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The Reserve Bank's philosophy and approach to stress testing

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Stress tests play an important role in the Reserve Bank's supervision of the banking system. Firstly, stress tests improve understanding of the implications of current and emerging risks to financial stability. Secondly, stress tests help assess the resilience of participating banks to severe but plausible scenarios. Results provide one lens on capital adequacy rather than a final conclusion, reflecting the uncertainty around how stress scenarios would play out and the level of capital required to maintain market confidence. Finally, supervisory tests make a significant contribution to the development of risk management capability at participating banks.

1 Introduction

Stress tests involve subjecting financial institutions to severe but plausible scenarios that are deliberately chosen for their potential to threaten the viability of their business model. By quantifying the impact of these scenarios on balance sheets and profitability, stress tests can help to both measure and manage the risks facing an institution. For example, stress tests are often used to assess financial resilience, inform changes to capital planning or other business practices, and assess contingency plans for mitigating the impact of stress scenarios.

The Global Financial Crisis prompted a significant increase in the use of stress tests, with stress tests becoming a well-established part of the banking supervision toolkit (Dent and Westwood (2016)). Supervisory stress tests involve subjecting several financial institutions to a common stress scenario, with oversight from regulators. Increased resourcing of stress testing is improving how tests are performed and incorporated into banking supervision (BCBS (2017)). Stress testing is also broadening beyond banks, with some regulators now regularly undertaking stress tests of insurance companies.

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Developing a comprehensive stress testing framework for the New Zealand banking system has been a strategic priority for the Reserve Bank in recent years. The Reserve Bank's objectives for supervisory stress testing are to:

- Investigate and understand the implications of current and emerging risks to financial stability;
- Assess the resilience of participating banks when subject to severe but plausible stress scenarios;
- Support improvements in the use of stress tests by individual banks to identify and manage the risks facing their business.

This article outlines the Reserve Bank's stress testing philosophy and approach to stress testing. We begin by placing the Reserve Bank's framework in a broader international context (section 2). We then summarise recent supervisory stress test activity (section 3), how stress tests are used to inform capital adequacy (section 4), and risks that aren't currently captured in typical stress test results (section 5). The final section concludes and discusses the future direction of stress testing in New Zealand. An accompanying *Bulletin* article outlines the results of a major stress test undertaken in conjunction with the Australian Prudential Regulation Authority (APRA) during 2017 (Lilly (2018)).

2 The Reserve Bank's framework in international context

Frameworks for supervisory stress testing vary markedly across regulators (table 1). At the intensive end, the Bank of England and the Federal Reserve dedicate significant resources to validating and benchmarking individual banks' results, have a prominent role for stress tests in setting banks' capital requirements, and publish individual bank test results to promote market discipline.¹ In contrast, regulators with less intensive frameworks tend to place less emphasis on stress test results in the capital framework and in market disclosure. For example, many regulators use stress tests only to provide insights into system risks and/or to review banks' own capital planning, and do not publish any stress test results.

The Reserve Bank's framework for stress testing involves a significant role for participant banks in assessing the impact of the stress scenario. Participating banks are expected to invest in stress testing models and infrastructure, and provide sign-off and oversight by leadership before submitting results. The benefits of this approach are that it allows a diverse range of views as part of supervisory stress tests, encourages banks to invest in frameworks to undertake their own stress tests, and promotes stress test frameworks that are credible to bank boards and senior management. By reinforcing the incentive of boards and senior managers to manage their own risks, this approach fosters the self-discipline pillar to financial soundness (Fiennes (2016)).

¹ Tarullo (2016) summarises the Federal Reserve's stress test framework, along with the findings of a review of their stress testing approach. See Bank of England (2015) for a summary of the United Kingdom framework.

Table 1
Range of practices when running supervisory stress tests

	Role	Range of practice		
		← Less intensive		More intensive →
Oversight of bank produced results	Validation and benchmarking of results assures quality and improve insights for supervisors.	Reasonableness test (eg compare to peers, past downturns).	Detailed instructions and some cross-checks (eg regulator models).	Intensive oversight of bank modelling. Granular data to cross-check or produce results.
Use of stress test results in supervision	Stress test can inform capital requirements, either for individual banks or for the financial system.	Provide insights into systemic risk and oversight of banks' own capital planning.	Provide insights into systemic risk and input to supervisory process.	Breach of minimum stressed capital ratio triggers regulatory action to increase capital.
Disclosure of stress test results	Disclosure can enhance public understanding of risks to stability and improve market discipline.	No public disclosure.	Disclosure of aggregated or anonymised results.	Publication of individual bank results (20% of regulators).

