Stress testing New Zealand banks' dairy portfolios

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Stress testing a bank loan portfolio by estimating potential losses in a severe economic scenario provides a useful way of evaluating the risks that lenders face. This article describes a model that the Reserve Bank has constructed to analyse the risks facing banks that are lending to New Zealand's dairy farming sector, which uses detailed information gleaned from bank loan portfolios. Simulations using the model show that simultaneous declines in both the dairy payout and security values have the potential to cause the greatest loan losses for banks. This is to be expected because the reduced earnings tend to increase farm borrowing initially, while falling rural land values erode the banks' security values, making it more likely that a farm will exceed its borrowing limit. It is hoped that this exercise will assist banks to enhance their individual stress testing programmes and internal risk modelling by providing a base model for assessing credit risks in the dairy sector that can be customised for internal use.

1 Introduction

Stress testing a portfolio of assets (such as loans) involves evaluating what would happen to the portfolio in the face of various adverse events. Applied across a bank, a stress test can be described as "the evaluation of a bank's financial position under a severe but plausible [economic] scenario."[2] Stress testing is an important risk management tool for banks in evaluating their vulnerability to various types of risk across their balance sheet. The Basel II international capital framework has a specific role for stress testing to help ensure banks have sufficient capital to absorb unanticipated losses in severe economic downturns.[3]

As a central bank with a financial stability function, the Reserve Bank is also interested in stress testing at an aggregate level. Stress testing is particularly useful for assessing financial stability by highlighting the vulnerability of the financial system to certain risks. Stress testing can assist the supervision of individual banks, and help in the formulation of prudential policy.

A stress test may examine the consequences for banks of a full macroeconomic scenario that affects multiple aspects of the banks' business, or concentrate on a downturn in a particular sector. Stress tests can also be classified by the source of the models used for the test. Bottom-up stress testing sees participating institutions use their own models to determine the effects of scenarios determined by the regulator. The regulator then collates results to provide insights into the system-wide impact. This is the type of stress test the Reserve Bank undertook in 2003 (see RBNZ 2004) and again in 2009 in collaboration with the Australian Prudential Regulation Authority (APRA) and the Reserve Bank of Australia (RBA).[4]

A top-down stress test involves the regulator collecting data on the whole financial system or a particular part of it and applying a modelling framework themselves. The Reserve Bank has previously done work of this sort to analyse the residential mortgage lending of the banks (see Harrison and Matthew 2008). In this article, we describe a model the Reserve Bank has recently constructed to analyse risk in the dairy farming sector.

The dairy stress testing model presented in this article is a model of credit risk – the risk that a bank will take losses because borrowers do not repay their loans. A credit risk stress testing model involves imposing changes to key macroeconomic variables that affect performance in the sector of interest, relating these changes to borrower default behaviour, and estimating the losses to the lending banks from these defaults and foreclosures.

1 The authors thank Ian Harrison, Bernard Hodgetts, Michael Reddell and participants in Reserve Bank seminars for helpful comments, and contacts at the major banks for data and comments.

2 Basel Committee on Banking Supervision (2009) .

3 This requirement is unchanged in the recently released Basel III framework. For a discussion of the Reserve Bank's approach to the capital treatment of rural exposures under Basel II, see the accompanying article in this issue and also Hoskin and Irvine (2009).

4 For more information on the 2009 stress test, see box D in the May 2011 *Financial Stability Report*.

The purpose of the dairy stress testing model is twofold. First, it may enhance banks' individual stress testing programmes by providing a base model for assessing credit risks in the dairy sector that the banks may wish to customise for internal use. Second, the model provides valuable insights into the vulnerabilities within the dairy sector and potential impacts of stress in this sector on New Zealand banks collectively.

International experts have noted that stress testing prior to the financial crisis often did not identify many of the important risks that had built up prior to the crisis and caused problems during it (see BCBS 2009). For example Geradi *et al* (2008) note that many analysts looking at the US housing market around 2005 felt nationwide house prices were extremely unlikely to fall substantially, partly as this had not happened in most of the historical datasets used by analysts. As residential loan defaults had also not occurred in great quantity in recent history, a historical analysis such as a regression would have had trouble identifying the risks of substantial loan defaults occurring in the future. Additionally, when large defaults did begin, the regression relationship would be likely to suddenly revise up estimated risks, potentially leading banks to reduce credit supply in order to safeguard their balance sheets. This would make perceived risk 'procyclical' rather than the stable 'through the cycle' view of risk that models should ideally provide.

