



# Reserve Bank of New Zealand Analytical Notes

## Estimating New Zealand's neutral interest rate

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## NON-TECHNICAL SUMMARY

It is important for the Reserve Bank of New Zealand to understand the extent to which current monetary policy settings are either contractionary or expansionary with respect to the macroeconomy. As a benchmark for this analysis, the Bank estimates a level of the nominal 90-day bank bill rate that it believes is neither expansionary nor contractionary. This benchmark interest rate is termed the 'neutral interest rate'.

The neutral interest rate is unobservable and significant judgement is required to assess its current level. The Bank continually monitors the economy for possible changes in the neutral interest rate. This includes a broad assessment of consumer attitudes towards debt and risk, the economy's potential growth rate, and international developments. Signs that the neutral rate may be changing are initially incorporated into the Bank's risk assessment when setting policy. If the economy shows clear signs of a change in the neutral interest rate, the Bank will formally change its estimate in its various modelling frameworks.

The Bank looks at a range of model-, survey-, and market-based estimates of the neutral rate to help inform this ongoing judgement. This paper outlines the methodology the Bank uses to arrive at these model-, survey-, and market-based estimates. The Bank currently uses five key methods to help inform judgements about the neutral interest rate. These include:

- a neo-classical growth model;
- implied market expectations of long-horizon interest rates;
- analysts' expectations of long-horizon interest rates;
- analysts' expectations of long-horizon annual nominal economic growth; and,
- a small New Keynesian model.

These estimates suggest the nominal neutral 90-day interest rate sits between 3.8 and 4.9 percent currently. The mean of these indicators is 4.3 percent. The Bank currently judges that the nominal neutral 90-day interest rate sits at 4.5 percent - within the range of estimates and close to the mean of these estimates. This implies that current monetary policy settings are expansionary, although these models highlight some emerging risk that the neutral interest rate is falling further. The Bank will continue to use these five methods, along with broader monitoring of the economy, to help identify any possible changes in the neutral interest rate. Furthermore, the Bank will continue to look for ways to improve its estimates, including the development of other estimation methodologies.

## 1. INTRODUCTION<sup>1</sup>

The Bank is directed by legislation and the *Policy Targets Agreement*<sup>2</sup> to keep future inflation between 1 percent and 3 percent on average over the medium-term, with a focus on the 2 percent mid-point. The Bank's primary instrument to achieve this target is the Official Cash Rate (OCR). Setting the OCR gives the Bank a degree of influence over the interest rates faced by businesses and households. This enables the Bank to influence economic behaviour, activity, and inflation – albeit with a lag. The Bank's communication about the future outlook for the OCR also has an influence on behaviour by affecting interest rates at longer maturities.

When future inflationary pressure is expected to be higher than is consistent with the inflation target, the Bank will tend to set interest rates at a 'contractionary' level. High interest rates encourage saving and discourage investment, constraining economic activity and lowering the rate of inflation. Such a policy reaction helps keep longer-term inflation expectations anchored close to the target mid-point. High interest rates also boost the exchange rate, dampening tradables inflation. When inflationary pressure is lower than consistent with target, the Bank will tend to set interest rates at an 'expansionary' level, boosting economic activity, lowering the exchange rate, anchoring inflation expectations, and lifting the rate of inflation.<sup>3</sup>

Therefore, in order to aid the setting of monetary policy, the Bank needs an estimate of the level of interest rates that is neither contractionary nor expansionary. This benchmark enables the Bank to assess the degree to which current interest rate settings are adding to, or subtracting from, activity and inflationary pressure. This benchmark interest rate level is labelled the 'neutral interest rate'.

This paper focusses on the neutral level of the nominal *90-day bank bill* rate. This is a market interest rate that is a common benchmark for many financial products in New Zealand, and is largely determined by the level of the OCR. It is also the interest rate the Bank publishes conditional forecasts for in its quarterly *Monetary Policy Statements*.

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<sup>1</sup> The authors would like to thank Willy Chetwin, Dean Ford, Matthew Galt, Yuong Ha, Gunes Kamber, Elizabeth Kendall, Ross Kendall, Leo Krippner, Roger Perry, Christie Smith, Evelyn Truong and Amy Wood for helpful comments. Any errors remain the responsibility of the authors.

<sup>2</sup> See [http://www.rbnz.govt.nz/monetary\\_policy/policy\\_targets\\_agreement/](http://www.rbnz.govt.nz/monetary_policy/policy_targets_agreement/) for the current *Policy Targets Agreement* and <http://www.legislation.govt.nz/act/public/1989/0157/latest/DLM199364.html> for the Reserve Bank of New Zealand Act 1989.

<sup>3</sup> See Drew and Sethi (2007) for a detailed outline of how changes in the OCR affect the New Zealand economy.