Source: BCBS (2017).

A downside of allowing participant banks a significant role in modelling stress scenarios is that it reduces the ability to benchmark results across banks. As discussed in Lilly (2018), different methodologies used by individual banks are likely to produce different outcomes for the same portfolio, even though supervisory stress tests include some common assumptions and instructions. To improve comparability of individual bank results, the Reserve Bank's stress tests typically include a second phase that involves increased use of common assumptions. Because it improves the Reserve Bank's ability to benchmark individual bank results, this phase of the stress test adds to the regulatory pillar of financial soundness.

Both phase 1 and phase 2 estimates are monitored closely by the Reserve Bank. Although phase 2 estimates are improving, they rely on simplifying assumptions and can still be biased by different approaches to risk measurement. For example, for corporate portfolios, phase 2 loss estimates are currently based on the probability of default assigned to a loan by the bank's own capital model. This limits the ability of the stress test to produce credit loss information that is comparable across banks. A potential area for future work is to collect more granular and standardised credit quality data from each bank.² This would enable more credible

² An example of an application of this approach was the RBNZ dairy portfolio stress test, which collected information on loan-to-value ratio and break-even payout that could be used to cross-check bank results. The dairy portfolio stress test is discussed further in section 2.

bank by bank loss estimates, giving more confidence that the differences in results across banks genuinely reflect differences in risk.

Compared to regulators that apply intensive stress testing frameworks, the use of individual bank stress test results by the Reserve Bank in setting capital buffers and promoting market discipline is relatively limited:

- Stress tests are used to provide insights into the adequacy of bank capital buffers, and can highlight vulnerabilities at the bank-wide level or in its various loan portfolios. However, the Reserve Bank does not take a mechanical approach to using stress test results in its supervision and, in practice, banks have maintained significant capital buffers under the scenarios tested to date (see section 3).
- The Reserve Bank publishes stress test results to provide insights into risks to financial stability for the public and market participants. The current practice is that individual bank results are not routinely published, although the Reserve Bank will publish ranges of stressed outcomes where this helps to illustrate the uncertainty around results.

An important factor limiting the use of individual bank results is that, as noted above, a significant proportion of variation between banks' stress test results is currently driven by different methodological approaches, rather than differences in actual risk. The Reserve Bank is also mindful that greater use of individual bank results in setting prudential requirements could increase the incentives for banks to under-report stress test losses and/or develop stress test frameworks that are less conservative. The role of individual bank results, including the publication of individual bank results, will be reconsidered over time as the stress test framework continues to evolve, and depending on the nature of the exercise in question.

3 An overview of stress testing activity

The Reserve Bank's stress tests have centred on the four largest banks. This reflects that these banks account for around 90 percent of banking system assets, as well as greater expectations around modelling capacity due to their accreditation as internal models banks.³ Stress tests are typically undertaken in conjunction with APRA. As the participating banks have parent banks in Australia, the stress test results for the New Zealand subsidiaries are clearly of interest to both the Reserve Bank and APRA. Scenarios in which the parent and subsidiary are both subject to stress are of particular interest for the Reserve Bank, since in that scenario the subsidiary is less likely to be able to rely on capital or liquidity support from the parent bank.

The Reserve Bank has run several supervisory stress tests in recent years, which have differed in their primary role and focus (table 2). With the loan books of major banks typically comprising more than 80 percent of their assets, there is an important role for cyclical stress tests that aim to understand the resilience of participating banks to a macroeconomic downturn. Cyclical scenarios mimic some of the worst downturns in advanced economies since World War 2, and typically feature sharp declines in economic activity and property prices, and stressed funding markets. By repeatedly assessing the impact of a similar downturn scenario, cyclical tests are used to track the resilience of the financial system over time (although the scenario will evolve based on new research and insights, such as the extent of over-valuation evident in property markets).

³ The only supervisory stress test of smaller banks to date was undertaken in 2014. Internal models banks are those banks that are allowed to model their own risk weights when calculating their capital ratio.