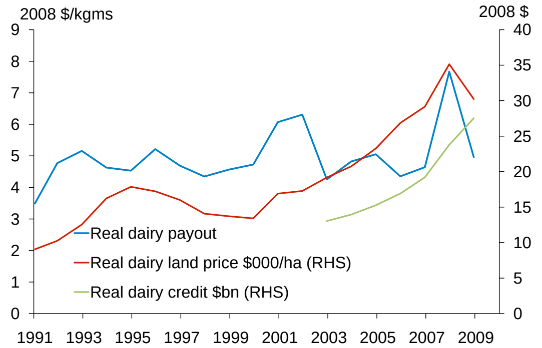
The recent financial crisis has demonstrated that expectations in credit markets (about property prices, for example) often become unrealistic during long economic expansions, and no modelling approach can completely counteract this inherent 'procyclicality' of the attitudes of banks and their customers. However, we consider that the modelling approach used in this paper overcomes some of the limitations described above. First, with recourse to a much larger historical dataset (including data from other countries), we are able to come to a more realistic view about plausible downturn scenarios. Second, rather than relying on a fully reduced form approach like a regression, we design a deeper model of the farming sector that incorporates cross-sectional data and considers realistic assumptions about what sort of events would lead a farm into default. These principles were also employed in the Reserve Bank's analysis of credit risk in the housing market.

In the remainder of this article, we provide some introductory material on the dairy farming sector in New Zealand and the data we gathered for the stress testing exercise. We then describe the model methodology in more detail and consider appropriate downside scenarios. Finally, we outline our results and provide some concluding comments.

2 The dairy farming sector

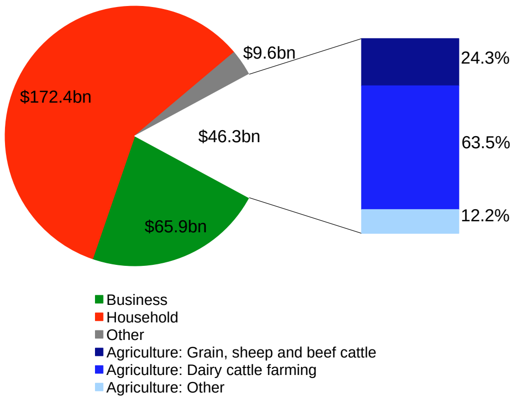
Debt levels in the dairy sector have increased markedly over the past decade, with high commodity prices and rising farm prices encouraging farmers to expand existing operations or to convert farms to dairying. Much of this activity was bank financed, with credit to the agricultural sector increasing at annual rates in excess of 15 percent. Following the peak in dairy prices at the end of 2007, dairy commodity prices fell sharply, leading to a large reduction in the dairy payout, and dairy land prices fell 16 percent in the year to June 2008. This downturn placed some farmers under significant financial stress. While the subsequent recovery in dairy returns has alleviated much of this stress, the experience served to expose the vulnerabilities associated with the dairy sector's heavy debt load.

Figure 1
Dairy land prices, commodity prices and credit



The agriculture sector comprises around 16 percent of total bank lending in New Zealand, up from around 9 percent a decade ago. The dairy sector alone accounts for 64 percent of agricultural lending and around 10 percent of total bank lending (figure 2). While the volume of lending to the agriculture sector is lower than the volume of residential mortgages, when adjusted for risk, it takes on much greater significance in banks' lending portfolios. A significant portion of the dairy sector has substantial borrowings and are thus vulnerable to declines in land prices. The income earned in the sector is also closely linked to commodity prices, which directly impacts on the ability of farmers to service their debt. The dairy sector also has an indirect effect on broader rural land values and therefore on risk in the sheep and beef sector, which accounts for a further 24 percent of bank lending to agriculture. A significant downturn event in the dairy sector could therefore inflict significant losses on banks' agricultural portfolios.

Figure 2
Registered bank lending by sector
(as at June 2010)



3 Constructing the data set

To obtain estimates of the likely extent of credit losses in a downturn event, it is necessary to have information on the cross-sectional distribution of debt and other important variables across the dairy sector. For example, if debt is concentrated in a few very highly leveraged farms, this would imply a greater risk of credit loss than if debt was spread more evenly across the sector.

In 2010, the Reserve Bank gathered this information by surveying the four largest New Zealand banks, requesting an anonymised sample of the financial records they hold on each dairy farming exposure. These four lenders accounted for 91 percent of lending to the dairy sector as at June 2008. The organisational unit we were interested in was the farming group (henceforth also referred to simply as a farm). A farming group treats all directly connected borrowers (eg, family, farming partnership, family trust) as one entity with one set of consolidated financial accounts. In many cases these entities will have cross-guaranteed borrowing by other entities in the group, and even if they have not, they are likely to generally be willing to support each other.