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It is the *real* neutral rate that is most relevant for the setting of monetary policy – that is, the nominal rate less the long-term expectation of annual inflation. However, the framework presented here describes the estimation of the neutral *nominal* rate. An assessment of inflation expectations, and therefore the real neutral interest rate, is overlaid during the Bank’s policy discussions in a separate assessment.<sup>4</sup> All model results, figures and discussion will refer to the *nominal* neutral interest rate unless specified.

The neutral interest rate is unobservable, which adds to the uncertainty in conducting monetary policy. The Bank puts considerable effort into estimating the neutral interest rate and monitoring the economy for any possible movements in the neutral rate.

Given the importance of the neutral interest rate in the setting of monetary policy, the Bank has presented a broad range of material on neutral interest rates in the past. The most recent discussion was presented in McDermott (2013) and Chetwin and Wood (2013). The theories of neutral interest rates, including their intuition and drivers, are explained in detail in these papers. Recent movements in New Zealand’s neutral interest rate and the changes in the Bank’s assumptions about the level of neutral are also covered in these papers. As a result, this paper will only briefly deal with the broader theory of neutral interest rates and recent changes to the Bank’s assumptions.

Instead, this paper aims to present the range of technical approaches the Bank uses to estimate and monitor the neutral interest rate in New Zealand. The goal is to inform the Bank’s key stakeholders of the technical factors the Bank monitors when assessing the level of the neutral interest rate.

## 2. THE CONCEPT OF A NEUTRAL INTEREST RATE AND THE BANK’S MONITORING

### FRAMEWORK

#### 2.1. THE NEUTRAL INTEREST RATE AND RELEVANT TIME HORIZONS

The neutral interest rate is a broad concept in economics, without a single definition. As discussed in Chetwin and Wood (2013), the time horizon being considered will determine the exact concept of neutral that is most relevant.

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<sup>4</sup> See Lewis (forthcoming) for further discussion.

The concept presented in this paper is a medium- to longer-term concept, consistent with the time taken for interest rates to have their full effect on inflation and for other monetary policy relevant variables, such as the exchange rate, to return to equilibrium. It is the interest rate that would prevail once all business cycle shocks have dissipated and inflation is expected to remain at target. This measure of neutral interest rates helps the Bank identify the degree of stimulus being provided to the economy by current and expected interest rate settings, at horizons relevant for the operation of monetary policy.

## 2.2. FACTORS THAT INFLUENCE THE NEUTRAL INTEREST RATE

The neutral interest rate is determined by long-term demand and supply of credit. For the horizons relevant for monetary policy, household decision making is a key driver of conditions in credit markets, and of the neutral interest rate.

Two assumptions in macroeconomic theory lead to the important role of the household sector in determining the neutral interest rate. First, it is assumed that households have a preference to smooth the amount they consume through their lifetime.

As a result, households look to the credit market to enable them to shift consumption through different stages of their life. For example, a student may borrow for living costs today in order to shift some extra consumption to today, on the expectation of higher income in the future. Broadly, households are assumed to have a preference to save when income is high and borrow when income is low.

Second, partially offsetting households' preference for smoothing, it is assumed that households have a preference for consumption today over consumption tomorrow. This can be thought of as a household's level of 'impatience'. If households are very impatient, they will be less willing to save when income is high, or even more willing to borrow when income is low.

The interaction of these two forces helps determine the demand and supply of credit in an economy. The first assumption means that there is both a portion of people willing to save and a portion of people willing to borrow, depending on the respective stages of their lifecycle. This means there will be a constant interaction of savers and borrowers affecting the interest rate in an economy. The second assumption implies that people will need some compensation to forgo consumption today for consumption in the future.

As a result of these assumptions, there are two major factors that influence the neutral interest rate. One will be the expected lifetime income of households, which will drive their preference for smoothing consumption through time and their overall borrowing and saving preferences. The second is the degree of impatience amongst households, which again will drive their preference for smoothing consumption through time and their overall borrowing and saving preferences.

This framework helps economists identify the factors that may drive changes in the neutral interest rate over the medium-to-long term. For instance, any factors that influence lifetime income expectations will influence the demand and supply of credit and the neutral interest rate. Lifetime income is closely related to trend GDP, and so will be influenced by factors including productivity growth, population growth, employment, labour force participation, and trend rates of investment.

As an example, consider an innovation that raises the economy's potential GDP and therefore the lifetime income of most individuals in an economy. In this case, households now expect greater consumption over their lifetime and will want to shift a portion of that increased consumption to today. In doing so, they will bid up interest rates as a broad range of households now wish to borrow more. In this case, the neutral interest rate would have increased.

Any factors that influence household impatience will influence the demand and supply of credit and the neutral interest rate. Households' preferences for consumption today relative to future consumption are driven by factors such as household attitudes towards risk and debt, and the degree of uncertainty of future income. Greater uncertainty means a greater degree of precautionary savings to guard against risks, and a lower level of impatience.

