What is the neutral real interest rate, and how can we use it?

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This article sets out the Reserve Bank's conception of the "neutral real interest rate", and identifies factors that influence its level. These factors provide a starting point for thinking about what might cause the neutral real interest rate to change over time, or differ across countries. We consider the uses and limitations of neutral real interest rates in answering some of the questions that are relevant to monetary policy, and present a range of estimates of the neutral real interest rate for New Zealand.

1 Introduction

The focus of this article is the neutral real interest rate. In order to understand the concept of a neutral real interest rate, it is first necessary to understand what we mean by the term 'real interest rate'.

The interest rates that we observe in day-to-day life are almost always expressed in nominal terms. For example, if an investor has money in a savings account, the nominal interest rate tells the investor how much money the bank will pay them as a return on their savings. The nominal interest rate does not tell the investor how much the return on their savings will be worth in terms of actual goods and services. To find this out, the investor would need to adjust the nominal return on their savings by the amount by which they think prices will change during the time when their money is held in their savings account. In other words, to determine the expected real interest rate, the investor would need to subtract the expected inflation rate from the nominal interest rate.

Assuming that we care about the quantity of goods and services that we can buy with money, rather than money itself, it would seem reasonable to suppose that it is the real interest rate, rather than the nominal interest rate, that drives our economic decisions. For many central banks, including the Reserve Bank of New Zealand, the policy instrument that the central bank can directly control is a short-term nominal interest rate. However, because inflation expectations tend to be stable over short periods of time, a change in nominal interest rates also changes the real interest rate.[2]

Central banks use their policy instrument, usually a short-term nominal interest rate, to lean against inflationary pressure when they judge that this can be done effectively.[3] Sometimes interest rates will be increased to lean against the possibility of inflation rising too much, and sometimes they will be lowered to avoid the possibility of inflation falling too much. But how do we know how high is high enough – or how low is low enough? One concept that sheds some light on this question is the *neutral* real interest rate.

A neutral real interest rate provides a broad indication of the level of real interest rates where monetary policy is neither contractionary nor expansionary. In this sense a neutral real interest rate can be thought of as a benchmark, where a contractionary real interest rate is sometimes referred to as 'above neutral', and a stimulatory real interest rate is 'below neutral'. The gap between the current real interest rate and the neutral real interest rate can be thought of as a rough measure of the degree to which monetary policy is stimulating or contracting the economy. However, it is important to remember that the real interest rate is not the only influence on economic activity; many factors influence the level of activity in an economy.

[1] The authors would like to thank Reserve Bank colleagues for comments on earlier drafts of this article. Special thanks are due to Anne-Marie Brook, Geof Mortlock, Christie Smith, and Bruce White.

[2] When there is a change in the short-term nominal interest rate, the short-term real rate will move in the desired direction, so long as there is less than a one-for-one movement in short-term inflation expectations.

[3] This will depend on the amount of time it takes for a change in the interest rate to have an effect on inflation. If, on balance, the inflationary pressure is anticipated to subside before the change in the interest rate would have any effect on inflation, then there will be little or no reason for the central bank to act.

Unfortunately, as explained later in this article, the neutral real interest rate is not directly observable and must therefore be derived from other data, with all the uncertainty that that entails. Another difficulty is that the phrase "neutral real interest rate" may mean different things to different people. How relevant different concepts of the neutral real interest rate are depends on the types of questions we are asking. For example, we may be able to use a neutral real interest rate to decide whether interest rates are *contractionary to demand*, but we will not necessarily be able to use it to answer whether interest rates will actually *cause demand to contract*.

In this article we expand on the above distinction and clarify alternative concepts of the neutral real interest rate. We argue that it is possible to think of neutral real interest rates in a short-run, medium-run or a long-run context. Although a central bank may wish to make use of all three of these ways of thinking about neutral real rates, this article's primary focus is the medium-run concept of neutral. We reserve the abbreviation 'NRR' to refer exclusively to the *medium-run* concept of the neutral real rate.[4]

In section 2, we set out what we mean by the NRR. In section 3, we outline the uses and limitations of the NRR. In section 4, we consider issues surrounding alternative interpretations of neutral real interest rates and the relevance of these interpretations for monetary policy. In section 5, we sketch out the key drivers of interest rates more generally, and explain how the NRR relates to observed nominal interest rates. This discussion helps us to pin down the factors that are likely to cause differences in the NRR across countries and variations in the NRR for a given country through time. In section 6, we outline the approaches taken to estimating the NRR and discuss the results. Lastly, we provide some concluding comments.

