Estimating the impacts of restrictions on high LVR
lending

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NON-TECHNICAL SUMMARY

The Reserve Bank recently announced the introduction of a 'speed limit' on high loan-to-value ratio (LVR) lending to take effect from 1 October. This speed limit policy requires banks to restrict the share of new mortgage lending with LVRs of over 80 percent to no more than 10 percent of their new mortgage flows.

The purpose of this restriction is to address the build-up in risk for the financial system and broader economy that is occurring as a result of house prices rising in excess of fundamental values, household balance sheets becoming increasingly stretched, and an increased concentration of high-risk loans on bank balance sheets. The restriction is designed to help slow the rate of house price inflation and housing credit growth, and hence reduce the consequences of any substantial downward correction in house prices at some point in the future. The improvement in the average credit quality of bank loans that the policy aims to achieve also means that banks would face smaller losses should such a downturn occur.

This Analytical Note outlines the analysis that the Reserve Bank has done on the likely impact of LVR restrictions on some specific macroeconomically significant variables. Since this is a new policy tool for New Zealand, and New Zealand appears to be unique in using a speed limit approach, any estimates of the exact quantitative impact are necessarily approximate.

We combine a simple approach estimating the likely effect on the number of house sales and housing credit growth with a statistical econometric model to assess the effect on house prices. Using these methods, we estimate that LVR restrictions are likely to reduce housing credit growth by 1-3 percentage points and house price growth by 1-4 percentage points in the next year, relative to the baseline of no LVR restrictions. We also use stress testing models of bank balance sheets to estimate the impact of LVR restrictions on bank credit losses. In one specific scenario featuring a severe housing market downturn and a sharp rise in interest rates, LVR restrictions imposed for two years would reduce bank losses on the residential loan book by 10-15 percent.

Even with hindsight it will be difficult to fully assess the impact that the policy has had, because we don't know exactly what would have happened without the policy. The Reserve Bank will be closely monitoring developments in housing and credit markets over the coming months to judge how much of an effect the LVR policy is having. The estimates presented here will help provide a benchmark for assessing the impact of the policy. The Reserve Bank will be reporting regularly on its assessment of these effects.

INTRODUCTION

Following a period of weakness, significant excess demand pressures have re-emerged in the housing market. This increased demand has not been matched by a corresponding increase in supply, resulting in significant increases in house prices. As at August 2013, nationwide annual house price inflation was sitting at 9.5 percent and growth in the Auckland region was even stronger at 17.9 percent (figure 1).

Figure 1: House price inflation
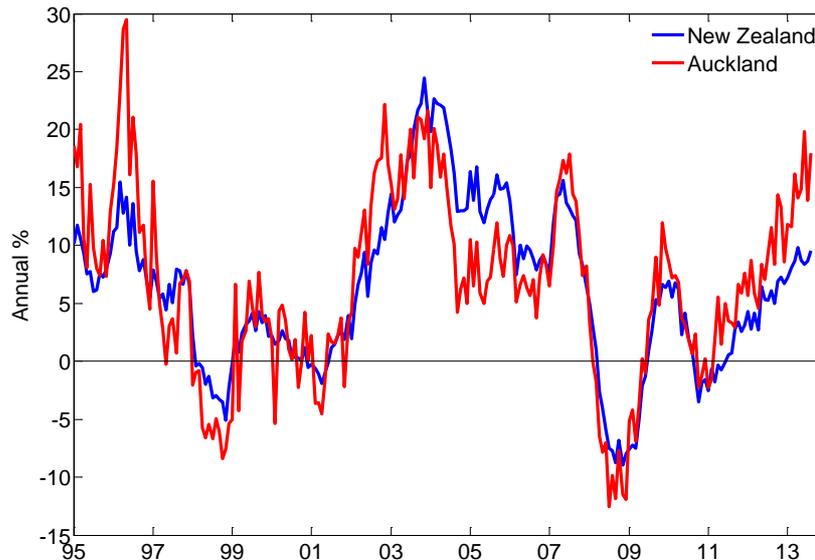
Source: Real Estate Institute of New Zealand.

The earlier weakness in house prices did not fully reverse the sharp increases in long-run valuation metrics, such as house-price-to-income and house-price-to-rent ratios. As a result, the recent run-up in house prices has further stretched those metrics. In addition, credit growth to the already indebted household sector has picked up to a little over 5 percent per annum. The Reserve Bank is concerned that the combination of rapidly rising house prices and high and growing household indebtedness, if continued, would lead to a significant build-up in financial system risk.

A relaxation of lending standards, and, in particular, an increase in the availability of low-deposit mortgages, has contributed to the strengthening in the housing market. International experience also suggests that high loan-to-value ratio (LVR) loans are particularly vulnerable to property market downturns, especially when the loan was written relatively recently.[1]

In response to the risk of a continued build-up in financial system risk, the Reserve Bank introduced a 'speed limit' on high-LVR mortgage lending with effect from 1 October. This speed limit requires that no more than 10 percent of registered banks'

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[1] See "Regulatory impact assessment: Restrictions on high-LVR residential mortgage lending" for further discussion of the case for imposing LVR restrictions – available at http://rbnz.govt.nz/financial_stability/macro-prudential_policy/5407434.pdf

non-exempt new mortgage lending is at LVRs of 80 percent or above. Some categories of lending are exempt from the restriction, notably loans made under Housing New Zealand's Welcome Home Loan scheme, refinancing of existing high-LVR loans, bridging finance, and loans made to borrowers who are moving house but not increasing the size of their mortgage. The Reserve Bank estimates that these exemptions, including the recent extension of the Welcome Home Loan scheme, account for about 5 percent of new mortgage lending. With high-LVR lending accounting for around 30 percent of new mortgage lending in the months prior to the imposition of LVR restrictions, the speed limit will require banks to reduce the proportion of high-LVR loans they write by about half (figure 2).