As an example, consider an increase in the degree of uncertainty regarding future income. This will cause a large number of households to increase the amount they want to save to build a buffer against future uncertainty. This will effectively lead to a decrease in household impatience. In such a case, a greater amount of savers will bid down interest rates, leading to a drop in the neutral interest rate.

### **2.3. THE BANK'S MONITORING FRAMEWORK**

The neutral interest rate is unobservable and therefore must be estimated. The Bank uses a combination of monitoring, judgement, and formal modelling to assess the level of the

neutral interest rate. This assessment is conducted continually, as part of regular evaluation of the appropriateness of current policy settings.

Guided by the theory discussed above, the Bank monitors a number of areas of the economy to assess the potential for any changes in the neutral rate. In particular, the Bank closely follows the economy's level of potential GDP, household attitudes towards risk and debt, supply-side conditions in the labour market, and the rate of investment. Changes in the trends of these elements could signal a change in the neutral interest rate.

Further informing this process, the Bank uses a range of formal estimation techniques. This includes market-based measures of the neutral interest rate, modelling frameworks, and survey measures of analysts' expectations. These techniques are outlined in section 3. Generalised movements in these indicators would provide emerging evidence of a change in the neutral rate.

The Bank's Monetary Policy Committee and Governing Committee bring all this information together and form a judgement on the level of the neutral interest rate. Early signs of a change in the neutral rate are often incorporated as a risk in the Bank's policy formulation, reflecting the slow-moving and medium- to long-term nature of such a concept. When this framework shows a clear weight of evidence that the neutral rate has changed, the Bank will formally update its neutral rate assumption in its modelling frameworks.

#### **2.4. RECENT TRENDS IN NEUTRAL INTEREST RATES IN NEW ZEALAND**

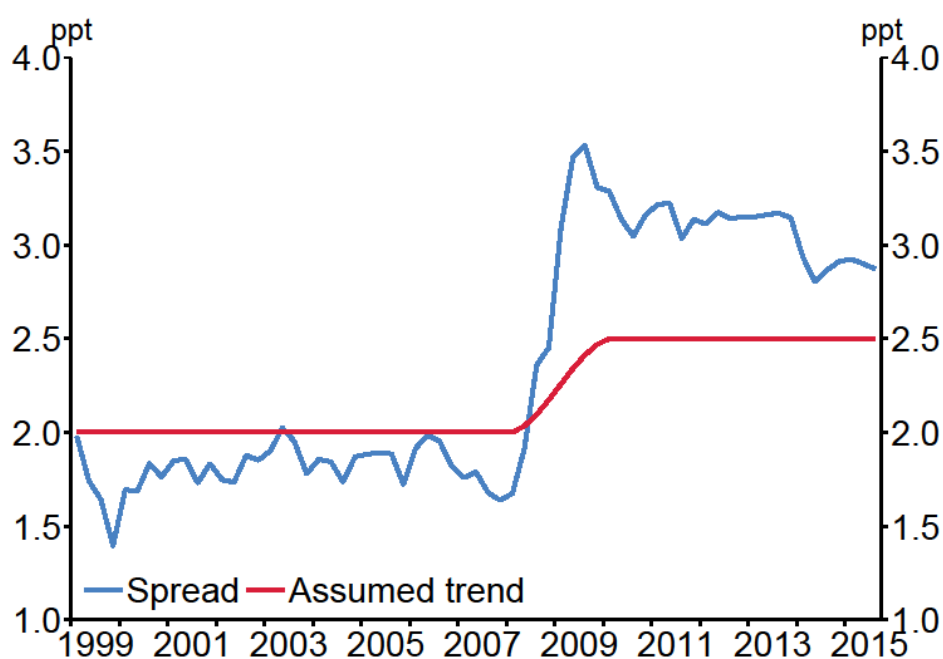
The interest rates that are most important for influencing behaviour are the ones actually faced by businesses and households. In this regard, the floating mortgage rate is an important benchmark rate that the Bank monitors when it sets policy. The nominal neutral floating mortgage rate is currently assumed to be 7 percent, having been lowered by 100 basis points over 2008 and 2009. This downward revision reflected changes in the structural factors outlined in section 2.2.

In particular, New Zealand's rate of potential growth has moderated since the period prior to the 2008/09 global financial crisis. This has likely dampened expectations of lifetime income and lowered the neutral interest rate. In addition, there is some evidence that households are more cautious in their attitudes towards debt and risk since the crisis. This may have lowered household impatience (or raised precautionary savings), and led again to a lower neutral interest rate.

However, the Bank influences market interest rates through the OCR, with the 90-day bank bill rate a closely related and liquid financial market security. The Bank's assumption of the nominal neutral 90-day interest rate was lowered by 150 basis points over 2008 and 2009, to 4.5 percent – an additional 50 basis points relative to the change in the neutral floating mortgage rate.

