RAMSI: a top-down stress-testing model developed at the Bank of England

By Oliver Burrows, David Learmonth, Jack McKeown and Richard Williams of the Bank's Risk Assessment Division.[1]

Top-down stress testing is one way of assessing the resilience of the financial system to the risks it might face now or in the future. The Risk Assessment Model of Systemic Institutions (RAMSI) developed at the Bank of England is an example of a top-down stress-testing model and is part of the Bank's risk assessment toolkit. This article offers an overview of RAMSI and illustrates its use in the stress tests carried out during the IMF's 2011 UK Financial Stability Assessment Program.

Introduction

The Risk Assessment Model of Systemic Institutions (RAMSI) developed at the Bank of England is a large-scale model of the UK banking sector that is designed to assess the solvency and liquidity risks faced by banks. RAMSI is a 'top-down' model: its focus is as much on the banking system as a whole as on individual institutions. Top-down stress testing applies the same model and the same set of assumptions to each bank. That allows for direct and transparent comparisons across banks, highlights particular areas of vulnerability in the banking system as a whole and captures the impact that actions by one bank can have on others in the system. The alternative, 'bottom-up' stress testing, uses a different model to assess each bank. This can capture more detailed bank-specific information than a top-down model, but does not allow for direct comparisons across banks.

In 2010, the Government outlined plans for reform of the UK regulatory framework, including the creation of an independent Financial Policy Committee (FPC) at the Bank of England. The FPC is charged with identifying, monitoring and taking action to remove or reduce systemic risks with a view to protecting and enhancing the resilience of the UK financial system. For more information on the FPC, see the box on page 206. In forming an assessment of the outlook for the stability and resilience of the financial sector, the FPC will consider a wide range of information, including outputs from models such as RAMSI.

RAMSI has been under development at the Bank of England for several years and previous publications have set out the details of the model.[2] This article provides a high-level summary of how RAMSI can be used as a tool to analyse the outlook for, and the risks surrounding, the UK banking sector. The first section gives an overview of RAMSI. The second section illustrates the use of RAMSI as a stress-testing tool, focusing

on the IMF's 2011 UK Financial Sector Assessment Program (FSAP).

The FSAP was constructed in early 2011. As a result, the FSAP stress test described in the article is not reflective of current conditions and the results do not take into account the changes in balance sheets, macroeconomic conditions or policy measures that have occurred since the time of the test.

An overview of the model

Structure of RAMSI

RAMSI is a model that generates projections for UK banks' profits. It uses a set of equations estimated by Bank staff to map projections for macroeconomic and financial variables, such as GDP and interest rates, into profiles for profits at the largest UK banks. The equations in RAMSI model each component of each bank's income. To do this, the equations use data from each bank's income statement, data on the composition of each bank's balance sheet (its stock of assets and liabilities) and projections for macrofinancial variables.[3] Alessandri et al (2009) describe the estimation and robustness of each of the equations. This article does not go into such detail, but instead focuses on the intuition underlying RAMSI and how it can be used in a stress-testing context.
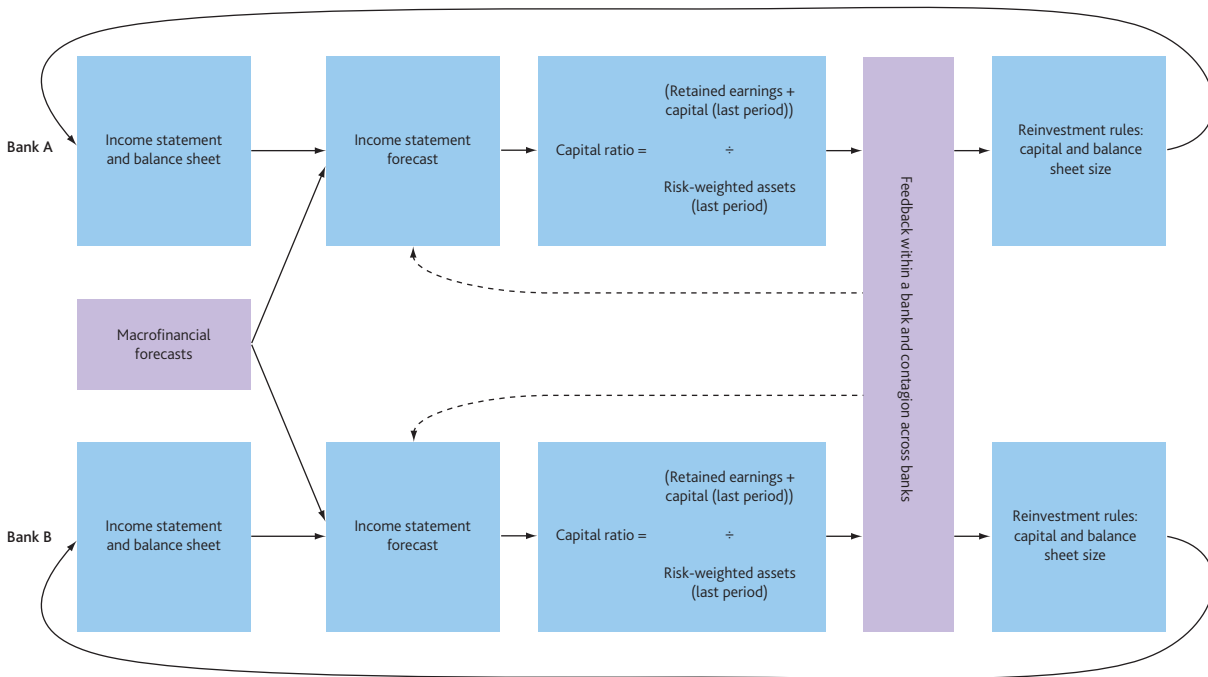
RAMSI is designed to be straightforward and easy to interpret. Forecasts of banks' income are largely based on simple econometric equations. And banks' responses to exogenous