[4] Allsop and Glyn (1999) and Blinder (1998) explore concepts of the neutral real interest rate that are close to the NRR, as defined in this article.

2 Understanding the NRR

This section sets out our understanding of the NRR. To provide context for this discussion, we first outline the role of monetary policy in influencing real interest rates over the business cycle, for the purpose of maintaining price stability.

Inflationary pressure can come from a number of sources. One important source of inflation is capacity constraints in the economy, which can give rise to increased pressures on factor prices, such as labour and capital costs. The level of output that is consistent with an economy operating at its highest sustainable level, *without* exceeding capacity constraints, is known as "potential output". The difference between actual and potential output is known as the "output gap". If actual output is greater than potential output (a positive output gap), then supply constraints tend to result in inflationary pressure.[5] Conversely, if actual output is below potential output (a negative output gap), this means that there is an under-utilisation of resources, which may contribute to deflationary pressures. As the level of potential output cannot be directly observed, it is often proxied by the trend level of actual output (see Claus et al (2000)).

In general, when a positive output gap is expected to persist, monetary policy-makers will set interest rates at a level that places downward pressure on demand, hence alleviating capacity constraints and thereby dampening the inflationary pressure that may otherwise arise. Conversely, when the central bank's assessment is that actual output will be lower than potential output, the central bank will set short-term interest rates at a level that places upward pressure on demand so as to avoid the emergence of deflationary pressures.

Of course, the output gap is only one of many sources of inflationary pressure that central banks have regard to when formulating monetary policy. Central banks will sometimes also wish to lean against persistent deflationary or inflationary pressures arising from other sources, such as changes in

[5] For example, some people might have to work longer hours, or machinery might have to be used for longer than would usually be the case. Workers need to be compensated for their extra effort, and machines may require additional maintenance. Therefore, the extra output produced is more costly than the output produced at normal capacity levels. If firms pass these higher costs on to consumers, inflation can result.

inflation expectations, exchange rate pass-through, or changes in price-setting behaviour.

For working purposes, we define the NRR as the interest rate that would prevail if there were no inflationary or deflationary pressures requiring the central bank to lean in either direction. In other words, the NRR is the interest rate that is consistent with a situation in which inflation and inflation expectations are stable at the inflation target and the output gap is zero and is expected to remain zero over the medium run. Note that this definition implicitly assumes that there is a corresponding neutral level for the exchange rate, such that the exchange rate neither stimulates nor contracts demand, and that the exchange rate is at this neutral level.

In order to understand the implications of this definition, let us suppose, for the sake of argument, that the real interest rate is held above the NRR for a prolonged period of time. Let us suppose further that, over time, positive and negative economic shocks have counter-balancing effects on inflation. And similarly, let us assume that the effects of downturns will exactly offset the effects of business cycle upswings on inflation, and that inflation expectations are stable unless they are disturbed by a shock to the economy. Under these assumptions, even if the real interest rate is held only marginally above the NRR, inflation will eventually fall.[6] Conversely, if the real interest rate is held marginally below the NRR, inflation could be expected to rise.

In section 4 we explain the distinction between our medium-run working definition of the NRR, and alternative ways of thinking about neutral real interest rates that are more short-run or long-run in focus. Before doing so, we discuss how the NRR, as we define it, may be used by monetary policy-makers.

3 How can policy-makers use the NRR?

Given that monetary policy-makers must take a view on the impact that different interest rate settings will have on the economy, they also must, at least implicitly, have a view on the level of the NRR. However, this view need not be set in stone. Indeed, as discussed later in this article, given the uncertainties surrounding the determination of the NRR, there are very good reasons for not attempting to quantify the NRR precisely and for not regarding the NRR as being stable over time. Different estimation methods and data may yield different, though arguably equally valid, results. This uncertainty is not unique to the NRR. There are many other unobservable variables that monetary policy-makers need to take a view on in order to determine appropriate policy settings, including, for example, the determinants of household saving and consumption decisions, the responsiveness of exports to the exchange rate, and the level of the equilibrium real exchange rate.

Given the uncertainty surrounding the ‘true’ value of the NRR, it is more common to describe a given interest rate setting as being ‘broadly’, rather than ‘exactly’, neutral. Given some agreement on what constitutes broadly neutral conditions, we can have a common understanding of the levels at which interest rates would be broadly stimulatory or contractionary. A range of estimates of the NRR is therefore used to give an indication of where appropriate interest rate settings may be, depending on whether a stimulatory, contractionary or neutral policy stance is required.

There is one particular time when we need to use a point estimate of neutral. This is when we use the NRR for modelling purposes. Models, and the various assumptions that they are built on, are used to arrive at a simplified, but internally consistent view of the linkages in the economy. Models cannot, and are not meant to, fully capture the real world. Instead, they are tools to be used in conjunction with, and to provide crosschecks on, judgement and experience.