We collected basic data on dairy lending from the four banks and applied a stratified random sampling strategy to this data to select the sample. Stratified sampling involves splitting the population into subgroups based on a common feature of the data prior to sampling. This approach generally improves the representativeness of a sample. We divided the data into three strata on the basis of the size of farm exposures – $1 million to $7 million, $7 million to $25 million, and greater than $25 million.[5] All of the exposures in the upper strata were included in the sample, along with 150 individual observations for each of the lower two strata.[6] This structure weighted the sample toward larger, potentially higher risk, farming operations, as it was deemed most important to gather details about the balance sheet of large borrowers.[7]

The final sample consisted of 347 farming groups, each with greater than $1 million of debt outstanding to one of the four banks. The banks provided us with detailed financial data from the balance sheets and income statements of each of these farms for the 2007-08 financial year.[8] The sample data was adjusted as appropriate. For example, the data was filtered to remove the effects of the 2007-08 drought on farm costs, and farm asset values were adjusted to make valuation dates more consistent.

5 Statistical tools such as the cumulative F rule were employed to assist in the selection of strata boundaries. However, the final determination of strata boundaries is a largely judgmental exercise.

6 Stratification could have proceeded on the basis of various financial variables. The best variable would have been the LVR on each farm exposure. However, this is subject to measurement difficulties, particularly with regard to the consistency of security valuations. Stratification by the size of the exposure was chosen as a next best alternative.

7 The sample sizes across strata mean we sampled around 4 percent of all farming groups in the lowest strata, and around 20 percent of farming groups in the middle strata.

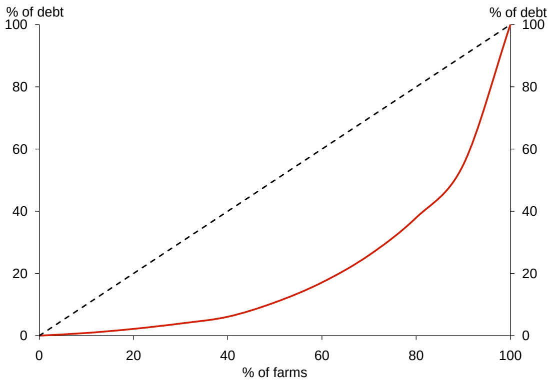
8 The 2007-08 year was the most recent year for which financial accounts were available at the time of collecting the data. The financial year and dairy season broadly coincide.

The sample data excludes farming groups with $1 million or less of debt. The sample data was therefore supplemented with a set of representative data for these low-debt farms. We used the Ministry of Agriculture and Forestry's National Dairy Model[9] as a benchmark in the construction of the financial accounts of these farms. To introduce some variation in this part of the dataset, we varied production and costs around these benchmark figures. Debt levels for these farms were inferred from the unit record data provided by the banks and official Reserve Bank data sources. When aggregate statistics were computed on the basis of the sample, the different strata were weighted to reflect the fact that a smaller proportion of farms in the lower strata were sampled.

The data collected provides a detailed snapshot of the financial position of the dairy sector at a point in time. It indicates that the total debt outstanding to the dairy sector at the end of June 2008 was around $20 billion; undrawn credit facilities amounted to a further $2 billion.[10] Figure 3 presents the distribution of debt across the sector. This distribution is heavily skewed – the most indebted 10 percent of dairy farms appear to carry 45 percent of the sector's total debt.

Figure 3

Distribution of debt across the dairy sector



The sample data suggests that over the 2007-08 season the average farming group was profitable and comfortably able to service its debts. This is to be expected given the 2007-08 season was one of high commodity and land prices. However, the data also reveals a significant number of farming groups that appeared vulnerable to a substantial downturn in the sector due to high loan-to-value ratios (LVRs), high cost structures, and/or low earnings relative to debt servicing obligations. It is the degree of vulnerability in these areas that the stress testing model presented in the remainder of this paper is designed to examine.

Figure 4

LVRs for sample farms

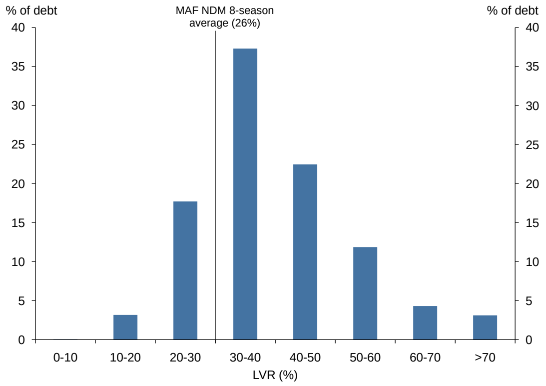
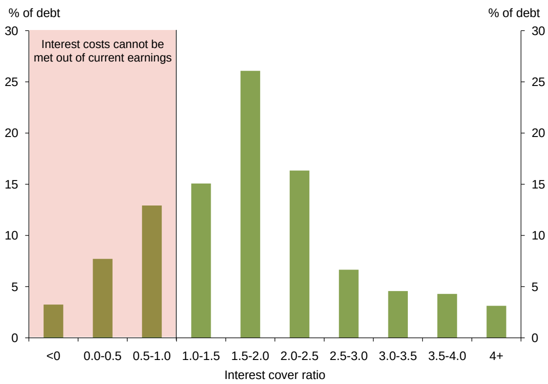


Figure 5

Interest cover ratios for sample farms



3 Modelling methodology

Having gathered data on the sector, we set about constructing a model of how a downturn scenario would affect farm accounts and potentially lead to loan defaults (the default model), as well as considering what a serious but plausible downturn scenario might look like.