Figure 2: High-LVR mortgage flows
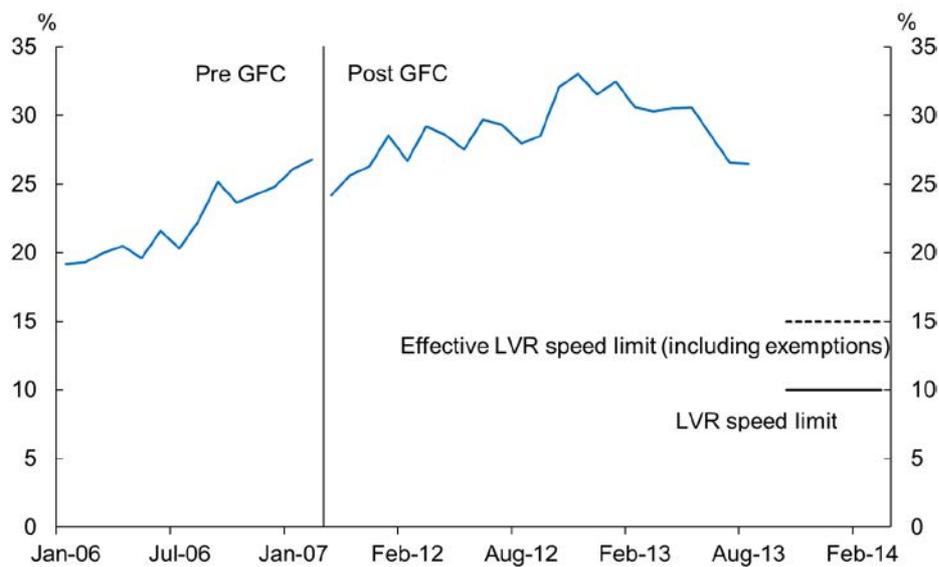
Source: Based on private reporting from the four largest banks. Data are not standardised and definitions may vary across banks.

The Reserve Bank has published estimates of the expected effect of LVR restrictions on the housing market, housing credit and bank resilience in the Regulatory Impact Assessment on LVR restrictions (RBNZ, 2013a), and in the September Monetary Policy Statement (RBNZ, 2013b). This Analytical Note provides further detail on the modelling approach that we have taken to estimate these effects.

INTERNATIONAL EXPERIENCE WITH LVR RESTRICTIONS

LVR restrictions have been actively used by a number of Asian countries since the 1990s to respond to developments in the housing market. Many of these countries have fixed or managed exchange rates, and periods of capital inflows often lead to substantial swings in real estate prices. With limited scope to respond with interest rates, LVR restrictions have often been seen as a tool to manage financial system resilience as well as generalised inflation pressures.

More recently, a number of developed countries have adopted various forms of LVR restrictions, along with other policy measures targeted at the housing market. While exact policy motivations have varied, policymakers in these developed countries have often faced rising imbalances in housing markets when low interest rates have been required to keep inflation near respective target levels. Policy moves have tightened the availability of high-LVR loans in Canada, Israel, the Netherlands and Sweden in recent years.

Studies estimating the effects of LVR caps in Hong Kong (Craig and Hua (2011), Wong et al (2011)), Korea (Igan and Kang, 2011) and Canada (IMF, 2013) found significant effects on housing transactions, house prices and/or housing credit growth. A recent study by Kuttner and Shim (2012) uses a large cross-country dataset, including both emerging and advanced economies, to estimate the effects of macro-prudential interventions on house prices and credit growth. They confirm the results of individual country studies, and estimate that a typical tightening of LVR restrictions of around 10 percentage points slows real house price inflation by around 4 percentage points, which would otherwise have required a 200 basis point increase in short-term interest rates to achieve. IMF (2012) performs a similar exercise focussing on the impact on credit growth, finding that a 10 percentage point tightening was associated with a reduction in total credit growth of around 1.3 percent – equivalent to around a 3-5 percent reduction in mortgage credit growth.

It is difficult to draw direct conclusions from this international experience for the likely effects for New Zealand, due to differences in institutional structures, typical deposit levels and differences in the design of LVR restrictions in each country. In particular, New Zealand appears to be unique in applying LVR restrictions using a speed limit approach rather than through the imposition of an outright prohibition of high-LVR lending. However, the international evidence provides a useful starting point and cross check on the estimates that we produce using our own modelling.

ESTIMATING THE EFFECT ON CREDIT GROWTH AND HOUSE SALES

To estimate the effect of LVR restrictions on credit growth and house sales, we calculate the share of bank lending that would be affected by restrictions. Then, using plausible assumptions, we try to account for some of the wider economic effects that would result.

The starting point for this analysis is banks' gross new mortgage flows. In the lead-up to the announcement of LVR restrictions, new monthly mortgage flows were running at an annualised rate of about $50 billion. Lending at LVRs of over 80 percent was about 30 percent of this figure, so roughly $15 billion annually. This figure represents just over 8 percent of the stock of outstanding housing credit of $184 billion.