[6] This is a similar idea to that advanced by Wicksell (1907), when he wrote “If, other things remaining the same, the leading banks of the world were to lower their real rate of interest, say 1 per cent. below its ordinary level, and keep it so for some years, then the prices of all commodities would rise and rise without any limit whatever; on the contrary, if the leading banks were to *raise* their rate of interest, say 1 per cent. above its normal level, and keep it so for some years, then all prices would *fall* and fall and fall without any limit except Zero.”

The NRR that has been calibrated into the Reserve Bank's baseline economic model is 4.5 per cent.[7] While there is no guarantee that this, or any particular assumption, will be maintained indefinitely, this number is well within the range of NRR estimates that we present later in the article.

Given the uncertainty that inevitably surrounds model assumptions, model-builders and users need to be pragmatic. Problematic assumptions may not be easily observable, as they may be offset by incorrect assumptions elsewhere in the model. Furthermore, when using the model for forecasting purposes, we may override the assumptions to some extent, as the output from the model may be altered in order to include influences that the model structure cannot automatically capture. We manage the uncertainty inherent in the assumptions of the model by paying close attention to the sensibility of the model as a whole, and by treating the judgementally-adjusted model forecast as part of a range of possibilities of how the future will unfold.

The NRR provides policy-makers with an indicative benchmark, by telling them whether a given level of the interest rate is likely to be contractionary or stimulatory. However, it does not tell the policy-maker the exact level at which to set interest rates. To decide on the appropriate interest rate setting, the policy-maker needs to decide *how* stimulatory or contractionary monetary policy needs to be, and for how long that stance needs to be maintained. These decisions will depend on a number of factors, the most important being:

1 The policy-maker's assessment of the strength and persistence of the inflationary pressure that they are trying to offset. Generally, stronger and more persistent inflationary pressures will lead to higher interest rate settings.

2 Preferences regarding the trade-offs between deviations of inflation from the target, and volatility in other economic variables, such as output or the real exchange rate.

Policy-makers face a trade-off between the variability in inflation and the variability in output. For instance, in some circumstances, in order to adhere strictly to an inflation target, aggressive monetary policy actions may be required (ie large movements in the policy rate – the OCR in the case of New Zealand). The advantage of aggressive policy is that the inflation target may be able to be better maintained. However, this may cause increased volatility in economic activity.

Recent authors have put this trade-off into an analytical framework that characterises inflation targeters as either 'strict' or 'flexible' (see for example Svensson (1997)). A 'strict' inflation targeter will be relatively more willing to accept greater variation in output in order to achieve reduced variation in inflation. A 'flexible' inflation targeter will be relatively more willing to accept greater variation in inflation in order to achieve reduced variation in output. In the event of an inflationary shock, the stricter an inflation targeter is, the faster they will try to return inflation back to the target. In comparison, a flexible inflation targeter will allow for longer periods of time to elapse before the inflation target is restored.[8]

4 Alternative ways of thinking about a neutral real interest rate

A central bank may also use the NRR as one piece of information to consider when addressing questions such as "is the current interest rate setting going to cause inflation to increase or decrease?" However, implicit in this type of

7 Note that 4.5 per cent is an annualised short-term real interest rate. The reader should not confuse the maturity of the interest rate with the lengths of time over which we discuss various concepts of neutral real rates. In this article all interest rate maturities are short-term. We consider neutral interest rates of short-*term* maturities in short, medium, and long-*run* contexts. In section 4 we discuss short, medium and long-run concepts of neutral real rates in more detail.

8 Note that points 1 and 2 above are not independent. For example, if inflationary shocks have the effect of destabilising inflation expectations, then a relatively more aggressive monetary policy response may be justified in order to prevent persistent inflation expectations from building. Conversely, if people believe that the central bank is relatively 'strict', then they may set their inflation expectations to be more in line with the inflation target, thus reducing the persistence of inflationary shocks.

question is an unspecified time horizon. For example, is the central bank asking whether interest rates will cause inflation to increase or decrease *soon*, or are we asking whether inflation will increase or decrease *ever*? If interest rates are contractionary to demand, *when* will they cause demand to contract? The time horizon that one has in mind when talking about neutral is relevant. Related to the question of the relevant time horizon, the central bank is also concerned with how many (and which) variables it thinks of as being in equilibrium when discussing the 'neutral real interest rate'.

