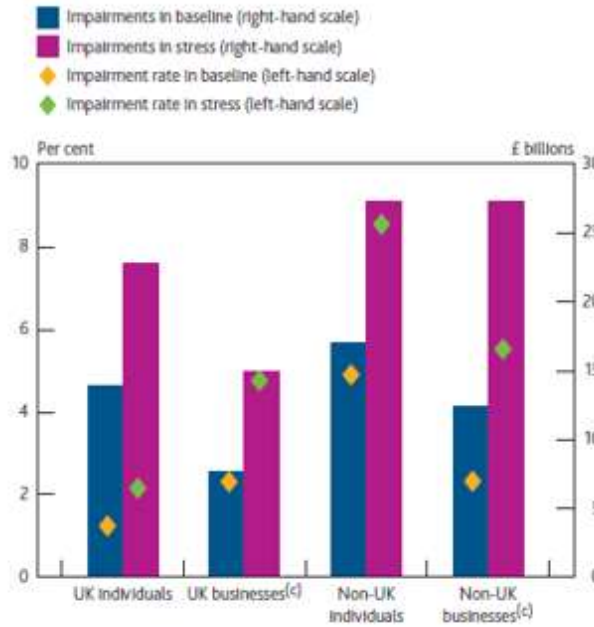
Sources: Participating banks' 2015 data submissions, bank analysis and calculations.

(a) For HSBC and Standard Chartered, annual profits are converted from USD to sterling using exchange rates consistent with the scenarios.

(b) 2007 data include the profits before tax of Alliance & Leicester (subsequently reported as part of Santander UK). 2007 and 2008 data include the profits before tax of Lloyds TSB Group and HBOS (subsequently reported together as Lloyds Banking Group).

Figure 4. United Kingdom: 2015 Stress Test Results—Impairments

Chart 12 Projected cumulative five-year impairment charges on lending to individuals and businesses^{(a)(b)}

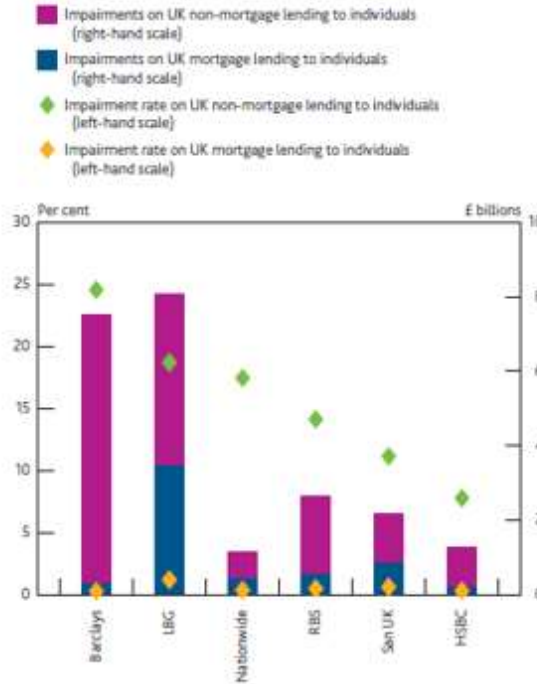


Sources: Participating banks' FDSF data submissions, Bank analysis and calculations.

- (a) Cumulative impairment charge rates = (five-year total impairment charge)/(average gross on balance sheet exposure), where the denominator is a simple average of 2014, 2015, 2016, 2017, 2018 year-end positions. This calculation may result in a lower impairment rate for those banks that expand balances significantly late in the stress as the economy starts to approach recovery. The HSBC and Standard Chartered impairment charge is calculated by first converting each component to sterling using exchange rates consistent with the stress scenario.
- (b) Data exclude material associates.
- (c) Businesses are non-financial businesses.

Source: BoE (2015b).