To get from this $15 billion figure to an ultimate impact on housing credit growth requires a number of judgements:

- The proportion of this lending that will either still be able to take place within the LVR speed limit or will be exempt from the restriction.
- The extent to which these affected borrowers will be able find alternative sources of financing or alter their borrowing plans to reduce their LVR below the 80 percent limit.
- The extent to which reduced buyer competition encourages higher-equity buyers to transact in the market, reducing the effect on housing transaction volumes.
- The effect that a reduction in housing transactions has on the debt position of sellers, noting that a house sale usually involves one party taking on debt and another party paying down debt.

Figure 3 summarises our judgement of each of these channels. After allowing for a reduction of total housing lending volumes as a result of the restriction, banks should be able to write about $4.6 billion of high LVR loans within their speed limit and a further $2.5 billion of high-LVR lending is expected to be exempted. This means that banks will be required to reduce their annual high-LVR lending by about $7.9 billion in order to meet the speed limit restrictions.

Figure 3: Effect of LVR restrictions on bank mortgage lending flows[2]
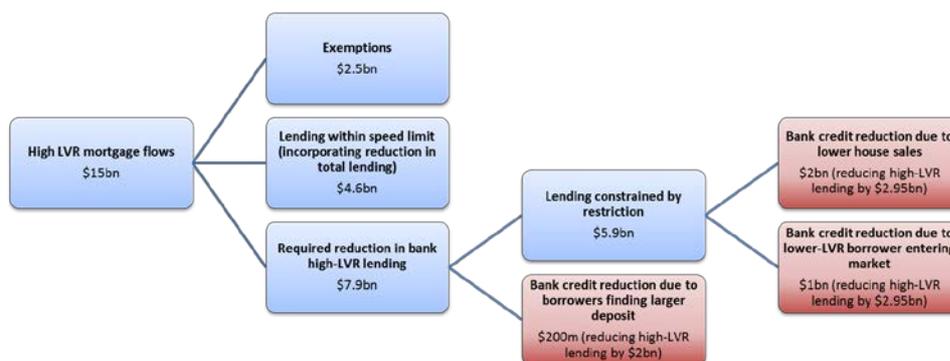
For the purposes of this analysis, we assume that around 25 percent of affected borrowers will be able to find alternative sources of funding to reduce their bank mortgage LVR to 80 percent (for example, by borrowing from family members). Where this money comes from outside of the intermediated financial sector, there will be a small reduction in measured credit growth. The larger effect on credit growth comes from the remaining $5.9 billion of borrowing stemming from housing transactions that are not likely to be completed as a result of the restrictions. This

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[2] For simplicity, all new mortgage flows have been assumed to relate to housing transactions. In practice a significant proportion by both number and value is due to top-ups of existing mortgages. Where top-ups are constrained by the LVR policy, this is likely to have a slightly larger effect on net credit growth, as there will be no offsetting increase in credit elsewhere.

number is expected to be offset somewhat by higher equity buyers completing purchases in some cases (taking on about $2 billion in debt)[3], and by about $1 billion of debt remaining on the balance sheets of prospective house sellers.

The net effect of this is that credit growth is expected to be about $3.2 billion lower over the first year that LVR restrictions are in place. This would lower annual housing credit growth by 1.7 percentage points in the first year. The longer LVR restrictions are in place, the more likely it is that borrowers would be able to find alternative sources of funding and alternative buyers would enter the market. As a result, we expect that LVR restrictions would have a diminishing effect on credit growth after the first year.

There is a degree of uncertainty to the assumptions that underpin this analysis. In addition, there are some further channels through which credit growth could be lower as a result of the restrictions. For example, a reduction in house prices may lead to less debt accumulation, above and beyond the transactional related reduction we have modelled. Furthermore, there could be something of a multiplier effect, whereby a whole chain of housing transactions does not take place as a result of a high-LVR borrower being unable to finance a purchase.

Taking into account the uncertainty of the assumptions, and some of the unmodelled channels, we believe that the annual credit growth impact is likely to fall in the 1-3 percentage point range over the first year.

Using the same assumptions as above, we are also able to estimate the likely reduction in house sales. The starting point for this is the 30 percent share of new mortgage lending by value that is at high LVRs. On average, high-LVR mortgages are about 30-40 percent larger than low-LVR mortgages, so the number of mortgages that are high-LVR is likely to be around 24 percent of the total. Furthermore, we assume that 10-20 percent of housing market transactions are undertaken without a mortgage, so the share of house sales involving a high-LVR mortgage is likely to be 20-22 percent. Allowing for the effect of the speed limit, the assumption that 25 percent of affected borrowers will be able to raise a larger deposit, and the effect of new entrants coming into the market, we estimate that the net effect on house sales is likely to be a reduction of around 5 percent.

MODELLING THE IMPACT ON THE HOUSING MARKET

To generate estimates of the impact of LVR restrictions on the housing market, we use the vector autoregression (VAR) modelling framework. VARs are flexible time series models that can be used to describe the interaction between economic and

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[3] The simplest example of this is at an auction. If LVR restrictions prevent the would-be highest bidder from bidding, the property would go to the would-be second highest bidder. This process would necessarily result in some reduction in price. More generally, to the extent that LVR restrictions do have some effect on house prices, some buyers may be encouraged to transact who would not have otherwise done so.

financial variables. They are widely used in empirical macroeconomic modelling to measure the transmission channels of various shocks on the economy. Each variable is modelled as a function of its own lags and lags of the other variables. We also allow for contemporaneous impacts between some variables (discussed below).