100 basis points of this revision reflect the reduction in the neutral floating mortgage rate discussed above. The remaining 50 basis points of this revision reflects the Bank's assumption of the permanent aspect to the increased spread between the 90-day rate and floating mortgage rate. This spread has increased due to higher wholesale private bank funding costs (figure 1).

Figure 1: Spread between the 90-day bank bill and floating mortgage interest rates



Source: RBNZ, RBNZ estimates.

### 3. ESTIMATES OF NEW ZEALAND'S NEUTRAL INTEREST RATE

As part of the Bank's framework for assessing the neutral interest rate, a range of model-, survey-, and market-based measures of the neutral interest rate are calculated. Each of these measures comes with its own uncertainty related to its estimation. Given this, the Bank uses a range of estimates, rather than a single estimate, to inform its judgement about the



level of the neutral interest rate. This range of techniques is presented in the following sections.

### 3.1. A NEO-CLASSICAL GROWTH MODEL APPROACH

The neo-classical growth model calculates the neutral interest rate as the sum of the annual growth rate of real potential output and trend annual inflation expectations. As discussed above, household expectations of lifetime income are an important determinant of the neutral interest rate, and potential GDP is a key determinant of lifetime income.

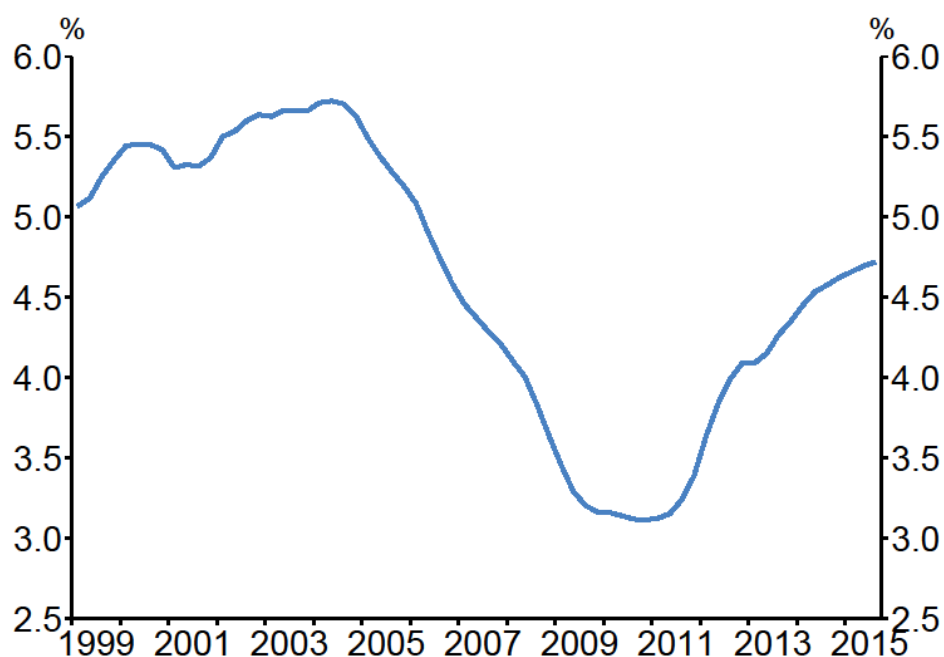
Potential annual GDP growth plus trend annual inflation broadly captures the nominal annual return expected from investing in an economy over the long run and, intuitively, should be a key factor driving the return on an investment and therefore the neutral interest rate. Technically, this definition of the neutral interest rate is derived from the Ramsey-Cass-Koopmans neo-classical growth model (see Romer (2006) for a presentation of the model).

This approach relies on an estimate of potential GDP growth, which is itself subject to significant uncertainty. The Bank's approach to estimating potential GDP is outlined in Lienert and Gilmore (2015). The results from this method are presented in figure 2, which assumes a trend rate of inflation expectations of 2 percent.

This method suggests that the neutral interest rate has dropped relative to the level that persisted prior to the 2008/09 global financial crisis. According to this estimate, the neutral interest rate sits at 4.8 percent.

McDermott (2014) discusses the evolution of potential GDP in New Zealand since the financial crisis, and factors that have contributed to the decline. The economy's potential growth rate slowed following the financial crisis, reflecting a slowdown in labour supply and productivity growth, and a subdued pace of investment. Potential GDP growth has recovered since 2012, as rates of investment have improved and population growth has increased.

Figure 2: Neo-classical growth framework estimate of the nominal neutral interest rate



Source: RBNZ estimates.

### 3.2. MARKET INTEREST RATE EXPECTATIONS

Market interest rates can provide an estimate of financial market participants' views of the neutral interest rate. At any point on the yield curve, the effective interest rate of a fixed income security will reflect the balance of market participants' views of the path of short-term interest rates over the lifetime of the security, as well as a term premium specific to the security.<sup>5</sup>

The yield of a shorter-maturity security (for example, a one-year government bond) will be heavily influenced by the outlook for shorter-term business cycle factors, like the strength of demand, current inflation, and the outlook for the exchange rate. These factors will drive short-term interest rates over the maturity of the security. A yield of a longer-maturity security (for example, a 10-year government bond) will be driven less by these business cycle factors, and more by expectations of where short-maturity interest rates will settle in the long-run.