Figure 1 Stylised overview of RAMSI

shocks are dictated by behavioural rules, not by the solution to a forward-looking optimisation problem. This makes it easy to trace the impact of a shock through the model and to provide a clear account of the result — an aspect that is particularly desirable in a policymaking context. But this approach does have some disadvantages. For example, the lack of optimising behaviour means that banks in RAMSI largely act in a passive manner, as discussed below.

Figure 1 gives a stylised overview of the sequence of events that occur in each period in RAMSI. The diagram shows just two banks for simplicity rather than all the banks in RAMSI.

Generating results and feedback effects
Starting from the left of **Figure 1**, there are two sets of inputs to RAMSI: banks' income statements and balance sheets, and forecasts of macrofinancial variables. These combine with the estimated equations in RAMSI to generate a projection for each individual item in each bank's income statement. Each bank's profit before tax can then be calculated as the sum of net interest income, trading income and other income, less credit losses and operating expenses. And each bank's retained earnings is that profit before tax less dividends and taxes.

Once retained earnings forecasts have been generated, each bank's capital position can be updated and its capital ratio can be calculated as the ratio of core Tier 1 capital to risk-weighted assets.[1] At this stage, feedbacks both within and across banks can occur, as represented by the dashed lines in **Figure 1**. For example, if bank fundamentals such as profitability and solvency were projected to worsen, banks would experience higher costs of funding in RAMSI. In addition, if fundamentals

passed certain thresholds, banks would be shut out of certain funding markets altogether, further pushing up their funding costs.

These feedback effects extend to interactions across banks. For example, a bank that is perceived to resemble a bank that has already been shut out of funding markets would experience an increase in the likelihood of being shut out of these markets itself.

The most direct forms of contagion occur when a bank suffers losses so severe that its capital ratio falls below a set threshold and it is deemed to have failed. Feedback effects then cause losses at other banks through, for example, counterparty credit exposures (when a bank defaults, other banks may experience losses on any assets they hold related to that bank) and asset fire sales (when a bank is in trouble it may sell assets, which can push down the prices of those assets and so cause mark-to-market losses at other banks).

Retained earnings and capital ratios
In the absence of bank failures, or after the feedback effects are completed, any retained earnings are used to update the banks' balance sheets. At this point, all top-down models have to make an assumption about what banks do with these earnings. One option is that banks use a certain proportion of their earnings to increase the amount of risk-weighted assets

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(1) Core Tier 1 capital is a commonly used measure of a bank's ability to absorb losses, and is defined as common shareholders' equity, adjusted for goodwill and intangibles and regulatory deductions. Risk-weighted assets are a measure of a bank's assets, such as loans to households and companies, weighted to take account of how risky they are. The risk weightings reflect the Basel Capital Accord as implemented by the Financial Services Authority.

The formation of the Financial Policy Committee

Safeguarding financial stability is one of the Bank of England's two core purposes. In 2010, the Government outlined plans for reform of the UK regulatory framework, including the creation of an independent Financial Policy Committee (FPC) at the Bank of England, a Prudential Regulation Authority (PRA) as a subsidiary of the Bank and a separate Financial Conduct Authority (FCA) to regulate conduct in financial markets and financial institutions not covered by the PRA.[1] In anticipation of legislation to create the FPC, the Government and the Bank announced the establishment of an interim FPC on 17 February 2011. The interim Committee comprises eleven voting members — five current executives from the Bank of England, the head of the PRA-designate, the Chairman of the Financial Services Authority (FSA), and four external members. The Head of the Conduct Business Unit of the FSA and CEO Designate of the FCA attends meetings in a non-voting capacity, as does a representative of HM Treasury.