Our model includes the following housing market indicators (see appendix A for plots of the data):
- net permanent and long-term immigration;
- house sales;
- median days to sell;
- residential consent issuance;
- house prices;
- household credit; and
- 2-year fixed mortgage rates.

We estimate the VAR on monthly data from January 1992 to June 2013. We include six lags of each variable in each equation. We estimate the model's parameters using Bayesian estimation.[4]

To identify the source of the movements (or shocks), we impose some short-run restrictions. We assume that variables immediately affect other variables only if they are ordered after them (referred to as a 'Cholesky' decomposition). The variables are ordered as above. This means that a mortgage rate shock occurs when mortgage rates cannot be explained by any of the model variables (contemporaneously or with a lag). Alternatively, a house sales shock is a change in house sales not explained by past information or by immigration in the same month.

Using this model, we simulate two scenarios that are each designed to approximate LVR restrictions. These scenarios are two different ways of modelling the impact of LVR restrictions and are not additive. They are 'approximate' because LVR restrictions have not been applied in New Zealand previously and our model is estimated on historic data. Therefore, we have to make some assumptions to link LVR restrictions to the variables in the model.

The two scenarios that we consider are:
1. A negative house sales shock that causes house sales to fall by 5 percent in the first year; and
2. A mortgage rate shock that raises the 2-year mortgage rate by 20 basis points for a year.

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[4] Our priors are set around a random walk mean. We implement the prior using dummy observations, as done by Bloor and Matheson (2010).

Scenario 1: House sales fall by 5 percent

In this scenario we estimate what happens in our model when, for no other reason, house sales fall by 5 percent for a year (this enters the model as 360 fewer house sales per month). This reflects the reduction in housing market turnover estimated in the previous section. Figure 4 shows the impact of LVR restrictions, assuming they affect house sales as described above (the dashed lines show the 90 percent confidence interval).

Figure 4: House sales scenario[5]
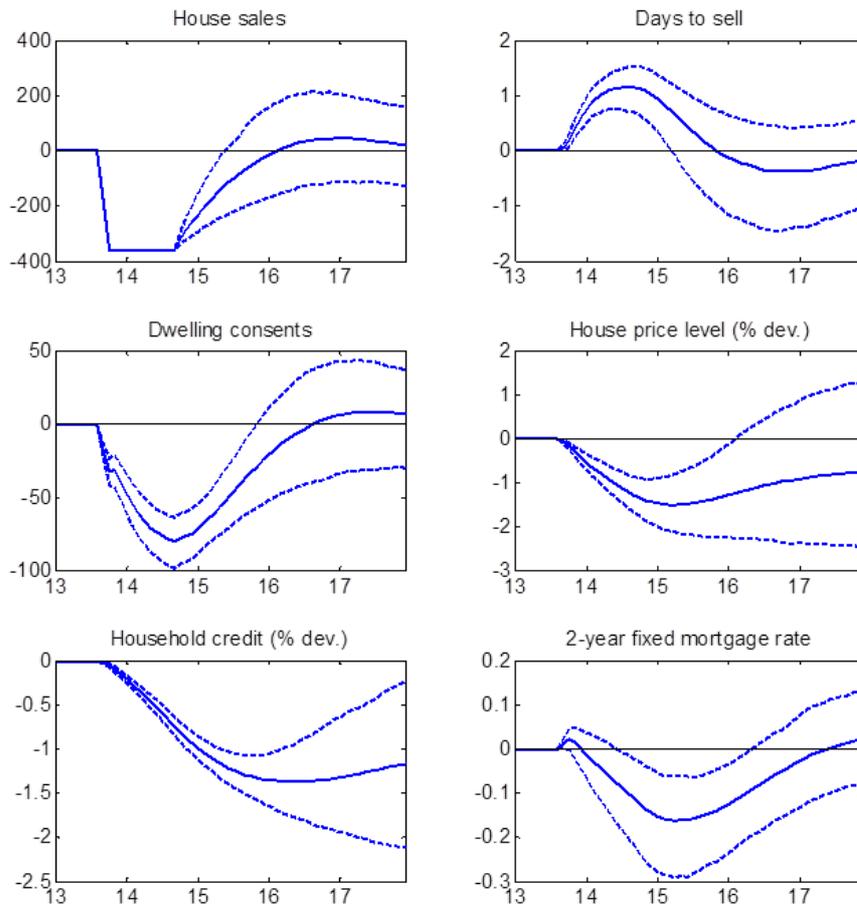
This exogenous decline in house sales results in statistically significant negative impacts on the model variables. Compared to the baseline, house prices and household credit are about 1.5 percent lower than otherwise over the two years after the restriction is put in place. The two-year fixed mortgage rate falls by slightly less than 20 basis points.

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[5] The dwelling consent series used in the model is the total floor area consented. However, for ease of interpretation, this has been converted to number of consents assuming an average floor area for new houses of 200 square metres.