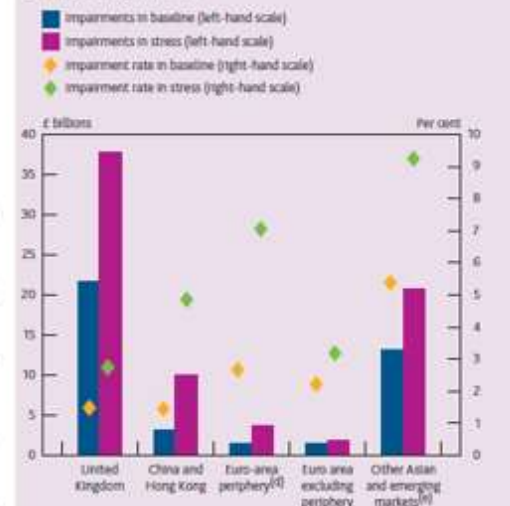
Chart 13 Projected cumulative five-year impairment charges on UK lending to individuals in the stress^{(a)(b)}



Sources: Participating banks' FDSF data submissions, Bank analysis and calculations.

- (a) Cumulative impairment charge rates = (five-year total impairment charge)/(average gross on balance sheet exposure), where the denominator is a simple average of 2014, 2015, 2016, 2017, 2018 year-end positions. This calculation may result in a lower impairment rate for those banks that expand balances significantly in the later years of the scenario as the economy recovers. The HSBC impairment charge is calculated by first converting each component to sterling using exchange rates consistent with the stress scenario.
- (b) Standard Chartered is excluded as it has minimal UK lending exposures.

Chart A Projected cumulative five-year impairment charges on loans to individuals and businesses in selected regions^{(a)(b)(c)}



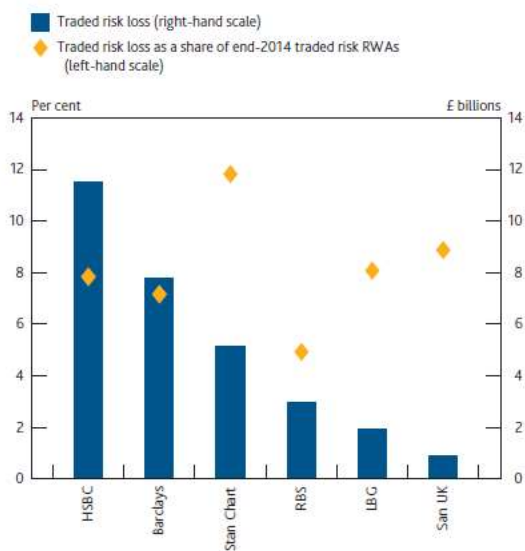
Sources: Participating banks' FDSF data submissions, Bank analysis and calculations.

- (a) Cumulative impairment charge rates = (five-year total impairment charge)/(average gross on balance sheet exposure), where the denominator is a simple average of 2014, 2015, 2016, 2017, 2018 year-end positions. This calculation may result in a lower impairment rate for those banks that expand balances significantly in the later years of the scenario as the economy recovers. The HSBC and Standard Chartered impairment charge is calculated by first converting each component to sterling using exchange rate consistent with the stress scenario.
- (b) Data exclude material associates.
- (c) Includes mortgages (including buy-to-let), other loans to individuals and loans to businesses.
- (d) Euro-area periphery is defined as Cyprus, Greece, Ireland, Italy, Portugal and Spain.
- (e) Other Asian and emerging markets include Korea, Singapore, Taiwan, Province of China and emerging market economies defined as countries not included in the IMF's group of Advanced Economies (Table B, page 148 of the IMF's October 2015 World Economic Outlook) to which UK banks had gross exposures greater than £10 billion as at end-2014. These include Brazil, India, Indonesia, Malaysia, Mexico, South Africa, Turkey and the United Arab Emirates.

Box 5. Disclosure of Trading Assets

Six of the seven firms were required to execute a trading shock.¹ There are four components to the traded losses (BoE, 2015b, p. 28): the direct marked to market impact (“market risk”); counterparty credit risk and credit value adjustment (CVA), which are losses due to derivatives exposures; and prudential value adjustment (PVA) which applies a degree of prudence where significant uncertainty in valuation exists such as with complex and/or very illiquid position. Disclosures of these results are a good example of providing enough detail to give insights, both on trading shock sensitivities for each bank and on category materiality, without revealing market sensitive and firm proprietary information. Disclosures by bank did not decompose the loss components; those components were shown by aggregating across banks.