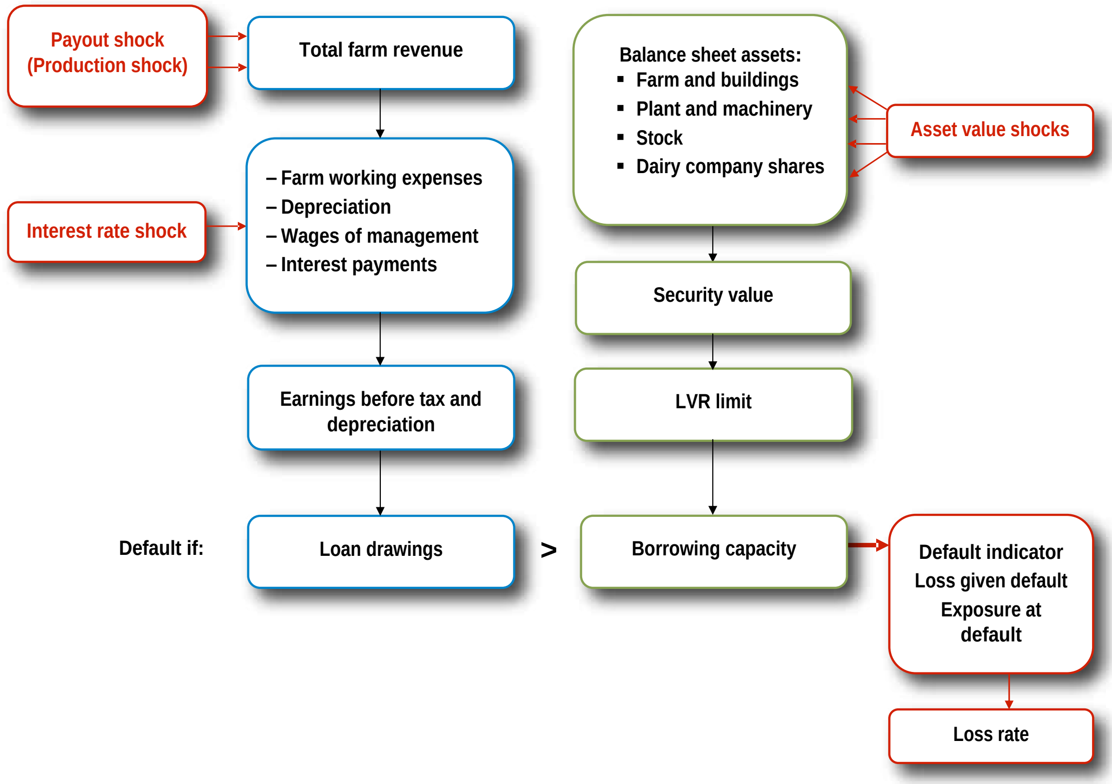
A loan default model is typically designed to predict bank losses under various macroeconomic scenarios using a series of behavioural relationships. Again, the precise form of the default model varies based on the type and complexity of

9 The National Dairy Model is constructed from a sample of dairy farms that is generally believed to concentrate on small-to-medium sized farms rather than very large 'corporate operations', so it should provide useful information about the low-debt farms.

10 This is consistent with figures on dairy lending in the RBNZ Annual Agricultural Survey.

Figure 6

Structure of the model for defaults on dairy lending



the overall stress test and the data available for use in the model. To generate a loss rate, the model requires a default rule, and estimates of loss given default (LGD).

*Loss rate (%)=Default rate (PD)*loss given default(LGD)*100*

The default rate or probability of default (PD) expresses the likelihood that an individual borrower will default on their loan. This will be based on indicators of debt servicing ability and/or leverage (loan size relative to collateral value, or LVR).

The LGD is the loss that a bank will incur in the event that a borrower has defaulted, once the collateral held against the loan and the costs of realising this collateral are accounted for. The LGD is expressed as a percentage of the borrower's total debt outstanding to the bank upon default (termed the exposure at default). The aggregate loss for the bank is simply the sum of the loss rates on individual exposures weighted by the size of each exposure.