Scenario 2: Mortgage rates rise by 20 basis points

Our second scenario shows the impact of mortgage rates rising by 20 basis points for a year (figure 5). This approximates the increase in average mortgage costs for new borrowers that would eventuate if all high-LVR borrowers avoided LVR restrictions by taking out an unsecured loan to top-up their deposit.[6] This is calculated assuming that 30 percent of borrowers take out a top-up loan for 10 percent of their total borrowing amount, and have to pay a 7 percent margin over mortgage rates for this top-up amount. This scenario implicitly assumes that banks increase the price of high-LVR loans within their speed limit such that borrowers are indifferent between taking a high-LVR loan from a bank, or obtaining an unsecured top-up.[7] We expect that mortgage rates for low-LVR customers will drop somewhat due to stronger competition. This will be counteracted by higher low equity premiums and less discounting on high LVR lending. As a result, the net effect on mortgage rates is somewhat ambiguous, so this scenario is best viewed as a proxy for the possible impact of LVR restrictions.

<p align="center">**Figure 5: Mortgage rate scenario**</p>

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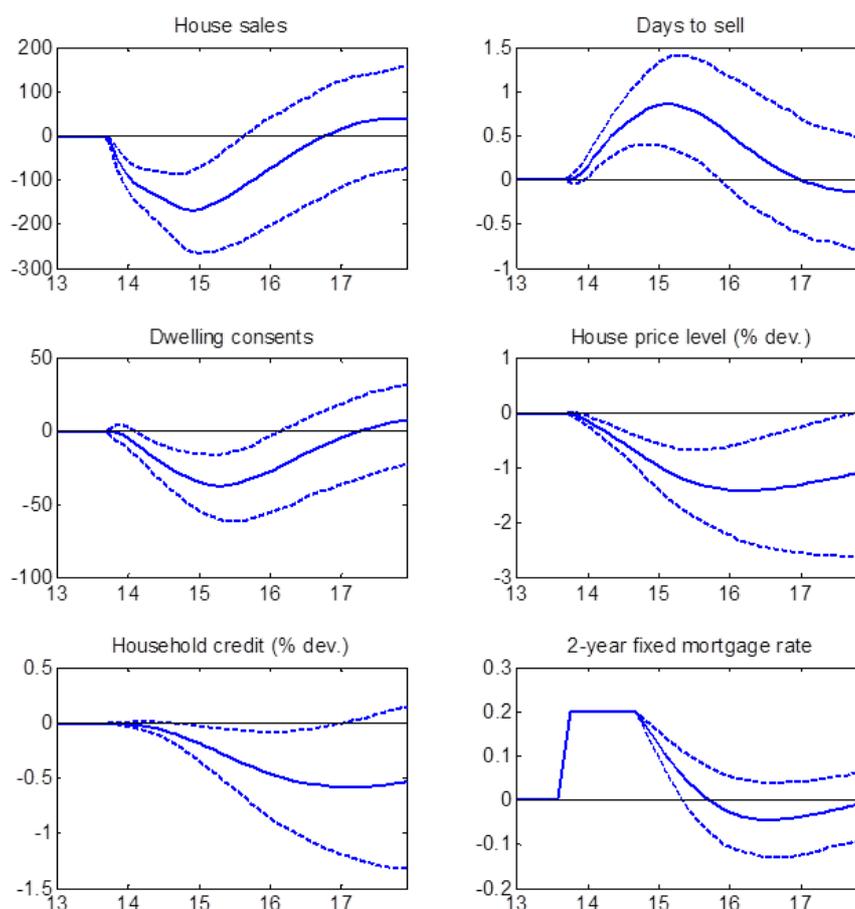
[6] For borrowers who did take this approach, the increased borrowing costs would likely be accentuated by shorter amortisation periods for the top-up portion of their loan, which would further stretch debt servicing constraints.

[7] This assumption appears plausible given recent changes in bank pricing for high-LVR loans. For loans with an LVR of between 85 and 90 percent, most banks are advertising one-off low-equity premiums of 0.5-0.75 percent, as well as carded fixed mortgage rates that are often 0.2-0.5 percent higher for high-LVR borrowers.

The impact from the two-year fixed mortgage rate being 20 basis points higher than otherwise for a year is to dampen housing market activity in a statistically significant way. Consistent with scenario 1, house prices compared to the baseline are around 1.5 percent lower than otherwise over the two years following the restrictions being active. Household credit falls by less in this scenario (only 0.5 percent), perhaps because of higher servicing costs for household debt.

Summary of the scenarios

The two scenarios suggest that the LVR speed limit policy could reduce house price inflation by 1-2 percentage points in the short term. However, these scenarios are only an approximation of the effect of LVR restrictions and there is a question as to whether they are able to adequately capture all of the channels through which LVR restrictions will affect the housing market.

For example, while we have used single shocks to model LVR restrictions, in reality they could be thought of as a combination of different shocks that may have larger effects than modelled here. In addition, current strong growth in house prices is likely, at least in part, to be due to house buyers expectations that prices will continue to rise. Influencing these expectations is likely to be a key channel of LVR restrictions (Rogers, 2013). While this channel is likely to be partially captured in the historical data, the significant publicity surrounding the announcement of LVR restrictions may mean that expectations effects are larger than suggested by these model estimates. There is also the possibility that the imposition of LVR restrictions could alter behavior in a way that makes these estimates less reliable (Lucas, 1976).

Combining these factors, with the international evidence of generally stronger impacts from LVR restrictions, we feel that there is likely to be upside risk to these model estimates. While it is difficult to quantify this, our estimated range of the reduction in house price inflation of 1-4 percentage points over the first year takes into account some of this upside risk.