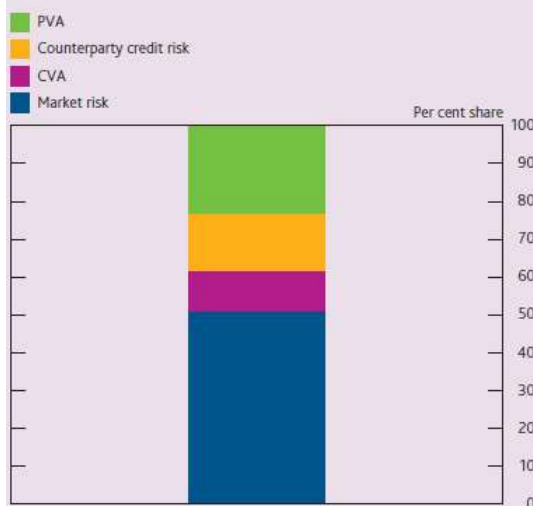
Chart 16 Traded risk losses under the stress scenario in 2015^{(a)(b)}



Sources: Participating banks’ FDSF data submissions, traded risk stress-testing submissions, Bank analysis and calculations.

- (a) Traded risk losses comprise: market risk, counterparty credit risk, CVA and PVA; and AFS and FVO parts of the banking book. Traded risk losses do not include investment banking revenues net of costs, to aid comparability between banks (for example allocation of costs to business lines may differ across banks).
- (b) Nationwide is excluded as it has minimal traded risk exposures.

Chart A Decomposition of traded risk losses under the stress scenario in 2015^{(a)(b)}



Sources: Participating banks’ traded risk stress-testing submissions, Bank analysis and calculations.

- (a) Traded risk losses comprise: market risk, counterparty credit risk, CVA and PVA; and AFS and FVO parts of the banking book. Traded risk losses do not include investment banking revenues net of costs, to aid comparability between banks (for example allocation of costs to business lines may differ across banks).
- (b) Nationwide is excluded as it has minimal traded risk exposures.

¹ Nationwide is not permitted to undertake trading activity with the exception of managing its liquidity.

52. In 2015, a separate misconduct cost component was added to the scenario, showing flexibility in scenario design. Because there remains considerable uncertainty in how the fines and legal settlements for crisis-related misconduct will unfold, including this add-on component would help to address some concerns regarding possible large outcomes. These costs are especially hard to estimate, requiring a lot of judgment; a stressed projection for potential misconduct costs and fines was included in the stress test results. Recognizing the sensitive nature of these results, the BoE only published an aggregate number of GBP 40 billion—this stressed misconduct cost projection was not a central forecast of misconduct costs and provisions in the period covered by the stress test. The disclosure document pointed out that at year end-2014, banks had already paid GBP 30 billion in fines and related costs since 2009, and had provided for an additional GBP 13 billion.

53. The disclosure document was not limited to just quantitative information and results. The BoE provided commentary on qualitative aspects and observations of banks' abilities to execute the stress test. These included comments on data quality, model risk-management capabilities, governance processes around interest income projections, and widely varying documentation standards. As bank capitalization continues to improve, these qualitative, largely microprudential aspects of the stress testing program will likely take on greater importance. The supervisory conclusions are informed by the separately run supervisory review and evaluation processes (SREP), which are complementary. These exercises, alongside all other relevant supervisory information help inform the decisions of the PRA Board on capital adequacy.

E. Governance

54. The BoE has a thorough but time-intensive governance process to oversee the concurrent stress testing program, bringing together a broad range of expertise and perspectives. Bank staff operate under the guidance of the FPC and PRA Board. The bank-specific results are approved by the PRA Board. The stress test results are used to inform the size of the various buffers, in particular, the UK countercyclical buffer rate and PRA buffers. If, upon review of the results of the stress test, the PRA Board and the FPC conclude that capital buffers need to be changed (either increased or decreased), the FPC moves first to consider the case for adjusting system wide capital buffers. Thereafter the PRA considers the capital adequacy of each individual bank, taking into account all available information, including the results of the stress test, any system wide buffer that has been set, any steps that the bank has taken to strengthen its capital position and the risk management and governance capabilities of the bank. If the exercise reveals a bank's capital position needs to be strengthened further, the PRA will consider the case for adjusting the PRA buffer.