In turn, long-run market expectations of short-maturity rates should reflect the equilibrium concepts discussed in section 2.1, which are the same concepts the Bank has in mind when determining the appropriate neutral interest rate for its purposes. In particular, market

<sup>5</sup> See Krippner (2010) for a discussion of New Zealand yield curves.

participants have strong financial incentives to reflect what they think is an appropriate neutral rate in longer-maturity securities, or otherwise offer easy profit opportunities to other participants.

In this regard, the 10-year New Zealand government bond yield is one instrument that largely reflects the market view of the neutral interest rate. However, business cycle factors are also likely to influence the yield of this bond to some degree – given near-term returns will have some influence on its value. 10-year yields will also contain term premiums, as previously mentioned.

To abstract from the business cycle effects, the Bank estimates the implied zero coupon 5-year-5-year forward government bond rate. This is the five-year interest rate that is expected to prevail starting five years from now, implied by the current structure of the yield curve. Business cycle expectations should have less of an impact on such an interest rate. Instead expectations of neutral will be a key driver.

However, this measure by itself incorporates a term premium specific to the 5-year-5-year security<sup>6</sup>. In contrast, we know that the 90-day bank bill rate in the future will be influenced by the term premium in a limited way, reflecting the short duration of the security. Hence, the 5-year-5-year forward government bond yield needs to be adjusted for a term premium.

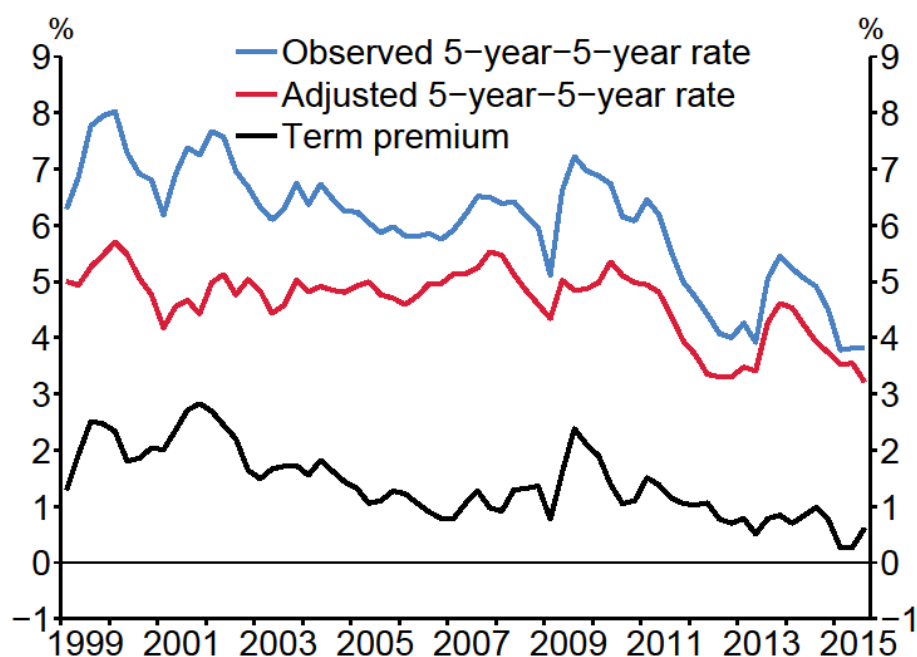
The Bank estimates this term premium in a standard three-factor arbitrage-free yield curve model for New Zealand, which will be detailed in a forthcoming note.<sup>7</sup> Figure 3 presents the 5-year-5-year government bond yield, the estimate of the term premium and the 5-year-5-year yield adjusted for this term premium.

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<sup>6</sup> Which, in turn, are due to premiums on the 5-year and 10-year government bond rates used in the calculation of the implied 5-year-5-year rate. These term premiums are both material in size, and time varying.

<sup>7</sup> Krippner (forthcoming).