It is worth noting that while the modelling here indicates that LVR restrictions are likely to have a smooth and gradual effect on the property market, in reality LVR restrictions are likely to result in a degree of volatility for the first few months. The six week notice period provided before LVR restrictions came into effect, as well as the significant stock of pre-approvals outstanding, could have caused some buyers to rush in. Conversely, significant uncertainty, as well as conservatism on the part of the banks in allocating the speed limit in the initial months, could result in sharp declines in activity initially. As a result, it may be a number of months until the impact of the policy can be properly gauged.

The analysis has focused on the effect of LVR restrictions on house prices and credit growth. However, LVR restrictions may also have some effect on the construction of new houses, which would be an unintended consequence of the policy. The two

scenarios suggest that the level of dwelling consent issuance could fall by 40-80 consents a month – a 2-5 percent fall from current levels – reflecting a historically close correlation between housing market turnover and the level of consent issuance. However, the effect of LVR restrictions could be somewhat smaller than this for a number of reasons. LVR restrictions do not apply to property developers, so will only affect new construction directly to the extent that the end customer is unable to obtain finance, or indirectly as effective housing market activity is dampened more generally. Banks are generally more reluctant to provide high-LVR loans for new building projects, so it is likely that a smaller proportion of new house purchases feature a high-LVR loan than for existing houses. Finally, new building activity is likely to be underpinned by the Christchurch rebuild and the relaxation of supply constraints in Auckland for the foreseeable future, which are unlikely to be materially affected by LVR restrictions.

To the extent that they take some demand pressure out of the economy, LVR restrictions will also reduce the amount of work required of monetary policy to maintain price stability (and perhaps modestly ease pressure on the tradables sector). The model presented here is not rich enough to estimate the size of this effect. The Reserve Bank's September *Monetary Policy Statement* presented estimates that if LVR restrictions reduced house price inflation by 2.5 percentage points (the mid-point of the estimated range), the resulting reduction in general inflation pressure would result in 90-day interest rates that were 30 basis points lower than otherwise. However, while these two policies would be equivalent in terms of reducing overall inflation pressure, the more targeted nature of LVR restrictions means that they are likely to have a larger impact on house prices. If monetary policy were to be used to target house prices directly, the OCR would need to be increased by much more than 30 basis points to achieve the same housing market outcomes as the LVR restriction.

ESTIMATED EFFECT ON DOWNTURN LOSS RATES

One of the goals of imposing LVR restrictions is to improve the resilience of the banking system to a significant fall in house prices. LVR restrictions do this in two ways. First, by increasing the average collateral coverage of loans on the books of banks, they reduce the probability that individual loans will default if house prices fall markedly, and also limit the size of losses for loans that do default. Second, by limiting both the degree of overshoot in house prices and the number of borrowers who become stressed in a downturn, LVR restrictions are expected to reduce both the magnitude and the probability of a major housing market downturn.

The Reserve Bank's housing stress testing model, TUI, provides one avenue to estimate the effect of LVR restrictions on downturn loss rates (see Harrison and Matthew, 2008). In this model, housing default occurs due to a combination of cashflow pressures on borrowers and an inability to sell the house to repay the mortgage in full. The key inputs into this model is the distribution of housing portfolios

across LVR and debt servicing ratio (DSR) buckets, and an economic scenario involving three-year movements in house prices, interest rates and the unemployment rate.

The starting point for the distribution of LVRs across banks' housing portfolios is taken from banks' March 2013 Disclosure Statements. This data provides bank lending in four LVR buckets – 0-60 percent, 60-80 percent, 80-90 percent and above 90 percent. In the absence of LVR restrictions, it is assumed that this stock position remains unchanged. For simplicity, and due to a lack of reliable data, it is assumed that all lending has a DSR of 30 percent of income. Allowing for a more realistic distribution of DSRs would alter the magnitude of the estimated downturn losses, but would have little effect on the incremental effect of imposing LVR restrictions.

To model the effect of LVR restrictions it is necessary to trace through how the stock position of banks' portfolios change as a result of a change in the flow of new mortgage lending. The following assumptions are made about the evolution of banks new mortgage flows and existing portfolios, based off the analysis in figure 3 and the historic behaviour of banks' portfolios:

- New high LVR loans are assumed to fall to $7.1bn annually, with two thirds of these loans in the 80-90 percent bucket and one third in the above 90 percent bucket.
- $2bn of loans are assumed to be written at an LVR of exactly 80 percent, in line with the assumption that around 25 percent of affected high-LVR borrowers are able to find alternative deposit funding to reduce their LVR to 80 percent.
- New mortgage flows at below 80 percent LVRs increase slightly to account for high-equity borrowers entering the market.
- 7 percent of existing loan balances in the 80-90 percent and over 90 percent buckets transition to a lower bucket each quarter.
- 6 percent of loans in the 60-80 percent bucket transition down, while 4 percent of balances are paid down each quarter.
- 6 percent of loan balances in the 0-60 percent LVR bucket are paid off each quarter.

There is a gradual reduction in the share of high-LVR loans on bank balance sheets over time. As a result, the resilience of bank balance sheets to a housing downturn gradually improves the longer LVR restrictions are in force.