55. The BoE faces three broad governance challenges: (a) balancing micro and macroprudential mandates; (b) avoiding group think; and (c) arriving at an objective and independent assessment of bank submissions and overall stress test results.

56. The BoE has both a macroprudential mandate through the FPC and a microprudential mandate through the PRA. These two mandates may be at odds with one another from time to

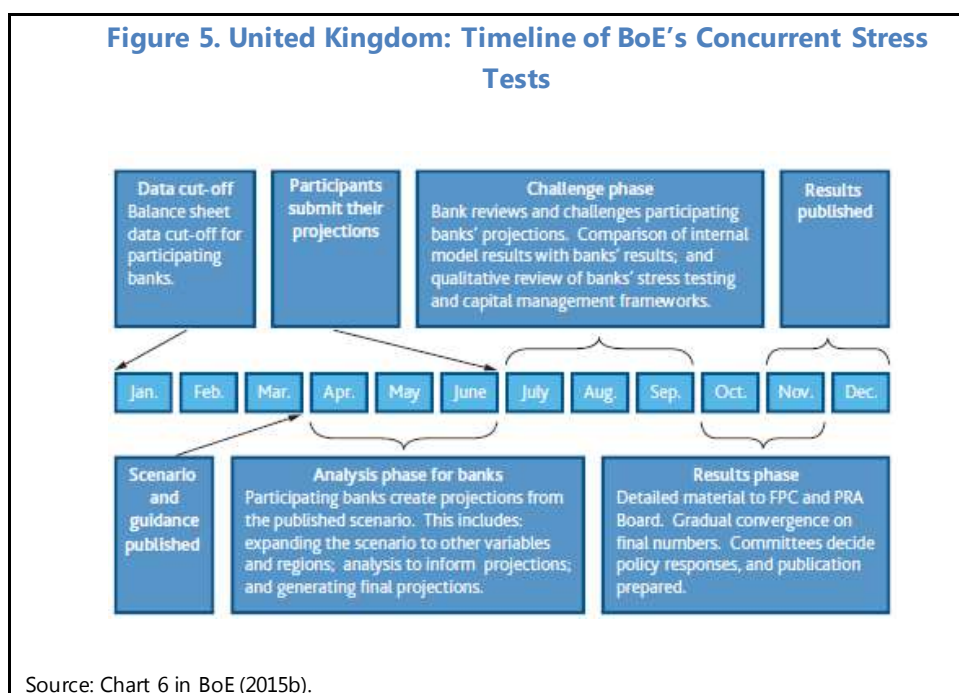
time; e.g. in an economic downturn, banks may be reluctant to extend credit creating the risk of extending or exacerbating the recession as firms and households are credit constrained. The concurrent stress testing framework has direct input into both mandates, and the different buffers are some of the tools used to help meet those mandates.

57. There are two important features of the governance process that help to manage and mitigate the potential conflicts between macro- and microprudential objectives. First, major decisions—choice of the stress scenarios, final results, and disclosures—are taken together after considerable debate from multiple sources; more on that below. Second, the decision on setting the U.K. countercyclical buffer is made by the FPC (which “owns” the macroprudential mandate) before the PRA Board takes the decision on sizing, on a bank-by-bank basis, the microprudential PRA buffer. This sequencing is important because any system-wide buffer can only be designed to work at an aggregate level, ignoring any heterogeneity that naturally exists across firms. That heterogeneity—in firm-specific risk profiles and concentrations—can then be accounted for one firm at a time by the microprudential supervisor, the PRA.

58. The second governance challenge is avoiding groupthink: any single institution is always at risk of myopic decision making, and the BoE’s governance process of the stress test has mechanisms in place to mitigate this risk. For example, the development of the stress scenario is done with broad participation from different parts of the bank to consider input from, for instance, economists in monetary analysis and international directorate and their insights into the macroeconomic and financial outlook, as well as supervisors and risk specialists from the PRA who bring insights into current bank risk profiles and vulnerabilities. Prior to finalizing the stress test results, the wealth of analysis from the challenge process of the banks’ submissions, plus any additional supervisory insights from, say, the most recent ICAAP submissions, are then debated in cross-bank challenge sessions by major area: retail, wholesale, net interest income, and so forth. Final recommendations are arrived at through a plurality of perspectives from across many disciplines and areas of the BoE. Both the FPC and PRA Board also include external members who provide challenge to the staff proposals.