Table 2
Overview of Supervisory stress tests used in New Zealand

Type of test	Characteristics	Examples
Cyclical	Assess ability of financial system prudential buffers to absorb a severe downturn. Similar scenarios run over time to monitor resilience.	Macroeconomic downturn scenarios from 2009, 2011, 2014, 2015, and 2017 tests
Exploratory	Direct resource and attention to measuring a less well understood risk, or atypical macroeconomic downturns.	2016 Reverse stress test 2017 Operational risk scenario
Targeted	Develop a detailed and granular understanding of specific portfolio risk. Typically focuses on risks that are heightened at the time.	2015 Dairy portfolio stress test

Exploratory stress tests are used by the Reserve Bank to investigate new or emerging risks to financial stability that aren't captured by cyclical tests. For example, the 2016 reverse stress test gathered a range of exploratory scenarios, by asking individual banks to identify the most plausible scenario that would result in a breach of a minimum capital requirement – an outcome that is significantly more severe than found in cyclical tests. Scenarios identified included various forms of operational risk, and threats to the ability to generate underlying profit during the stress scenario. The Reserve Bank drew on these ideas for an exploratory scenario involving mortgage conduct risk as part of the 2017 test, and expects to test other scenarios in future stress tests. Several of the reverse test scenarios are discussed in more detail in section 4.

On occasion, the Reserve Bank will also target its stress tests at particular lending portfolios or a specific component of a bank's overall risk. An example of a targeted stress test is the 2015 dairy portfolio test.

Risks to the dairy sector had been part of previous stress test exercises, and were already a major focus for banks due to the widespread cash losses among dairy farms at the time. However, the portfolio test provided a much more granular assessment of the implications of continued low milk prices, and how banks would respond to this scenario (Dunstan (2016)). Participating banks reported that this approach led to very useful engagement with boards on risk appetite for dairy lending. The concept of a targeted test can also be incorporated into larger exercises – for example, the 2017 test required significantly more detailed analysis of banks' underlying profit.

Regardless of the category of stress test, the Reserve Bank aims to support improvements in industry capabilities as part of its supervisory stress tests. Banks' stress testing capabilities are assessed through: comparison of stress test results to peers, previous test results, and historical downturns; supplementary reports provided to the Reserve

Bank and discussions in engagement meetings; and reports prepared for boards on the implications of stress test results. RBNZ (2016) discusses best practice for bank's stress testing frameworks, including:

- **Credible modelling:** Stress test models should be improved over time with reference to international practices, and should be able to quantify the impact of changing portfolio quality over time. They should be built with reference to data from severe downturns (if necessary from the distant past or other countries), rather than relying on loan performance during a short history of benign economic conditions.
- **Conservatism and judgement:** Banks should allow a role for well-documented and conservative expert judgement, to recognise the significant uncertainty around stress test modelling. For example, banks are expected to challenge modelled stress test results against outcomes in past tests and historical downturns.
- **Use in strategic decision-making:** Stress test results should deliver risk information that is seen as a credible input to board decisions on capital planning, setting risk appetite and contingency planning. Boards should be aware of the uncertainty around stress test results and the key assumptions underlying them, and banks are encouraged to present sensitivity analysis showing the impact of these assumptions.

4 Insights for adequacy of capital buffers

Stress tests provide insights on the likely decline in capital ratios during specific scenarios, and can also shed light on whether capital requirements for specific loan portfolios are appropriate when compared to the potential losses on these loans. Assessing the implications of stress tests for capital adequacy, however, requires regulators to make judgements on the desired amount of system capital during the stress scenario. This standard for stressed capital ratios may need to take account of the nature of the specific stress scenario, views about what sort of capital levels the bank will need to maintain market confidence, and risks that may not be adequately captured by stress tests. For these reasons, the Reserve Bank uses stress test results as one lens on capital adequacy rather than a final conclusion.

An important question is whether capital buffers are sufficient to absorb stress without further amplifying the economic downturn. As bank capital ratios approach the minimum requirements, banks are likely to increase their attempts to mitigate the adverse conditions by cutting operating expenditure, increasing net interest margins or reducing exposures to riskier asset classes. Such 'mitigating actions' are regularly observed in individual bank stress test responses. Although these behaviours could be viable for an individual bank in isolation, tighter lending standards and fire-sales of stressed assets could worsen the downturn in economic activity and property markets if they are undertaken by many banks at once.⁴ Because of the difficulties in judging the viability of mitigating

⁴ The possible difficulties associated with this deleveraging strategy are supported by the cross-country evidence, which suggests that there are very few historical downturns where the banking system was able to reduce lending materially. The exceptions to this result are crises where bank failures were widespread.

actions, the Reserve Bank primarily focuses on results that exclude their impact.