The baseline economic scenario that we use to assess downturn losses features a 40 percent decline in house prices, a 4.5 percent increase in the unemployment rate and a 3.75 percent increase in mortgage interest rates.[8] This scenario is similar to the downturn scenario that bank capital requirements are calibrated to, and is also similar

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[8] While the unemployment and interest rate assumptions affect the overall level of losses, the estimated incremental effect of imposing LVR restrictions is not affected by changes to these assumptions. With more benign housing market declines, LVR restrictions would result in an even larger percentage (but not dollar value) decline in losses.

to the scenario in the 2011/2012 APRA-led stress tests of the major New Zealand banks (RBNZ, 2012).

With LVR restrictions in place, this scenario is modified slightly to account for the expected attenuating effect on house prices. In line with the estimates of the impact on house prices, it is assumed that the house price fall in a downturn would be 2 percent smaller than under the baseline if LVR restrictions were in place for one year, and 3 percent lower if they were in place for two or more years. This is a somewhat conservative assumption, as it does not factor in any change to the level to which house prices fall as a result of LVR restrictions.

Figure 6 summarises how bank portfolios are expected to evolve following the introduction of LVR restrictions, and forecast loss rates if a severe housing market downturn occurred at that point of time. In this scenario, LVR restrictions are expected to lower downturn loss rates on banks' housing portfolios by around 14 percent if LVR restrictions are in place for the two years immediately prior to the sharp fall in house prices. Around half of this improvement comes about from improvements in banks' portfolios, with the other half coming from the assumed attenuation in the housing cycle itself.

Figure 6: Mortgage portfolios and estimated downturn loss rates
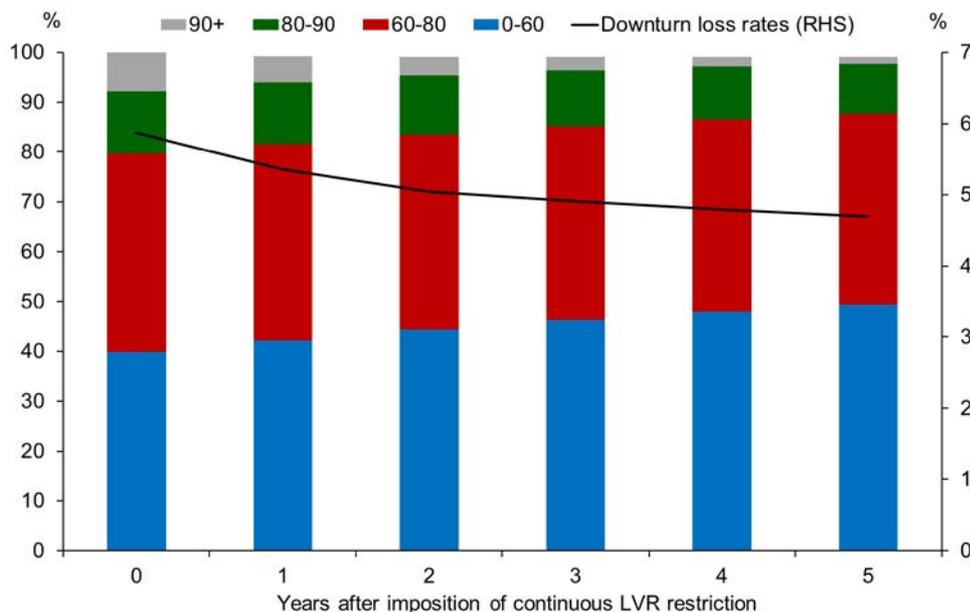
As a cross check on both the model and the methodology used to map the evolution of bank portfolios, we use confidential portfolio and loss rate information provided as part of the 2011/2012 APRA-led stress tests. Using portfolio loss rates estimated by APRA, this methodology suggests that LVR restrictions would lower average downturn loss rates by around 19 percent.

Considering the range of estimates here, we conservatively estimate that the reduction in banks' downturn losses on their housing loan portfolios would be 10-15 percent if LVR restrictions were applied for two years immediately prior to a major fall in house prices.

CONCLUSION

Regulatory restrictions on high LVR housing lending are a new policy tool in New Zealand and as a result estimating the quantitative impact is not an exact science. This Analytical Note has outlined the analysis that the Reserve Bank used to judge that the recently introduced LVR speed limits would reduce house price inflation by 1-4 percentage points, household credit growth by 1-3 percentage points, and, in a specific scenario, downturn loss rates on banks' housing portfolios by 10-15 percent. However, it is possible that LVR restrictions also lead to a reduction in house price expectations and to a change in consumer behaviour. While a small allowance has been made for this channel in these estimates, a significant change in behaviour could result in larger quantitative impact on house prices and credit growth than modelled here.

The Reserve Bank will be watching developments in house prices and household credit very closely in coming months to assess the effect of the policy. We expect to provide analysis on this in our six-monthly *Financial Stability Report*, starting with an assessment of early signs of impact in our November *Report*. However, house prices and credit growth are affected by a wide range of factors, so even in retrospect estimating the impact of the LVR restriction will be complex.

REFERENCES

Bloor, C. and Matheson, T. (2010) 'Analysing shock transmission in a data rich environment: A large BVAR for New Zealand' *Empirical Economics*, 39(2), pages 537-558.

Craig, R. and Hua, C. (2011) '"Determinants of Property Prices in Hong Kong SAR: Implications for Policy', International Monetary Fund *Working Paper*, 11/277.

Harrison I. and Matthew C. (2008) 'Project TUI: A structural approach to the understanding and measurement of residential mortgage lending risk', mimeo.