The Government envisages that the FPC will contribute to the Bank's financial stability objective by identifying, monitoring and taking action to remove or reduce systemic risks with a view to protecting and enhancing the resilience of the UK financial system. Subject to that, a secondary objective for the FPC is to support the economic policy of the Government. The first policy meeting of the interim FPC was held in June 2011. The Government's consultation document states that the FPC will meet at least four times a year and will publish a record of its formal meetings. It will also be responsible for the Bank's twice-yearly *Financial Stability Report* (*FSR*).

The Government proposes providing the FPC with two main powers to address systemic risks. First, the FPC would have the power to make a recommendation that the PRA and FCA would have to either comply with or explain in writing to the FPC why they had not done so. The FPC could also make recommendations to bodies other than the PRA and FCA, but without the comply-or-explain mechanism. Second, the FPC would have the power of direction over certain macroprudential tools, which the PRA and FCA would be required to implement.

In March 2012, following HM Treasury's earlier request, the interim FPC agreed unanimously a statement outlining its advice on potential powers of direction for the statutory FPC. This included that the FPC should seek powers of direction over a countercyclical capital buffer, sectoral capital requirements and a leverage ratio. In addition to banks, the range of institutions to which these tools would apply could include building societies, investment firms, insurers and a variety of funds and investment vehicles. The Committee also identified a number of other potential instruments that may be desirable, but decided not to include them in its advice on initial powers of direction.[2]

Although lacking the proposed statutory powers of direction and recommendation of the statutory FPC, the interim FPC contributes to maintaining financial stability by identifying, monitoring and publicising risks to the stability of the financial system and advising action to reduce and mitigate them. For example, it has made recommendations that the major UK banks improve their disclosure of exposures and that they build a sufficient cushion of loss-absorbing capital against current risks.

In forming an assessment of the outlook for the stability and resilience of the financial sector, the FPC will consider a wide range of information, including outputs from models such as RAMSI. Recent *FSRs* provide an indication of some of the information that the FPC might consider in forming these assessments.[3]

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(1) See www.hm-treasury.gov.uk/d/consult_financial_regulation_condoc.pdf.
(2) See www.bankofengland.co.uk/financialstability/Documents/fpc/statement120323.pdf.
(3) For example, the June 2012 *FSR* can be found at:
www.bankofengland.co.uk/publications/Pages/fsr/2012/fsr31.aspx.

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they hold, and retain whatever is left over as capital. Another option is to assume that each bank has a specific capital ratio target in mind. In that case, banks would only increase their risk-weighted assets once they have met those targets.

As a conditioning assumption, the illustrations presented in this article assume that banks behave in accordance with the second option: they have a specific capital ratio target in mind. This seems an appropriate description of observed bank behaviour, especially in the current environment where the market is focused on banks' resilience. A number of profiles for each bank's capital ratio target could be specified: for example, banks could be assumed to have targets that are unchanged from their current ratios, or to have targets that increase over time, perhaps based on prospective regulatory requirements. If a bank does not earn sufficient profit to hit its capital ratio target, it will not increase its risk-weighted assets. If, however, a bank is at or above its capital ratio target, it will increase its risk-weighted assets to ensure a ratio equal to its target.[1]

Once any reinvestment of earnings has taken place, the next period begins. The updated assets and liabilities on each

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(1) Any increase in the size of a bank's balance sheet is assumed not to alter the composition of that balance sheet — so the proportions of the different types of risk-weighted assets in the balance sheet are unchanged.

bank's balance sheet combine with the macrofinancial conditions in that period, and the sequence of events shown in **Figure 1** is repeated. RAMSI is therefore a complex feedback loop. For example, if banks make sufficient income, they increase their risk-weighted assets, which can allow them to make more income, and so on.

The IMF's 2011 UK FSAP: illustrating the use of RAMSI as a stress-testing tool

RAMSI can be used to run stress tests of the UK banking system. Stress tests are forward-looking evaluations of the resilience of banks to a range of plausible but severe paths for the macroeconomy and financial markets. They provide supervisors, and the banks themselves, with a better understanding of weaknesses and vulnerabilities in the financial system, and can be an important input into supervisory actions and banks' planning decisions.

This section provides an example of how RAMSI can be used as a top-down stress-testing tool based on the example of the IMF's 2011 UK FSAP.[1] An FSAP is a comprehensive and in-depth analysis of a country's financial sector. For the world's 25 biggest and most interconnected economies, including the United Kingdom, these assessments happen every five years. The 2011 UK FSAP contained both top-down — using RAMSI and the IMF's Contingent Claims model — and bottom-up stress tests — run by the banks themselves under the oversight of the Financial Services Authority (FSA).