As a working assumption, it may take one to two years for interest rates to have their full effect on inflation. The time it takes to return inflation and inflation expectations back to the mid-point of the target band, the output gap back to zero, and the exchange rate back to equilibrium, assuming an absence of new disturbances, may be longer. It is this longer horizon, which we loosely characterise as the 'medium run', which is relevant for the NRR.[9]

Because the Bank's definition of the NRR falls short of requiring *all* economic variables to be in equilibrium, it is not a 'long-run' definition. Furthermore, we argue that there is a difference between thinking about what real interest rate is neutral over the medium run, and what real interest rate is neutral at the current point in time, or in the short run. We choose a medium run concept for our NRR definition because it is less abstract than the long run concept, yet more stable than the short run concept.

The "short run neutral real interest rate" and the "long run equilibrium real interest rate" are discussed in the next sections.

[9] The horizon relevant for the NRR should not be confused with the period by which the policy-maker would wish to return inflation to the target rate. There is no clear link between the length of the horizon that is relevant for the NRR, and the preferences of the inflation targeter over volatility outcomes, as described above. Although, in the event of an inflation shock, a strict inflation targeter will achieve the inflation target sooner, they may create instability in the real side of the economy, which may cause the real interest rate to deviate from neutral for a long time. The more flexible the inflation targeter is, the less likely it is that the real interest rate will deviate much from the NRR, but the more likely it is that inflation may deviate from the target rate.

4.1 A shorter run concept of neutral real interest rates

At any given point in time, an economy will almost certainly be in a state of disequilibrium. For example, it is unlikely that an economy will simultaneously have a sustained zero output gap, and the exchange rate at neutral. An economy may be in a position where the interest rate is above the NRR, the exchange rate is below its neutral level, and the output gap is positive. In these circumstances, holding the real interest rate above the NRR will cause inflation to fall eventually. However, it is unclear whether the combined effect of these influences will be to push inflation up or down over the time period with which the policy-maker is concerned.

This suggests that another way of thinking about the NRR is to ask whether the real interest rate, in combination with other variables in the economy, will actually cause demand and inflation to expand or contract in the short run, where we define the short run as the time that it takes for interest rates to affect inflation. The NRR in this context would be the real interest rate that is consistent with inflation neither increasing nor decreasing over the short run. A short run definition of the neutral real interest rate takes us closer to the actual policy setting in that it takes account of current and expected economic conditions.

4.2 The long run equilibrium real interest rate

Over longer periods of time the structure and features of economies change dramatically. Social, political and technological influences can lead to large upheavals. Yet, over a long enough span of time we expect economies to settle down to more or less stable ways of operating.

We think of this abstract horizon as the 'long run, steady-state equilibrium'. This is a period of sufficient length to enable all markets to clear and to allow all variables in the economy to settle at constant growth rates, in the absence of new economic disturbances. Note that this includes equilibrium in stocks as well as in flows - for example, the long run equilibrium ratio of total foreign assets/liabilities to output. For expositional reasons, we consider the long run equilibrium state of the economy to be without risk and without impediments to capital flows.

A distinguishing feature of these three concepts is their associated degree of volatility. We would expect the short run concept of a neutral real interest rates to be the most volatile of the three concepts, as it is affected by shocks that hit the economy. For example, in response to a sudden appreciation of the exchange rate, the short run concept of the neutral real rate would tend to fall. In contrast, the medium and long run concepts would be unaffected. The long run equilibrium real interest rate is the most stable, as it is a feature of the economy in the abstract notion of the long run - when all markets are in equilibrium and there is therefore no pressure for any resources to be redistributed or the growth rates for any variables to change.

Between these short and long-run extremes lies the medium run concept that we apply to the NRR. The NRR shifts over time not in response to temporary disturbances to the economy, but rather, in response to changes in the structure of the economy. Examples of these changes include demographic features, technological change, industrial organisation, international relationships (eg trade agreements), long-term government policies for health, education, social welfare etc.