Igan, D. and Kang H.(2011) 'Do Loan-to-Value and Debt-to-Income Limits Work? Evidence from Korea', International Monetary Fund *Working Paper*, 11/297.

International Monetary Fund (2013) 'Recent experience with macro-prudential tools in Canada: Effectiveness and options going forward', IMF Country Report, 13/41.

Kuttner, K. and Shim I (2012) 'Taming the Real Estate Beast: The Effects of Monetary and Macroprudential Policies on Housing Prices and Credit', in Heath A, F Packer, and C Windsor (ed.), *Property Markets and Financial Stability*, Reserve Bank of Australia, December 2012.

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Lucas, R. (1976) 'Econometric Policy Evaluation: A Critique'. In Brunner, K. and Meltzer, A. 'The Phillips Curve and Labor Markets'. *Carnegie-Rochester Conference Series on Public Policy 1*, New York: American Elsevier. pp. 19–46.

Reserve Bank of New Zealand (2012) 'Box D', *Financial Stability Report*, November 2012.

Reserve Bank of New Zealand (2013a) 'Regulatory impact assessment: Restrictions on high-LVR residential mortgage lending', http://rbnz.govt.nz/financial_stability/macro-prudential_policy/5407434.pdf

Reserve Bank of New Zealand (2013b), *Monetary Policy Statement*, September 2013.

Rogers, L. (2013) 'Unpacking the toolkit: the transmission channels of macro-prudential policy in New Zealand', paper prepared as background to Reserve Bank of New Zealand consultation on 'Macro-prudential policy instruments and framework for New Zealand', http://rbnz.govt.nz/financial_stability/macro-prudential_policy/5169081.pdf

Wong, E. Fong, T. Li K. and Choi H. (2011) 'Loan-to-Value Ratio as a Macroprudential Tool – Hong Kong's Experience and Cross-Country Evidence', Hong Kong Monetary Authority *Working Paper,* 01/2011.

APPENDIX A - MODEL VARIABLES

Net PLT immigration
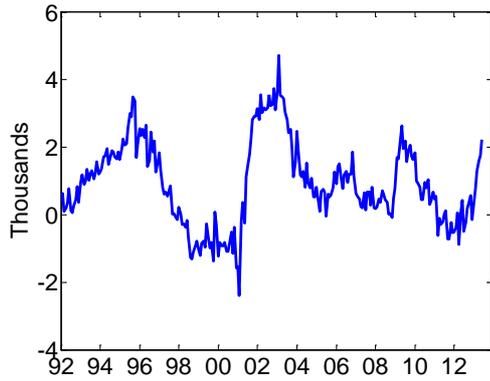
REINZ house sales
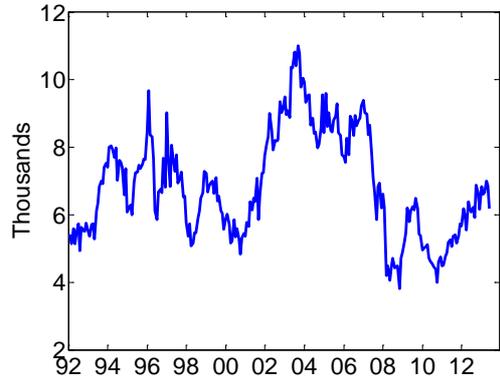
REINZ days to sell
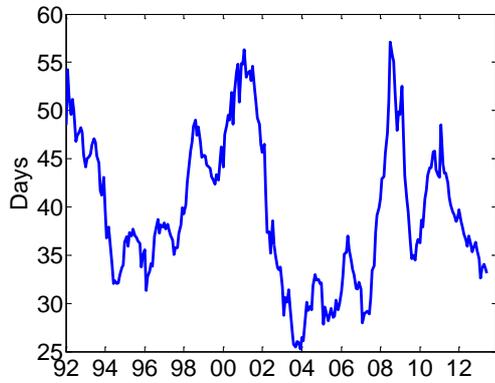
Residential building consents (floor area)
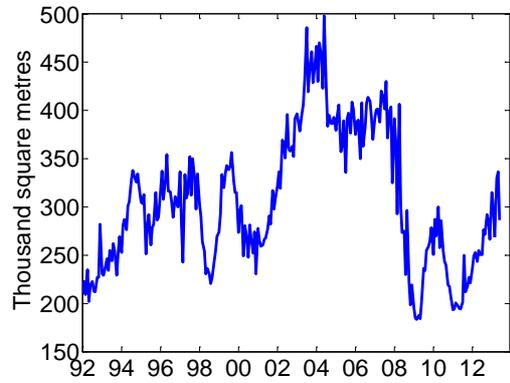
REINZ housing price index
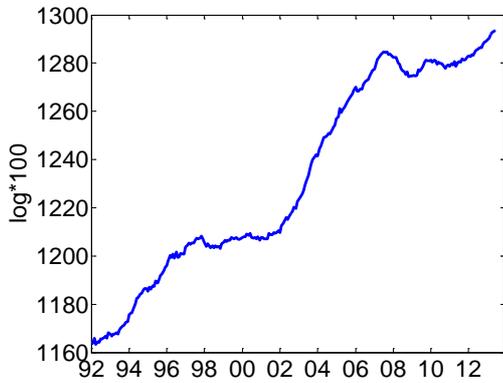
Total household credit

2-year fixed mortgage rate