The structure of the model

We elected to allow three variables to shift from their 2007/2008 base values in order to generate a downturn scenario: the dairy payout, interest rates, and land prices (asset values).[11] We refer to the changes in these variables as 'shocks' in the model. Falls in the dairy payout (which relate to movements in commodity prices and the exchange rate) can systematically reduce farm income. These reductions are generally nationwide and can last multiple years, making it an obvious stress variable to examine. Declining land prices reduce the prospect of an owner selling a farm to escape a mortgagee sale and can increase the losses to a bank in the event of a default, making it another key variable. Interest rates impact on the ability of the farm to meet its debt servicing obligations. Figure 6 illustrates the basic structure of the default model and the path of the shocks through to the default rule and determination of losses.

A shock to the dairy payout affects farm earnings by reducing revenue. However, during periods of stress when farm cash flow is reduced, farmers are likely to respond to

[11] The model also has the capacity for a production shock in the form of a drought. A drought reduces milk solids production by a specified proportion in the year of drought. Production rebounds to the level prevailing in the 2007-08 season in the year following the end of the drought. At this stage, the model does not allow for this production shock to flow through to higher dairy prices but the model could be extended to incorporate this.

lower revenue by reducing costs. In our model, we allow working expenses to vary with the payout – costs decline as the payout falls and increase as the payout rises.[12] This cost adjustment mechanism dampens the effect of the drop in revenue on farm earnings to some degree. We also allow working expenses to increase in the presence of drought and incorporate an upward trend in costs over time.

Wages of management also adjust in a stress situation. Wages of management generally fluctuate with the value of a farm's balance sheet assets. However, in the model, wages of management cannot fall below a minimum allowance for labour and are limited in size by farm earnings. If a farm has near zero or negative earnings (before wages of management are subtracted), it is assumed that the ability to pay wages of management is curtailed.

The interest rate shock affects the interest payments a farm is making on its outstanding debt. A positive interest rate shock will increase interest payments and decrease earnings. In the model, all debt is assumed to be floating rate and therefore is affected by a change in interest rates almost immediately.[13]

The payout and interest rate shocks ultimately affect farm earnings. The level of farm earnings determines the change in a farm's outstanding debt from year to year. It is assumed that any cash shortfall is met by drawing down additional funds from the bank. If earnings are negative, loan drawings and outstanding debt increase by the amount of the cash shortfall. If earnings are positive, a portion of the cash surplus is committed to principal repayments.

Shocks to farm asset values affect the value of security held by the bank against a farm's borrowings and affect the LVR on the exposure. A farm's LVR directly affects its borrowing capacity and is a key determinant of default. While each class of farm assets (ie, farm land and buildings, plant and machinery, stock, dairy company shares) can be subjected to shocks of differing magnitudes, the main focus of our interest is on land prices. An idiosyncratic term is also included in the asset value shock to alter the magnitude of a given shock across farms. This allows for variation in farm values around the average market price change and recognises that the value of certain farms may be more susceptible to price shocks (and others may be less affected) due to, for example, the quality of the farm or its location.[14]

Banks will generally only periodically attempt to mark to market the value of the security they hold (eg, annually). During a severe downturn, particularly if the farm sales market is very thin, valuations recorded by banks may change a bit more gradually than the prices that can be realised in the market. We allow for this potential delay, but assume that banks fully mark asset values to market in the final year of the simulation. This mostly affects the timing of losses rather than the total losses incurred.

Default analytics

There is a range of different rules that could be used to describe default. We define a farm as being in default when:

(i) the farm's drawn exposure has exceeded a specified borrowing limit, ie, it has exceeded its maximum LVR;[15] and

(ii) the farm has negative cash flow.

Both a farm that is within its borrowing limit but has negative cash flow and a farm with positive cash flow but above its borrowing limit would not be regarded as being in default by this definition. We assume that so long as a farm has positive cash flow it will continue to service its debt and the bank will not take enforcement action despite the eroded equity position. We also assume that a farm with negative cash flow but sufficient remaining equity to borrow against will not be foreclosed on, as the farm can either borrow to meet its working capital needs or can sell the farming

12 The relationship between costs and the payout, the presence of drought, and a trend were determined using simple regression techniques. Working expenses fall approximately 14 cents per kilogram of milk solids in response to a $1 decline in the payout.

13 We do not allow for penal interest rates for farms that are not generating enough cashflow to meet interest payments or breaching other covenants – this is a possible future extension.

14 The idiosyncratic shock factor for each farm is a random draw from a normal distribution. The mean of the distribution is set to 0 and the standard deviation is set at 0.075.

15 The borrowing limit and maximum LVR are based on the book value of the security as recognised by the bank rather than the market value.

operation itself and repay the bank debt without the bank incurring a loss.