Figure 3: 5-year-5-year government bond yield and risk premium

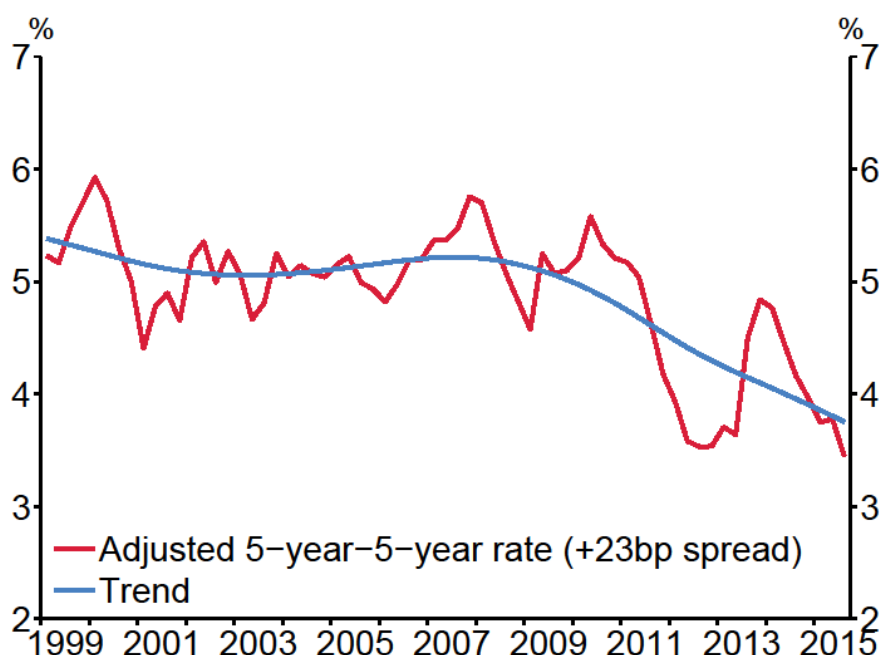


Source: RBNZ estimates.

This gives an estimate of the average short-maturity government yield that is likely to prevail in the long run. A spread of 23 basis points is added to this estimate to get an estimate of the 90-day rate that will prevail in the long run. This spread reflects the difference in risk between short-maturity bank and government securities, estimated as the average spread between the 90-day overnight indexed swap rate and the 90-day bank bill yield.

With these adjustments, such an estimate should reflect the market's view of where the Bank is likely to set the 90-day rate in the long run, and therefore the market's view of the neutral interest rate (figure 4). Despite the long-run nature of this neutral rate indicator, such a measure can be volatile, as markets continually update prices in reaction to economic news. To abstract from this volatility, Hodrick-Prescott-filtered data are also presented in figure 4. The Bank tends to focus on this less volatile measure of interest rate expectations, given the neutral rate is assumed to shift only gradually.

Figure 4: Adjusted 5-year-5-year government bond yield and trend



Source: RBNZ estimates.

Overall, this measure of long-run interest rate expectations has shifted lower over the past few years. In particular, market perceptions of the neutral interest rate seem to have shifted lower since the financial crisis. Currently, this measure sits at 3.8 percent.

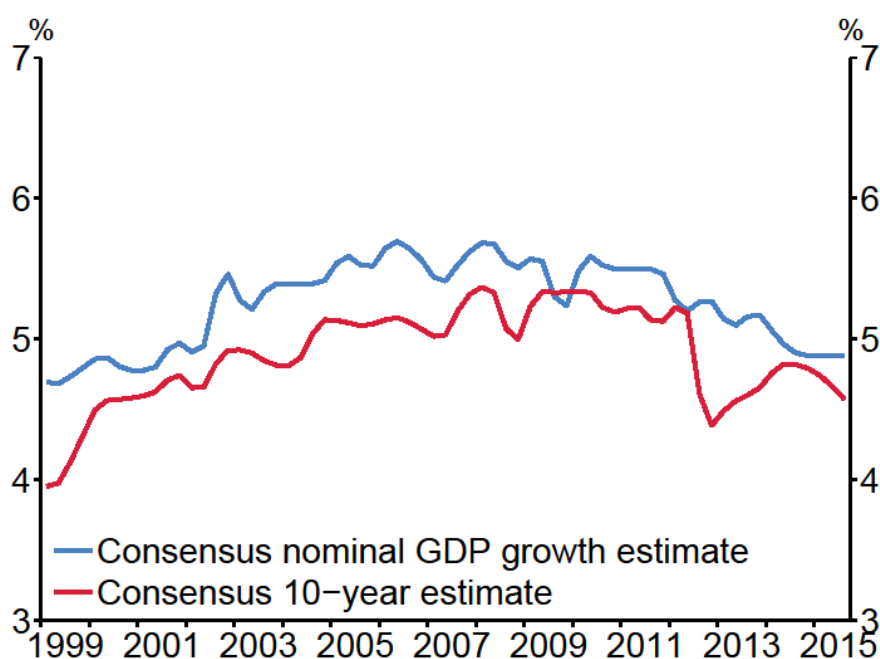
### 3.3. LONG-TERM CONSENSUS EXPECTATIONS

Analyst expectations can also provide an estimate of the neutral interest rate. Consensus Economics surveys analysts covering the New Zealand economy on their expectations of macroeconomic and financial variables. One question asks what the 10-year government yield will average over the five year period starting in five years' time. Analogous to the 5-year-5-year rate in section 3.2, the five-year forward horizon abstracts from the business cycle, leaving analysts to assess where interest rates will equilibrate in the long run. In this case, the interest rates are for 10-year maturities, so they are adjusted for a 10-year term premium estimated from the same model noted in section 3.2.