It is important to note that the 2011 UK FSAP was based on banks' balance sheets as they were at the end of 2010, and that the stress test was constructed in early 2011 — so it reflects the conditions at that time. As a result, the stress test described below is not reflective of current conditions and the results do not take into account the changes in balance sheets, macroeconomic conditions or policy measures that have occurred since the time of the test.

It is also important to note that there is always uncertainty around the results of any stress test. One reason for this is that an actual period of stress is likely to involve different paths for macroeconomic and financial variables than those assumed in the test. Moreover, even if the paths for the macrofinancial variables were correct, there would be uncertainty about how those paths would affect banks' income and capital ratios — RAMSI is only one possible model of that relationship.

The FSAP macroeconomic scenarios
The FSAP outlined a baseline and three distinct stress scenarios over a five-year period (2011–15). The baseline is a non-stress scenario, which provides a comparison for the stress scenarios. The baseline scenario in the 2011 UK FSAP was a projection of

the profits, losses and capital growth of banks under the specific assumptions for bank behaviour described below, combined with the IMF's central macroeconomic projections from its *World Economic Outlook*.

Two of the stress scenarios simulated 'double-dip' recessions of differing magnitude, one more moderate and one severe, and shared similarities with other stress tests: the European Banking Authority (EBA) stress-test scenario in the 2011 EU-wide exercise and the FSA's 2011 anchor stress-test scenario. The two scenarios involved simultaneous adverse demand and supply shocks, emanating from a sharp fall in demand from the rest of the world for UK exports and a rise in commodity prices respectively. The third scenario was unique to the FSAP, and outlined a negative shock to productivity that markedly reduced the trend growth rate of the UK economy.

The focus in this article is on the 'severe double-dip' stress scenario.[2] It involved annual average UK real GDP growth in 2011 of -0.2% (compared with +2.2% in the baseline), -2.6% (+2.0%) in 2012 and +0.2% (1.9%) in 2013 (**Chart 1**). The assumptions for both the baseline and the stress test were provided by the IMF to ensure that the results would be comparable with those from the other stress tests carried out as part of the FSAP.

**Chart 1** UK real GDP growth in the FSAP[a]
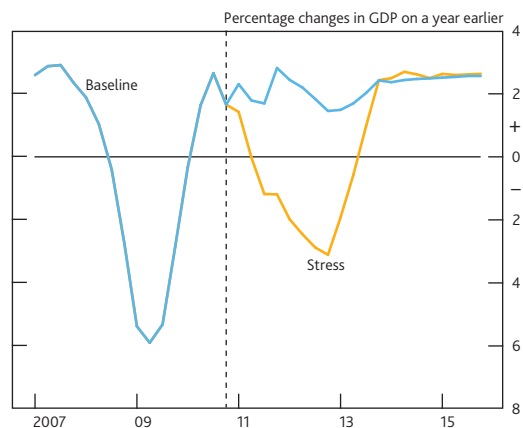
Source: IMF.

(a) Data to the right of the dashed vertical line are projections.

The severe double-dip scenario also included sharp falls in house and commercial property prices (**Chart 2**), as well as equity prices, along with a large persistent increase in the unemployment rate. Because the scenario included a shock to the United Kingdom's supply capacity, inflationary pressures were projected to remain fairly elevated, and abated only gradually. So despite depressed demand, short-term interest rates in these scenarios increased gradually over the forecast period, broadly in line with the baseline projection. Long-term

(1) For a general overview see www.imf.org/external/pubs/ft/scr/2011/cr11222.pdf.
(2) The results of the other two stresses can be seen in the Technical Note accompanying the FSAP: www.imf.org/external/pubs/ft/scr/2011/cr11227.pdf.

Chart 2 Non-financial asset prices in the FSAP[a]

Indices: 2007 Q1 = 100
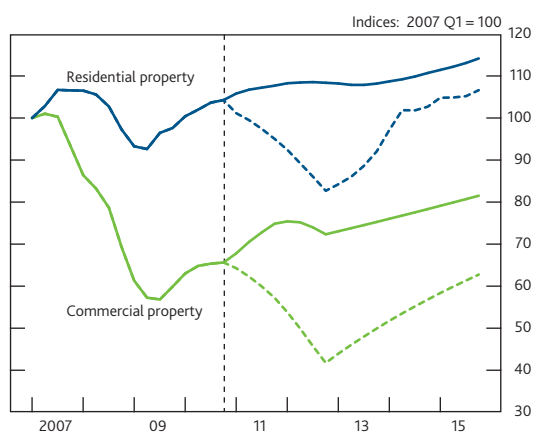
Sources: Bank of England, Department for Communities and Local Government, IMF, Investment Property Databank and Bank calculations.