59. The third challenge is arriving at an objective and independent assessment of bank submissions and overall stress test results. As stated clearly in the 2015 results document on p. 13, “Bank staff used participating banks’ own projections as a starting point and used a range of analysis to make adjustments to banks’ projections.” Because banks have powerful incentives to steer away from generating conservative projections of losses, profitability, balance sheet evolution and thus capital impacts, it is critical to gain an independent perspective of the results through the use of BoE-built models and analytical tools to be able to make an objective assessment. The BoE is fully aware of this tension and has a program in place to build up this analytical infrastructure. Section C has a more extensive discussion of the challenges still facing the BoE in realizing this objective.

60. The governance process follows the timeline of the BoE’s stress test which lasts eight months from the scenario release to disclosure of results (Figure 5). To facilitate the discussion, consider the expected timeline for 2016, which will have December 31, 2015, as the data cut-off for bank financials such as balance sheets. The scenario and guidance were released on 29 March, 2016.



61. Banks have three months (April to June) to complete the stress tests. There is a considerable amount of work involved in this time period, beginning with the expansion of the stress scenario. Even with 57 macro variable projections across several geographies plus 11 yield curve paths, banks may need richer specification of, for instance: credit spreads and other interest rates and real economic variables, such as regional home prices indices, especially if the bank has concentrated exposures in certain regions and/or asset classes. The bulk of the analytical effort is around the projections, i.e., the mappings or translation from the scenario to the stressed outputs: losses; profitability; balance sheet; and capital ratios. Finally, the submission has a wealth of supporting documentation often exceeding 1,000 pages.

62. Once the banks submit their results to the BoE, the quality assurance process by BoE staff begins. In this phase, the BoE is in regular contact with the banks to minimize data errors and misinterpretations of results. As discussed in Section C, the BoE makes use of a wide variety of analytical approaches and tools to review and challenge the bank projections. During this challenge phase, BoE staff present the results as submitted by the banks to a joint PRA Board and FPC meeting. This meeting is also used to provide initial perspectives on themes and issues that are emerging from the challenge process.

63. The next step towards final results involves considerations around adjusting the bank generated numbers. During the results phase (typically October/November), the FPC and PRA Board discuss the results of staff analysis and their respective policy responses. Final decisions on the results of the stress tests are made by the FPC and PRA Board the day before final publication. Publication is typically around the end of November/beginning of December.

64. By the time the results are disclosed, they represent bank resilience from 11 months ago since the balance sheet cut-off date is the prior year-end. One would be hard pressed to cut short the review and challenge process, even with the likely efficiency gain from a better-developed analytical infrastructure. However, that same infrastructure could help to shorten the release date of the scenario. Banks typically have their internal financials in place within two to three weeks of a quarter-end. Were they to receive the scenario, with instructions, by the end of January,²¹ they would be able to submit by end-April, cutting two months off the entire timeline without compromising either the production-and-review process at the banks or at the BoE. As the process matures and the data model stabilizes, further production efficiencies can likely be found.

CONCLUSION

65. Stress testing is an important regulatory tool employed by the BoE both through the concurrent stress test and the ICAAP. The concurrent stress test is a congruent and additive part of that regime, insofar as it adds a simultaneous stress with published results, whereas the ICAAP is a staggered exercise with different scenarios employed and where results are not public. However, there is room for improvement in designing an approach that is both additive to achieving the stated objectives and proportional. The BoE has specified that banks outside the concurrent stress test should consider using the annual cyclical scenario as part of their ICAAP assessment, but the BoE could consider whether greater synergies could be created between the two processes.²² Similarly, focus should be on improving elements of the concurrent stress test that are especially additive to the rest of the regime—that is in improving the value to market participants of the disclosed information, increasing speed/timeliness of the exercise to make the results more directly market-relevant, and potentially increasing the extent of disclosure.