Recent stress tests suggest that the major banks can maintain significant buffers above minimum capital requirements during stress scenarios. The capital buffers of the banking system have typically troughed at around 200 basis points above minimum capital requirements, with the most severe outcome to date being a buffer of 125 basis points.⁵ The decline in capital ratios typically proves short-lived, with retained earnings driving a significant improvement in capital ratios later in the scenario. Moreover, as these results exclude the impact of mitigating actions, it seems likely that banks would be able to maintain significant capital buffers without reducing their lending or significantly tightening lending standards. It is important, however, to reiterate the uncertainty around stress test results, as highlighted by historical examples where institutions encountered difficulties shortly after stress tests suggested they held adequate capital.⁶

The main driver of robust stressed capital buffers is the underlying profitability of the New Zealand banking system, with banks generally modelling this to remain strong enough to absorb substantial credit losses throughout the scenarios. The ability of the system to generate substantial underlying profits during the stress scenario further reduces the incentive for banks to drastically cut back on lending, as capital can be increased via retained earnings and/or additional capital issuance. It follows that an important issue to arise from the stress tests is whether

profitability would necessarily prove as durable to a stress event as the banks commonly claim. The following section discusses scenarios that could lead to higher losses or lower underlying profitability during a stress event, which would likely result in more severe outcomes for the banking system.

5 How uncertain are stress test results?

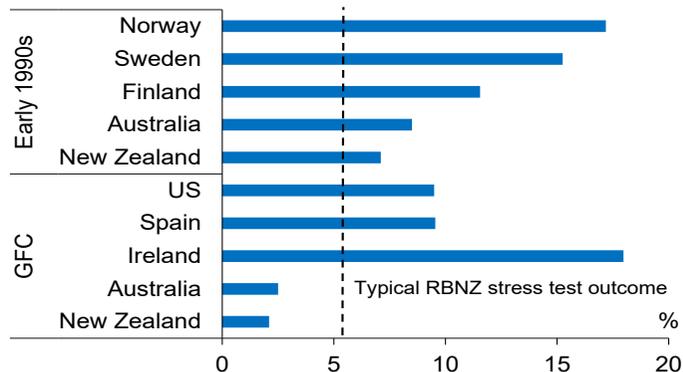
Banks expect to make losses that amount to around 4-7 percent of their initial loan portfolios throughout a typical stress test, which is well below the loss rates observed in some severe historical crises (figure 1). There are various factors that could explain this divergence. For example, domestic monetary policy and a falling exchange rate would provide a significant buffer for the New Zealand economy that was unavailable during many of these stress episodes in countries without floating exchange rates. Banks in New Zealand also appear to originate loans without utilising some of the extremely weak origination practices present in the US before the GFC. Nevertheless, historical loss rates highlight the scale of upside risk to stress test losses, especially given that they were often concentrated within a few years.

Historical experience and insights from stress tests suggest three key areas of upside risk to losses. First, residential mortgage losses could be higher than expected. Although banks' loss estimates are consistent with historical evidence prior to the GFC (Kragh-Sorenson and Solheim, 2014), household debt levels have increased significantly in recent decades and some countries experienced much higher loss rates on household loans during the GFC. Second, non-credit losses could emerge alongside a severe macroeconomic downturn. For example,

5 The quoted figures are formally referred to as the buffer ratio. Banks are subject to dividend restrictions when the buffer ratio falls to below 250 basis points, with the scale of the restrictions becoming progressively larger as the buffer ratio falls to zero.

6 Frame et al (2015) discuss the example of Fannie Mae and Freddie Mac, where stress testing prior to the GFC significantly underestimated losses and associated capital needs. Other examples include stress tests of the Irish and Icelandic financial systems undertaken by the IMF prior to the crisis; and Banco Popular failing in 2017 after maintaining buffers above minimum capital requirements during the 2016 stress test run by the European Banking Authority.

Figure 1
Estimated cumulative bad debt charge during historical crises
(% of total loans)



Source: Rodgers (2015), Drees and Pazarbaşıoğlu (1998), ECB, FRED, RBNZ.

compensation and fines for misconduct have been a significant driver of losses overseas following the GFC. Third, banks could face lags in disposing of non-performing assets, either because asset markets struggle to absorb rising stressed sales, or political and public pressures reduce the scale or speed of foreclosures. Delays to write-offs could result in higher losses on defaulted loans, larger expansion in risk weighted assets, and increased uncertainty about the eventual scale of losses.

The results of cyclical stress tests typically imply that banks are able to maintain underlying profitability by passing on most funding cost increases to new or re-financing customers. In deciding how aggressively to re-price their lending rates, banks would weigh the risk of reduced market share and/or increased defaults against a boost to profitability

that is likely to be significant.⁷ Based on the experience during the GFC and the fact that competitors are unlikely to be aggressively seeking market share while under stress, a significant re-pricing of loan rates is a plausible baseline assumption for stress tests. There are, however, a number of possible scenarios resulting in less relief from underlying profit.