(a) Solid (dashed) lines show baseline (stress) scenario. Data to the right of the dashed vertical line are projections.

interest rates were projected to be lower than in the baseline, however. Internal Bank of England macroeconomic models were used to generate projections for the other macrofinancial variables used in RAMSI but not fixed by the FSAP, such as household income gearing and unsecured debt levels.

Underlying assumptions made in the stress test

The conditions under which any test is run are an important determinant of the results, and small changes in definitions can lead to large changes in the results. The main assumptions underlying the top-down stress tests are described below.

Capital ratio targets

An important assumption in RAMSI is the choice of banks' capital ratio targets. As discussed earlier, these targets determine how banks use their retained earnings. For example, a high capital ratio target may lead to retained earnings being used to invest in safe assets, while a lower target might allow more room to increase risk-weighted assets. The choice will have implications for profits in the following period. On the one hand, riskier assets tend to have a higher yield. On the other hand, if capital ratios are too low then funding costs will tend to rise, eating into profits. Higher profitability will support balance sheet expansion in future periods. The FSAP stress test included relatively challenging capital targets.

The setting of capital targets is one of the ways that this particular illustration of a top-down stress test differs from the majority of stress tests. The FSAP bottom-up tests, for example, require each bank's risk-weighted assets to grow in line with nominal GDP, while the recent EBA stress tests imposed the assumption that risk-weighted assets were held constant over the projection. In the application of RAMSI illustrated here, risk-weighted asset growth is a function of banks' actual and target core Tier 1 capital ratios, and cannot be exogenously imposed.

Dividends

It is assumed that banks' dividend policies are linked to their capital levels in the baseline and stress scenarios. If banks are on course to meet their capital targets, then dividends are paid as a proportion of profits — where the proportions are calibrated based on those observed at the end of 2010. But if banks are not on course to meet their capital targets, they do not pay out dividends, and retain all income instead. There are other plausible assumptions that could be made about banks' dividend policies. For example, competition could lead banks to increase dividends prematurely.

Provisions

Banks set aside funds — provisions — to cover anticipated future losses, and how to treat those provisions appropriately is a challenging issue faced in all stress tests. The FSAP baseline and stress scenarios use the credit equations in RAMSI to forecast bank-by-bank write-offs. UK banks built up a stock of provisions from 2008 and, in the stress tests, banks are assumed to deplete that stock to cover some of the write-offs, using the assumption that starting stocks fall back halfway to their pre-crisis averages by the end of the projection. That is equivalent to forecasting lower credit losses than would be suggested by write-offs alone, and therefore boosts banks' profitability relative to that counterfactual.

Asset disposals

In line with the guidelines provided for the FSAP bottom-up tests and the recent EBA stress tests, the exercise did not incorporate planned asset disposals by UK banks. In practice, however, asset disposals would boost capital ratios by reducing risk-weighted assets. In that case, both the top-down and bottom-up results would overstate the need for banks to retain earnings to build up capital.

Haircuts

The FSAP assumed that the value of banks' holdings of certain debt instruments would be reduced in the stress scenario — those reductions in values, called haircuts, were applied to the UK banks' holdings of certain sovereign and bank debt. Banks' holdings of these assets were estimated using the most recent data available at the time of the exercise, which were Bank for International Settlements exposures data for bank debt holdings and 2010 Committee of European Banking Supervisors stress-test disclosure data for sovereigns.

Results under the stress scenario

The baseline and stress scenarios were run for the largest five providers of banking services to the UK economy: Barclays, HSBC, Lloyds Banking Group, Royal Bank of Scotland and Santander Group. The results of the baseline scenario are described in the box on page 210.

In the stress scenario, profits were projected to be materially weaker than in the baseline. Banks in aggregate were forecast

to make a small loss in the first year of the projection (2011) (**Chart 3**), and profits in future years were significantly lower than in the baseline scenario (**Chart 4**). Over the projection as a whole, those lower aggregate profits were due to lower trading income and net interest income, as well as higher credit losses and haircuts on debt.

Chart 3 also shows how the projections for profitability under the stress scenario compares to actual bank profitability during the financial crisis. In 2008, aggregate profits for the largest five UK banks were negative: two banks made large losses and profits dipped at the others. And profits remained low in 2009. In the stress scenario, aggregate profits in 2011 and 2012 were projected to be comparable to those made in 2008 and 2009, which suggests that the stress scenario represented a similar-sized shock to aggregate profits as that experienced during the crisis.

The total reduction in aggregate profits over the five years of the stress scenario, relative to the baseline, was around £115 billion (**Chart 4**), or 60% of profit in the baseline. The components of profit driving that result are described in more detail below.