In our framework, we distinguish between two default states: non-performance and foreclosure. A farm is assumed to be in a non-performing state when it is not servicing its debts, and has a LVR on land and buildings that has reached 75 percent (which would typically exceed limits agreed in the loan documentation).[16] While many farms in this position may technically be classified as in default at this stage, rather than immediately foreclosing and possibly realising a loss, banks may well exercise forbearance in the hope that the farm will return to profitability and resume servicing the loan. Banks tend to exercise a high level of forbearance with their rural clients, due in part to recognition of the cyclical nature of farm earnings and the long-term nature of these lending relationships. A farm in non-performing status is not in severe enough condition in terms of potential losses to a bank to typically motivate enforcement action. Banks may behave differently in a severe downturn, possibly adopting unduly pessimistic assumptions themselves. On the other hand, they will be aware that pushing large numbers of farms onto the market during a downturn may push prices down, increasing their losses on those loans and potentially weakening the financial position of other customers.

The LVR threshold for the foreclosure rule is assumed to be 90 percent on farm land and buildings.[17] At this point, it seems likely that if the loan is not being serviced, the bank will choose to recognise an economic loss on the loan and either dispose of the security or come to some other arrangement. The foreclosure rule identifies realised bank losses, while the non-performance rule reflects the broader degree of stress in the sector. The results reported in the next section of this paper focus mainly on the foreclosure losses to which the banking sector is exposed.

16 The overall LVR threshold for a given farm is calculated using different thresholds against different types of collateral reflecting the likely recovery value to a bank. For non-performance these LVR thresholds are set at 75 percent for farm land and buildings, 75 percent for dairy company shares, 50 percent for stock and 20 percent for plant and machinery.

17 For the foreclosure rule, the LVR thresholds are set at 90 percent for farm land and buildings, 75 percent for dairy company shares, 75 percent for stock and 25 percent for plant and machinery.

Loss given default is the loss that the bank will suffer once a farm has defaulted and the collateral held against the loan and the costs of realising this collateral are accounted for. The costs of realising the collateral include disposal fees, a foreclosure discount, and the cost of holding the property until such time as it sells.

Selling properties in a market that is already depressed due to a stress event may well have the effect of further depressing farm prices, particularly if the foreclosing bank attempts to achieve a quick sale and buyers widely perceive 'fire sales' to be occurring. The foreclosure discount captures the likelihood of a lower sales price than might otherwise prevail.

The disposal fees are the costs associated with actually selling the property, such as listing fees and commissions. The discount rate reflects the cost of holding the farm property while pursuing a foreclosure sale. It comprises the average interest rate on lending plus a risk premium.

We assume transaction costs are 5 percent of the sale price of the property and the foreclosure discount is 7.5 percent.[18] The discount rate is set at 13 percent. The time to collection on a defaulted loan in a stress situation is set at 1.25 years. These parameters imply that a bank may face a loss in the event of default when a farm's LVR exceeds 79 percent. A lower limit of 0 is set on the LGD as a bank cannot make money from a foreclosure sale – surplus funds are returned to the borrower.

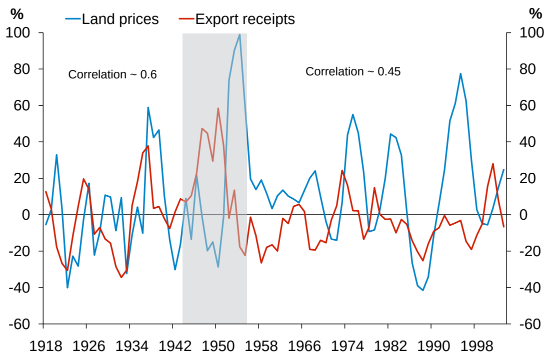
Realistic downturn scenarios

As outlined above, our a priori assumption was that the macroeconomic shocks most relevant to dairy farm stress would include shocks to land prices, dairy output prices and interest rates. In hindsight, the 2007-08 data on farms we collected marked an apparent high point in dairy land prices, as well as being a strong year in terms of output prices. We used data on falls from previous high points over history to gauge what a severe but realistic downturn scenario might look like.

18 Some of the foreclosure discount will be picked up in the depressed market value of the property.

We examined historical data from New Zealand and the US (being another agricultural country for which a good time series of data was available) to form an idea of the frequency and size of movements in land prices and commodity prices. Real land prices have declined substantially twice in the past century in both countries. The initial decline in each country began around World War I and appears to have been quite prolonged (see figure 7). The second decline occurred through the 1980s. Real land prices fell 40 to 50 percent in each of these episodes, with 25 to 40 percent of that decline concentrated in a five-year period.[19]

Figure 7
Five-year changes in real land prices and export prices in New Zealand (1918-2003)



Source: SNZ long-term data series spreadsheets, Greasley and Oxley (2005), New Zealand Official Yearbook (1949), RBNZ calculations.

Note: The shaded area represents a period of caps on nominal land prices. The correlation between export prices and measured land prices breaks down through this period.