66. A key component of financial stability is the resolution regime. If the failure of a large financial institution can be accomplished without major disruption of the financial system and concomitant adverse knock-on effects on the real economy, then the need for “thick” capital buffers—as determined by the stress test—becomes less critical. This seems to be the approach taken with the large subsidiaries of foreign banks via recovery, and resolution, planning requirements. However, it speaks to the tight linkage between a stress testing and resolution regime, a linkage that could benefit from more clarity. How plausible are the wind-downs, particularly if they were to occur in the stressful environments that the concurrent stress test simulates? What are the potential contagion or knock-on effects of the failure of a subsidiary or nonbank financial institution on the U.K. financial system? The BoE’s stress testing framework, supported by a solid and rigorous analytical infrastructure, could provide relevant insights into these, and other important questions.

²¹ This would broadly match the scenario release timing of the Federal Reserve’s CCAR program, which occurred this year on January 28.

²² <http://www.bankofengland.co.uk/prs/Pages/supervision/activities/stresstestscenario.aspx>

References

- BoE, 2015a, "The BoE's Approach to Stress Testing the U.K. Banking System." October 21. Available at <http://www.bankofengland.co.U.K./financialstability/Documents/stresstesting/2015/approach.pdf>
- _____, 2015b, "Stress Testing the U.K. Banking System: 2015 Results." December 1. Available at <http://www.bankofengland.co.U.K./financialstability/Documents/fpc/results011215.pdf>.
- BoE—PRA, 2015, "The Internal Capital Adequacy Assessment Process (ICAAP) and the Supervisory Review and Evaluation Process (SREP)," Supervisory Statement | SS31/15. Available at <http://www.bankofengland.co.U.K./pra/Documents/publications/ss/2015/ss3115update.pdf>
- Burrows, O., D. Learmonth and J. McKeown, 2012, "RAMSI: a Top-down Stress-Testing Model." Financial Stability Paper No. 17, BoE. Available at http://www.bankofengland.co.U.K./financialstability/Documents/fpc/fspapers/fs_paper17.pdf.
- Demekas, D. G., 2015, "Designing Effective Macroprudential Stress Tests: Progress so Far and the Way Forward," IMF Working Paper 15/146.
- Goldstein, I. and H. Sapra, 2013, "Should Banks' Stress Test Results be Disclosed? An Analysis of the Costs and Benefits," *Foundations and Trends in Finance*, Vol. 8, 1-54.
- Finansinspektionen, 2015, "Decision Regarding the Countercyclical Buffer Rate." Decision, FI Ref. 15-11646. Available at http://www.finansinspektionen.se/upload/90_English/20_Publications/20_Miscellaneous/2015/kontracykliskt-buffertvarde-beslut-2015-09-07-eng.pdf
- Greenlaw, D., A. Kashyap, K. Schoenholtz and H. S. Shin, 2012, "Stressed Out: Macroprudential Principles for Stress Testing," U.S. Monetary Policy Forum Report No.5, Initiative on Global Markets, University of Chicago Booth School of Business. Available at http://www.hks.harvard.edu/m-rcbg/rpp/Greenlaw_Kashyap_Schoenholtz_Shin.pdf.
- Hirtle, B., T. Schuermann and K. Stiroh, 2009, "Macroprudential Supervision of Financial Institutions: Lessons from the SCAP," FRB of New York Staff Report No. 409. Available at https://www.newyorkfed.org/research/staff_reports/sr409.html
- Hirtle, B. and A. Lehnert, 2014, "Supervisory Stress Tests," FRB of New York Staff Report No. 696. Available at https://www.newyorkfed.org/research/staff_reports/sr696.html
- Kahneman, D., 2011, *Thinking, Fast and Slow*. New York: Farrar, Straus and Giroux.
- Kapinos, P.S. and O.A. Mitnik, 2015, "A Top-Down Approach to Stress-testing Banks". Forthcoming, *Journal of Financial Services Research*.
- Ong, L. L. and C. Pazarbasioglu, 2013, "Credibility and Crisis Stress Testing." IMF Working Paper 13/178.
- Tucker, P., S. Hall and A. Pattani, 2013, "Macroprudential Policy at the BoE," *BoE Quarterly Bulletin* Q3, 192-200.