Components of banks' profits

Net interest income

Across the first two years of the stress scenario, net interest income in aggregate was projected to be over £20 billion weaker relative to the baseline. In the stress scenario, banks' funding costs increased and because it was assumed that banks could not immediately pass on to customers that rise in their funding costs, banks' profitability was squeezed.

Credit losses

Credit losses were the largest driver of the reduction in profits in the stress scenario over the five-year period, reducing profits by around £50 billion relative to the baseline. But much of this effect was slow to come through, with the peak impact of the stress scenario on credit losses in 2014 (**Chart 4**). The lags in the transmission from macroeconomic deterioration to banks' credit losses reflects the fact that it takes time for borrowers to fall into distress following a shock to their income, and that it takes banks some time to record losses once borrowers have fallen into distress.

Trading income

The largest impact on profits over the first few years of the stress scenario came through trading income. Trading income was about £45 billion lower than in the baseline over the first three years of the stress scenario. Trading income fell during the 2008/09 recession and this experience was used to calibrate the likely fall in income given the fall in GDP in the stress scenario.
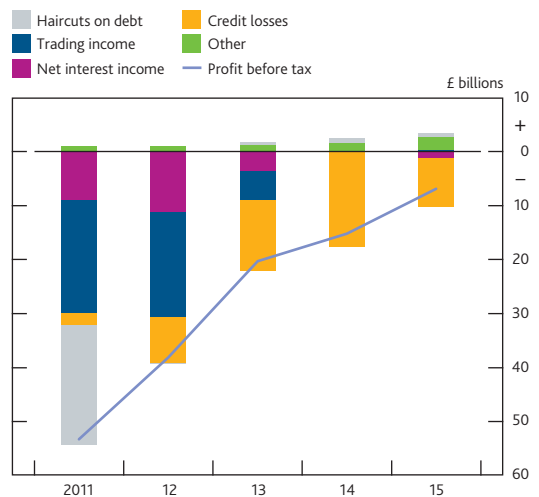
Chart 3 Aggregate profits in the stress scenario[(a)]
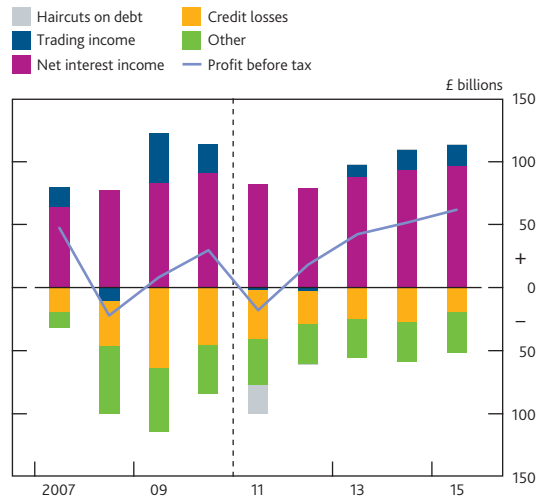
Sources: Published accounts and Bank calculations.

(a) Data to the right of the dashed vertical line are projections. The combination of other income and operating expenses is shown as 'Other'.

Chart 4 Aggregate UK banks' profits, stress scenario relative to the baseline[(a)]

Sources: Published accounts and Bank calculations.

(a) The combination of other income and operating expenses is shown as 'Other'.

Other income and operating expenses

Other income fell, relative to the baseline, in the stress scenario, in line with its historical procyclical relationship with GDP growth. But its effect on headline profits was muted by a fall in operating expenses, which are themselves related to income. As a result, their combined impact is negligible (**Chart 4**).

Haircuts

The haircuts had a large impact on aggregate profits in the first year of the stress scenario. They lowered profits by more than £20 billion in 2011, relative to the baseline.

Outcome for banks' capital ratios

The combined impact of these elements of profits pushed core Tier 1 capital ratios in the stress scenario materially

The baseline scenario

Chart A shows the breakdown of UK banks' profits before tax in the baseline scenario. Profits were projected to rise steadily over the five-year projection, largely driven by smaller credit losses. There are two factors behind this. First, as the macroeconomic outlook improved and unemployment fell, write-off rates declined. Second, the assumed partial release of excess provisions built up over the crisis to cover potential write-offs further reduced credit losses.

Chart A Aggregate profits in the baseline scenario[a]
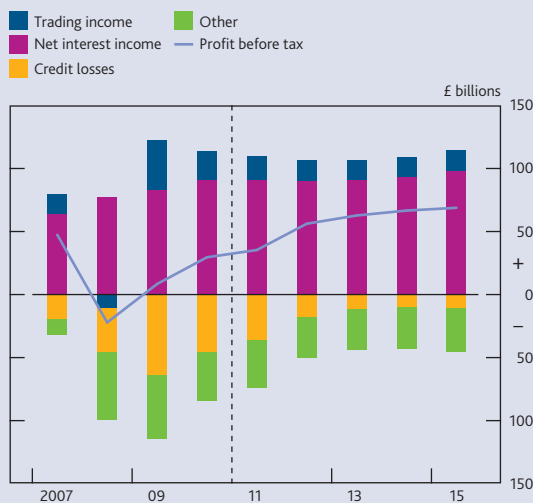
Sources: Published accounts and Bank calculations.