There is a positive correlation between the change in land prices and the change in export prices over long (approximately five-year) periods. The correlation tends to be stronger in downturns. The sharp falls in land prices discussed above were coincident with export prices falling about 30 percent over a five-year period. These export prices are not just for agricultural exports, but much of the volatility comes from agricultural exports. Thus export receipts from farming will have a similar profile, but are likely to be more volatile.

The importance of interest rate shocks has likely varied over time. Before World War II, the government was an important lender to the agriculture sector and the role of commercial banks was much smaller. The government retained an important role in the sector in the 1980s via the Rural Bank. In contrast, almost all lending is now provided by the commercial banks (although a small amount of informal lending still occurs), which is likely to limit the offering of concessional interest rates and the level of forbearance by lenders. In addition, interest rates were regulated until the 1980s and were often very high in nominal (and sometimes also real) terms in the 1980s. Since the early 1990s, nominal interest rates have declined on average and have become more stable. Partly reflecting the monetary policy framework, interest rates now tend to move lower during economic downturn (which reduces the risk that interest rates will be high during a prolonged rural downturn). However, there remains the potential for an inflationary shock or a funding shock to the financial system, which could raise interest rates and also potentially depress land prices. For these reasons a scenario with rising interest rates and falling dairy and land prices is not out of the question.

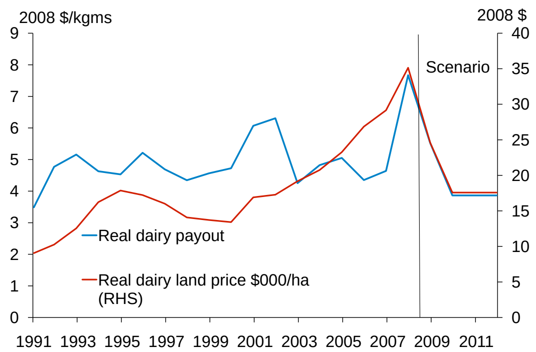
It is possible to formally write down a joint distribution for the multi-year movements in the macroeconomic drivers discussed here, and do a Monte Carlo analysis where a large number of randomly generated scenarios are then analysed. This can be used to determine the distribution of possible losses (for example, given model assumptions, what is the loss that will occur in the worst year in any given century?) We experimented with this approach when working with prototypical versions of our model, but do not use it for the results presented below, which instead use some simple representative shocks to illustrate the model output.

The historical analysis showed that it is possible for real land prices to fall 40 percent or more over a five-year period, alongside a fall of around 30 percent in export prices (which would involve a larger fall in agricultural export prices). It is interesting to note that falls of this magnitude from the highs recorded in 2007-08 would keep land and commodity prices still remaining well above their longer-term averages. More stressful scenarios could also be tested. For example, a fall in the dairy payout to below its long run average and

[19] New Zealand had another measured decline in real land prices around World War II, but this stemmed from nominal caps on official land prices (which meant transactions typically involved unofficial side payments).

a consistent fall in land prices to return the land price to farm earnings ratio to around its longer-term average could have seen the payout roughly halve from 2007/08 levels (to around $3.80/kgms) and land prices also approximately halve. This scenario, shown in the graphs below, is the most serious of the downturn scenarios we examine in our modelling work in the next section. It is clearly substantially different to what actually happened after the end of 2009 (land prices have not fallen this much, and the dairy price recovered in the current season after a weak 2009/10 price).

Figure 8
Dairy land prices and dairy output prices (actual and scenario)



4 Results and insights from the model

In this section, we take representative shocks from the macro analysis undertaken above and feed them into the stress test model to investigate the magnitude of losses they would generate. The period for the results reported below is five years. Results are compared to a baseline where interest rates and security values do not change, while the payout drops to around historical average in real terms ($5.50) in year one. The further shocks around this baseline occur over the following two years in the case of land prices and interest rates, and in year two in the case of the dairy payout. Shocked variables then remain at their new levels for the remainder of the simulation. Sudden shocks like this tend to cause somewhat larger losses than more gradual (though still severe) downturns.

Results of various runs of the model are summarised in table 1. Scenarios 1 to 3 test the response of the model to single shocks to one of the macroeconomic variables around the baseline. Scenarios 4 and 5 show the effects of a substantial decline in commodity prices and land prices simultaneously (something the historical data suggests has occurred before).

Banks' loan losses are relatively insensitive to payout and interest rate shocks on their own (scenarios 1 and 2 in table 1). Losses are larger in the case of independent asset value shocks (scenario 3 in table 1). However, the condition in the default rule dictating that a farm in default must have

Table 1
Indicative results from stress test model[20]

				Foreclosures (5-year scenario)	
	Payout	Security value	Interest rate	farms (%)	Loss rate (%)
Baseline	$5.50	No change	No change	0.15	0.05
Scenario 1	-30% ($3.80)	-	-	2.5	0.63
Scenario 2	-	-	200bp	2.6	0.61
Scenario 3	-	-35%	-	6.5	6.0
Scenario 4	-30%	-35%	-	15.1	10.1
Scenario 5	-30%	-50%	-	32.9	20.6

Scenarios shown as deviation from baseline.