In addition, the survey asks analysts for their long-run expectations of real GDP growth and inflation. This gives an idea of what analysts are expecting for long-term average nominal GDP growth. As a result, it reveals analysts' expectations consistent with the neo-classical growth model approach outlined in section 3.1.

These series are presented in figure 5.<sup>8</sup> There is some lag in the publication of these figures, with the bi-annual survey undertaken in October and April. These measures shows analysts' expectations of the neutral 90-day rate held around 4.5 to 5.5 percent through the 2000s. However, expectations have dropped recently, below 5 percent. Both measures have fallen since the financial crisis. The nominal growth expectation implies a neutral rate of 4.9 percent. The 10-year bond expectation implies a neutral rate of 4.6 percent.

Figure 5: Expectations of long-run interest rates and annual nominal GDP growth



Source: Consensus Economics, RBNZ estimates.

### 3.4. A SMALL NEW KEYNESIAN MODEL APPROACH

A model-based approach is another option for estimating the neutral interest rate, using economic theory and New Zealand macroeconomic data. One model the Bank uses is a small, open economy New Keynesian model, the details of which are outlined in Kirker (2008).

The model is an open economy adaptation of the New Keynesian business cycle model. The building blocks of the model are:

- an IS curve that relates the level of output gap to the 90-day interest rate, the exchange rate, and foreign demand;

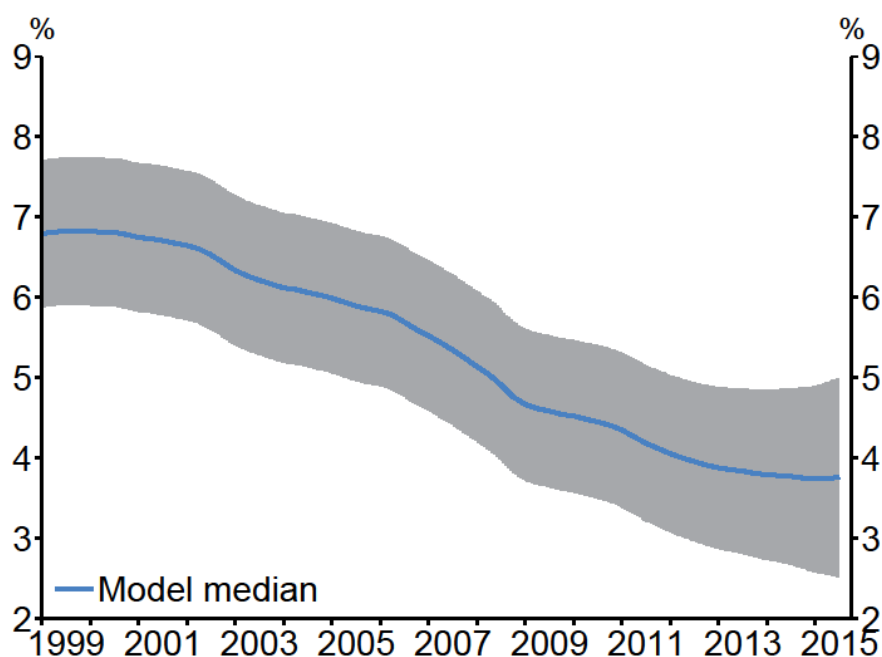
<sup>8</sup> A spread of 23 basis points is added to the series to make them comparable with bank risk, rather than government risk, as in the yield curve models in the preceding section.

- a Phillips curve that relates the level of inflation to the output gap and the exchange rate;
- a monetary policy rule that targets expected inflation;
- an uncovered interest rate parity condition; and,
- an assumption that macroeconomic dynamics in the rest of the world evolve independently from NZ.

All variables and relationships in the model are expressed in gap terms, i.e. as deviations from their trend or neutral rates. The estimation methodology aims to simultaneously find the most likely decomposition of each variable into trend and cycle terms given the model structure and the specification of trends.

The resulting estimate of the nominal neutral 90-day interest rate is presented in figure 6 below. This model suggests that the neutral interest rate has shifted lower since the global financial crisis, with the point estimate of the neutral interest rate currently 3.8 percent. However, the 90 percent confidence interval is 2.5 to 5.0 percent, highlighting the estimation uncertainty inherent in this modelling technique.

**Figure 6: Nominal neutral 90-day interest rate implied from New Keynesian model**



Source: RBNZ estimates.

Note: shaded area represents 90% confidence intervals.