(a) Data to the right of the dashed vertical line are projections. The combination of other income and operating expenses is shown as 'Other'.

UK banks collectively generated a small increase in net interest income over the five-year period in the baseline scenario, due to the rise in short-term interest rates over the forecast period.[1]

The profitability of trading activity returned to around pre-crisis levels for most banks, although trading income over

the projection was substantially lower than the level seen in 2009.

The projected increase in profitability translated into higher capital ratios across the banks. **Chart B** shows that, on a Basel II basis, UK banks' aggregate core Tier 1 capital ratios were projected to increase by 5 percentage points over the five years in the baseline scenario.

Chart B Aggregate core Tier 1 capital ratio in the baseline scenario[a]
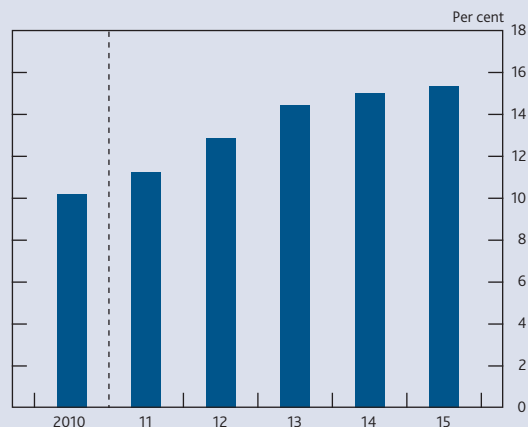
Sources: Published accounts and Bank calculations.

(a) Aggregate capital ratio defined as total core Tier 1 capital as a percentage of total risk-weighted assets. Expressed in Basel II terms. Data to the right of the dashed vertical line are projections.

As noted previously, banks may choose in practice not to meet the capital targets imposed in the exercise, or capital ratios may be increased through asset disposals. In both cases that would allow banks to increase their risk-weighted assets by more than suggested here. In addition, the projections did not take account of the possibility that banks could raise capital externally, for example, through public issuance in the equity markets.

(1) See Alessandri and Nelson (2012) for evidence of how UK bank profitability is affected by interest rates.

below the baseline scenario (**Chart 5**). And although capital did not fall sufficiently far at any bank to trigger the various crisis effects modelled in RAMSI — in which banks can be shut out of funding markets and/or forced to sell liquid assets, with knock-on effects for other banks — risk-weighted assets expanded at a slower pace than in the baseline scenario.

Taken at face value the results suggested that the UK banking system would have been resilient to a severe macroeconomic downturn. But the results are highly uncertain and are sensitive both to the top-down approach using RAMSI and to the particular assumptions that have been used.

Identification of system-wide risks

Although the UK banking sector appeared to be relatively resilient, the FSAP stress test highlighted some areas in which the UK banking sector might be vulnerable to specific shocks. One such risk is the potential for overreliance on wholesale funding. A prolonged period of higher funding costs could have a damaging impact on banks' aggregate profits.

The FSAP exercise also identified that haircuts on sovereign and bank debt could have a significant impact on system-wide profitability. In the second half of 2011, following the publication of the FSAP, banks' exposures to certain European sovereigns came under close scrutiny by financial markets.

Chart 5 Aggregate core Tier 1 capital ratios: stress and baseline scenarios[a]
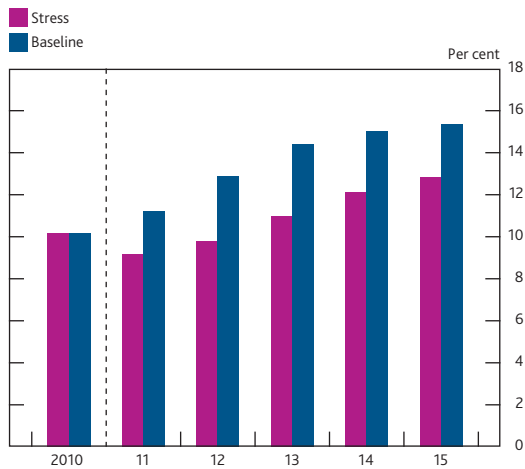
Sources: Published accounts and Bank calculations.

(a) Aggregate capital ratio defined as total core Tier 1 capital as a percentage of total
    risk-weighted assets. Expressed in Basel II terms. Data to the right of the dashed vertical line
    are projections.