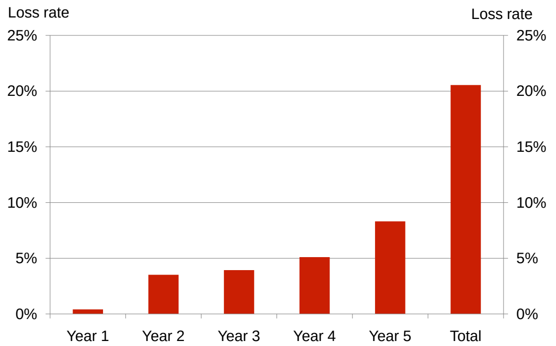
[20] We remove the idiosyncratic shock term from these results so the results are reproducible rather than random. A more sophisticated analysis would run the model (with idiosyncratic shocks turned on) multiple times and look at the distribution of results.

negative earnings limits the extent of losses for even very large security value shocks.

Farms are most vulnerable to contemporaneous declines in both the payout and security value and it is therefore these combined shocks that cause the greatest loan losses for banks in the model. This is not surprising as the payout decline reduces earnings and increases farm borrowings while at the same time the security value is being eroded, making it more likely that a farm will exceed its borrowing limit.

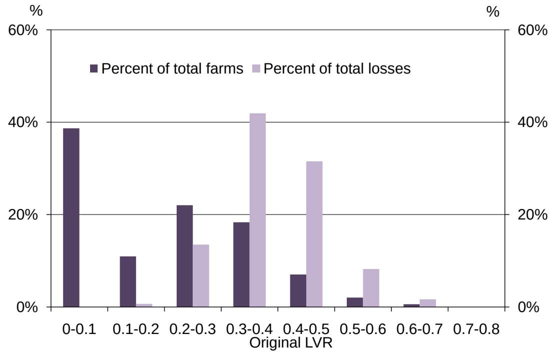
A bad downturn in land prices and the dairy payout (scenario 4 in table 1) pushes around 15 percent of farms into foreclosure, generating expected losses of around 10 percent of total exposure. A more severe downturn (scenario 5) pushes around 33 percent of farms into foreclosure. The expected loss rate for the banks is around 20 percent. The loss rates are quite high, which partly reflects the fact that the largest farms tend to be relatively more indebted and likely to get into financial difficulty. By construction, the worst losses tend to occur in the final year of the scenario period, which is when the banks are assumed to mark security values to market (figure 9).

Figure 9
Year-by-year loss profile in severe five-year downturn



When loans within the sample portfolio are grouped according to their starting LVR, there is a natural tendency for losses to be higher in high LVR buckets. However, while farms with very high starting LVRs (greater than 50 percent) display higher loss rates, it is farms with starting LVRs in the range of 30 to 50 percent (still reasonably high) that have the greatest impact on banks in terms of dollar losses, simply due to the greater volume of farms in these categories (figure 10).

Figure 10
Losses by initial LVR



5 Conclusions

The results presented above imply that losses and foreclosure in lending to the dairy sector will be low in most years. However, the severe downturn scenario shows the potential for a very bad multi-year scenario to cause significant losses for the lending banks. To some degree, this reflects the fact that borrowers in this industry are all exposed in a similar and major way to some factors that have shown they can be volatile (particularly dairy prices). This differs from (for example) residential lending, where a key risk factor like unemployment will only affect a small proportion of New Zealand households at any point in time.

Our analysis is consistent with the discussion in recent *Financial Stability Reports*, where we have identified dairy lending as a potential credit risk factor for the New Zealand banks. Land prices have fallen significantly but relative to the scenarios we consider here, the actual cash returns from dairy farming have remained quite resilient, and interest rates have fallen substantially. Our model is consistent with the low rates of foreclosure anecdotally seen to date in dairy lending, but implies that the outcome could have been worse if interest rates had not fallen and dairy output prices had been substantially weaker.

While our model is not designed to be used in formal risk weighting for bank capital allocation, it does provide a view of the potential downside risks in the sector and illustrates some characteristics of dairy lending that a risk-weighting model might want to address. We have made our results and model available to the participating banks, who can utilise the model at the level of their individual institutions.

As noted in the introduction, we think our modelling approach is likely to be more resilient than the sorts of stress test models criticised recently by the Basel Committee on Banking Supervision (2009). For example, we are not reliant on a short historical sample of possible downturns, or a reduced form regression approach to determining default likelihood. In the case of the dairy farming sector, which has faced pretty low losses in recent years, our approach will tend to produce higher (but more realistic) estimates of potential downside risk than those approaches.

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