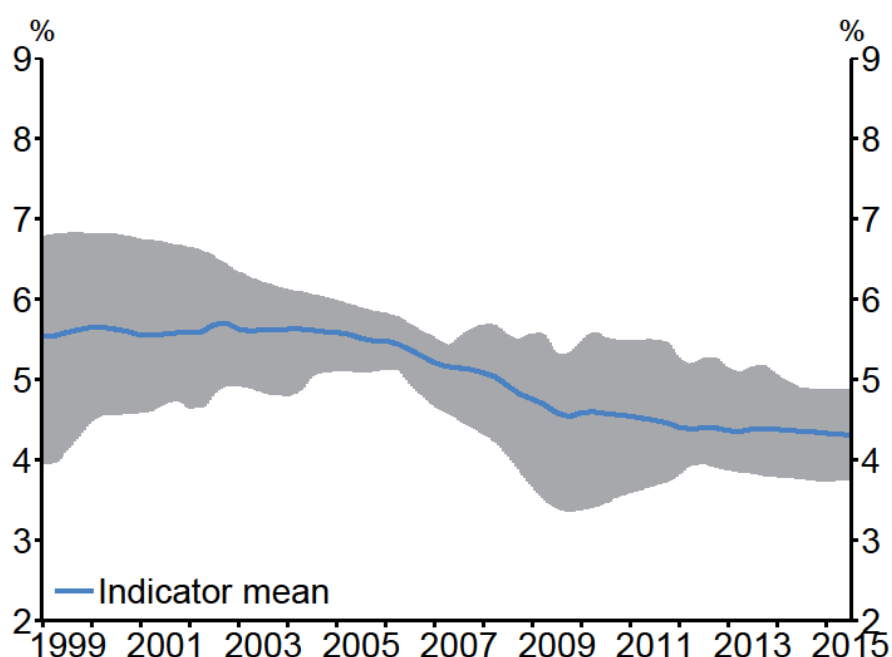
#### 4. THE RANGE OF ESTIMATES AND CURRENT ASSUMPTIONS

The different approaches discussed above provide a range of estimates of the nominal neutral 90-day interest rate (figure 7). The Bank uses this range of estimates to help inform the Monetary Policy Committee and the Governing Committee in their policy deliberations. These estimates feed into the broader assessment framework discussed in section 2.3.

Overall, this collection of modelling techniques points to a range for the neutral interest rate between 3.8 percent and 4.9 percent. The mean of these indicators is 4.3 percent.<sup>9</sup> As discussed in McDermott (2013), the Bank currently judges the nominal neutral 90-day interest rate is 4.5 percent. This point estimate sits comfortably in the range of the estimates from the techniques discussed above, and close to the mean.

This implies that current monetary policy settings are expansionary, although these models highlight some emerging risk that the neutral interest rate is falling further. The Bank will continue to monitor the validity of these assumptions when considering policy settings.

Figure 7: Neutral 90-day rate indicator suite



Source: RBNZ estimates.

Note: The shaded area shown here is the range between the minimum and maximum point estimates in each quarter from the indicators already presented.

<sup>9</sup> The Consensus Economics 10-year yield expectation is excluded from the mean calculation, in order to avoid overweighting measures of analysts' expectations.



## CONCLUSION

An estimate of the neutral interest rate is required, in order for the Bank to assess the degree of monetary stimulus being provided to the economy. This concept is used as a benchmark to assess how expansionary or contractionary current monetary policy settings are.

This paper presents the range of techniques the Bank uses to inform monetary policy decision makers' wider judgements around the nominal neutral interest rate. The neutral interest rate is an unobservable variable, and the Bank uses a range of techniques and estimates to guide its judgement.

These techniques use information from economic theory, economic models, surveys and market prices. Overall, these estimates suggest the neutral interest rate has fallen since the financial crisis. Further, the current assessment of the neutral interest rate sits comfortably in the range of estimates.

## REFERENCES

Chetwin, W and Wood, A. (2013) 'Neutral interest rates in the post-crisis period', Reserve Bank of New Zealand Analytical Note AN2013/07.

Drew, A and Sethi, R. (2007) 'The transmission mechanism of New Zealand monetary policy', Reserve Bank of New Zealand Bulletin June 2007.

Kirker, M. (2008) 'Does natural rate variation matter? Evidence from New Zealand', Reserve Bank of New Zealand Discussion Paper DP2008/17.

Krippner, L. (2010) 'Connecting the dots – a yield curve perspective on New Zealand's interest rates', Reserve Bank of New Zealand Bulletin September 2010.

Lewis, M. (forthcoming) 'Measuring inflation expectations', Reserve Bank of New Zealand Analytical Note.

Lienert, A and Gillmore, D. (2015) 'The Reserve Bank's method of estimating "potential output"', Reserve Bank of New Zealand Analytical Note AN2015/01.

McDermott, J. (2013) 'Shifting gear: why have neutral interest rates fallen?', comments by Assistant Governor McDermott 2 October 2013.

McDermott, J. (2014) 'Realising our potential: Potential output and the monetary policy framework', comments by Assistant Governor McDermott 9 July 2014.

Romer, D. (2006) 'Infinite-Horizon and Overlapping-Generation Models', Advanced Macroeconomics, Third Addition, McGraw-Hill, Chapter 2.