Structural change

New Zealand banks' elevated profitability (by international standards) could prompt increased competition from a new entrant, reducing banks' net interest margins during a stress scenario. For example, increased competition could come from a well-capitalised foreign bank with a cheap funding source at home, or a financial institution offering digital banking services on a large scale and with low costs. It would present a significant challenge if the increased competition persisted throughout the stress scenario – a scenario from the 2016 reverse stress test, for example, assumed that NIM averaged only 100 basis points during the stress period. However, historical experience suggests that new entrants that have recently grown rapidly are more likely to come under stress during a crisis, which would limit their willingness and ability to maintain competitive pressure.

Name crisis

An individual bank facing a loss of confidence could be forced to pay more for its funding than peers, eroding their underlying profitability at

⁷ A simple analysis suggests that banks would have strong incentives, as a group, to increase loan rates. For example, a 25 basis point re-pricing of loan rates over the first three years of stress would generate enough net interest income to increase capital ratios by around 60 basis points. Although the impact of higher interest rates on loan defaults is much harder to quantify, overseas evidence on the relationship between loan rates and defaults (see Byrne et al (2017)) suggests the impact would be relatively small in comparison.

the prevailing market loan rates. This could occur quite suddenly, and would likely be a result of other underlying problems within that particular bank(s) – for example, a scenario from the reverse test assumed that idiosyncratic operational risk losses resulted in an individual bank suffering a 3-notch rating downgrade compared to peers. A name crisis fits with the pattern of historical crises, where losses have often been very unevenly distributed.⁸ An important aspect of a name crisis is that it would not affect all banks at once. This increases the likelihood that competitors could limit the economic impact of deleveraging by the stressed bank.

Speed of losses

If losses are mostly recognised in a short period (perhaps because banks are late to recognise customer deterioration, and continue to pay dividends until they do), underlying profitability will not be able to offset the losses to the same degree. As noted above, some international crisis events have demonstrated concentrated periods of loss.

6 Conclusions and future work

Stress tests are an important tool for investigating current and emerging risks to financial stability, monitoring the resilience of participating banks, and strengthening their risk-management capability. Recent supervisory stress tests have improved understanding of the likely implications of a severe macroeconomic downturn, and are increasingly exploring

⁸ For example, the worst affected banks during the early 1990s period of distress in Australia (State Banks of Victoria and South Australia) lost more than 300% of starting shareholders' funds, compared to 36% of starting shareholders' funds for the system (Gizycki and Lowe, 2000).

additional risks to the financial system. Reflecting the considerable uncertainty around stress test results, the Reserve Bank views stress tests as one lens on capital adequacy rather than a final conclusion.

Stress testing is still a relatively new field. The Reserve Bank expects to continue to evolve its stress testing framework in coming years, drawing on both developments in global stress test practice and the recommendations around stress testing from the IMF's recent Financial Sector Assessment Program (IMF (2017)). There are a number of areas where the stress test framework could potentially be improved:

- Exploring a broader range of risks: In addition to running regular cyclical tests, the Reserve Bank will continue to undertake exploratory stress tests. Consistent with the discussion in section 4, future tests could include the impact of a name crisis or structural change in business models. Liquidity risk is another area that is relatively undeveloped in typical stress tests, where there is an increasing focus internationally (BCBS (2013)). For example, a liquidity stress test could be used to provide insights into the sensitivity of the current BS13 liquidity policy to a variety of assumptions.
- Insights for the resilience of individual banks: It may be possible to make increased use of stress tests in assessing the risk of individual banks. One promising approach is to collect more standardised credit quality data alongside the stress test, and use this data to improve the sensitivity of stress test outcomes to actual bank risk. Improvements in this area would likely increase the case for greater use of individual bank results in supervision, and for publishing the results of individual banks to support market discipline.

- Expanding scope: Stress tests to date have primarily focused on the four largest banks. In the future the Reserve Bank plans to apply stress tests to smaller banks more frequently. The scale and complexity of these exercises would be tailored to ensure the resource cost is appropriate for smaller institutions. Stress tests are also being used by some regulators as a tool for monitoring the resilience of insurance companies, and this is another potential avenue for future work.
- Capturing feedback and amplification mechanisms: The current stress tests do not formally account for how an individual bank's actions could impact on the wider banking system. There is an evolving literature on modelling these feedback effects (BCBS (2015)). The Reserve Bank plans to continue to monitor this research, but in the near term expects to focus resources more on the other areas discussed above.

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