Chart 6 Aggregate core Tier 1 capital ratios: bottom-up and top-down baseline scenarios[a]

Sources: FSA, published accounts and Bank calculations.

(a) Aggregate capital ratio defined as total core Tier 1 capital as a percentage of total
    risk-weighted assets. Data to the right of the dashed vertical line are projections.

Chart 7 Impact of the stress scenario on aggregate core Tier 1 capital ratios: bottom-up and top-down results[a]

Sources: FSA, published accounts and Bank calculations.

(a) Aggregate capital ratio defined as total core Tier 1 capital as a percentage of total
    risk-weighted assets.

And haircuts could potentially be larger than those assumed in the stress test.

In contrast, an increase in credit losses following a severe global recession was not identified as a prominent risk to the banking system. It is possible that that result reflected conservative provisioning by banks over the period before the test was run, in which case the results are informative. But equally, it could be the case that the modelling of credit losses in RAMSI understated the possible impact. And it is important to note that although the exercise suggested that UK banks could have withstood a generalised global slowdown, it could say little about their resilience to sharp downturns in specific regions of the world.

Comparison with the bottom-up results

An important check on the conclusions taken from the top-down stress test is to compare it with the aggregate bottom-up results, as shown in **Chart 6**. A notable difference between the results from the two tests is that the baseline core Tier 1 capital ratio projection was higher in RAMSI. It is difficult to identify exactly what drove that difference. One possible cause is the assumption about risk-weighted asset growth. Risk-weighted assets were assumed to grow in line with nominal GDP in the bottom-up tests, but were held flat until capital targets were met in RAMSI. The higher risk-weighted asset growth in the bottom-up tests would reduce capital ratios.

But despite the different baseline projections, comparisons of the impact of the stress scenario relative to those baselines is still useful. And the impacts on capital ratios of the stress scenario were broadly similar (**Chart 7**). But it is difficult to know whether this is due to the tests identifying the same risks and vulnerabilities to UK banks, or is simply due to chance.
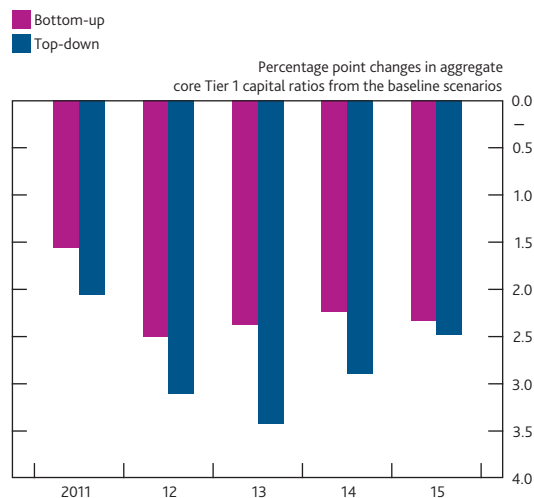
Overall, however, the similarity of the stress-test impacts provides some reassurance about the robustness of the results.

Conclusion

Top-down stress testing is a way of assessing the resilience of the financial system and can shed light on the vulnerabilities facing the system and the institutions within it. RAMSI is a top-down stress-testing model that has been developed at the Bank of England. The model makes it possible to consider the impacts of different macroeconomic stress scenarios on the UK financial system.

The RAMSI model was used as part of the IMF's 2011 UK FSAP exercise, alongside bottom-up stress tests run by banks and other top-down stress tests run by the IMF. It is important to note that the FSAP was based on banks' balance sheets as they were at the end of 2010, and that the stress test was constructed in early 2011 — so it reflects the conditions at that time. As a result, the stress test described in the article is not reflective of current conditions and the results do not take into account the changes in balance sheets, macroeconomic conditions or policy measures that have occurred since the time of the test. For example, the stress tests were carried out before the heightening of concerns, from the summer of 2011, about the sustainability of imbalances within the euro area.

The FSAP exercise tested the resilience of the UK banking system to a severe global downturn, which included large falls in UK output and property prices. The results from the RAMSI model suggested that such a scenario would have material impacts on UK banks' profits and capital ratios. In particular, the results highlighted the potential vulnerability of UK banks to wholesale funding market stresses and to substantial sovereign debt haircuts. But, despite these material impacts, the results suggested that the UK banking system was resilient enough to withstand the severe scenarios considered in the exercise. The results from RAMSI were consistent with the results from the other stress-test elements of the FSAP.

Looking ahead, the Bank hopes to develop RAMSI further to understand better the second-round effects that are the hallmarks of systemic crises. RAMSI already includes some prototype feedback mechanisms — for example, for funding liquidity and asset fire sales — but the aim is to improve these mechanisms as well as to introduce macroeconomic feedback loops.

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