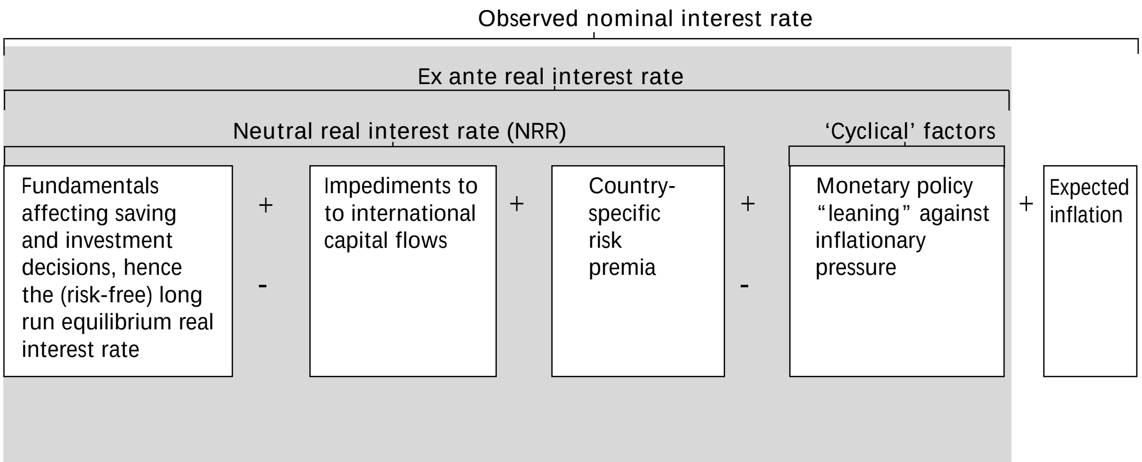
As the economy moves towards long run equilibrium, the NRR will be converging to some long run equilibrium real interest rate. Therefore, the determinants of the long run equilibrium real interest rate may help us to understand movements in the NRR over long periods, and may help explain differences in the NRR between countries. Towards this end, in the next section we discuss the theoretical determinants of long run equilibrium real interest rates, in the broader context of factors that influence the NRR and interest rates more generally.

5 Decomposing observed nominal interest rates

Figure 1 decomposes the observed nominal interest rate into different component parts. First, we identify factors that would influence the risk-free long run equilibrium real interest rate. We can then arrive at the NRR by incorporating risk premia and impediments to capital flows, to the extent that these exist. For reasons we will outline later, for any given country, impediments to the free flow of capital could have a positive or negative effect on the level of the NRR. However, a country risk premium will always add to our estimate of the NRR relative to our starting point of a riskless world. Hence both "+" and "-" signs precede the box for impediments to capital flows, but only a "+" sign precedes the box for country-specific risk premia.

When we bring cyclical influences into the analysis, we add another component to figure 1 - the degree to which monetary policy is leaning against inflationary pressure. These components are discussed in more detail below.

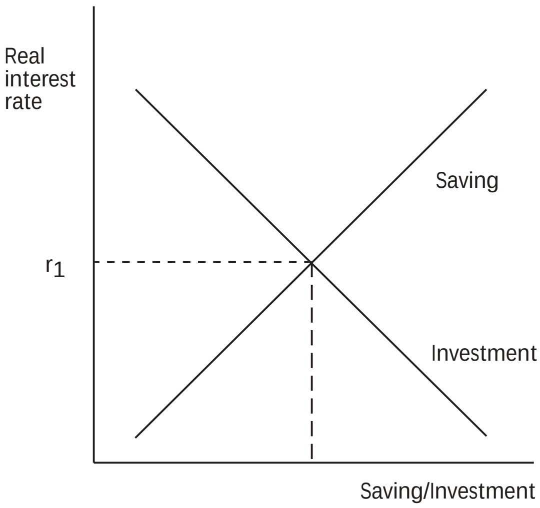
Figure 1
Decomposition of short-term nominal interest rates



5.1 Fundamentals affecting savings and investment decisions

Just as for price of a good can be thought of as the mechanism which equates the demand and supply of that good, the interest rate can be thought of as the mechanism which equates the demand for, and supply of, loanable funds. In the stylised representation given in figure 2 below, we refer to the supply of loanable funds as 'savings' and we loosely refer to the demand for loanable funds as 'investment'. Other things being equal, we would expect savings to increase with the interest rate, as people are prepared to save more in order to reap the benefits of higher returns. Correspondingly, we would expect investment to fall, as the cost of borrowing increases, since fewer investment projects would be financially viable. We expect the market real interest rate to be approximately the one that prevails at the intersection of the savings and investment curves, r_1, in figure 2.[10]

Figure 2
Stylised relationship between saving, investment and the real interest rate



[10] Empirical evidence on the impact of interest rates on savings is in fact inconclusive. We have omitted the 'income effect' from this discussion, but it is possible that an increase in interest rates would lead to more current consumption and less savings, as people realise that to arrive at a given level of wealth in the future they do not need to save as much as they would have had to with lower interest rates. If the income effect did in fact dominate for some levels of the interest rate then it would be more realistic to assume a non-linear relationship between interest rates and savings rather than the simple linear relationship depicted in figure 2. For a recent discussion of determinants of saving rates in New Zealand see Choy (2000).

For the time being, we assume that funds can flow freely between countries. This means that the saving and investment curves in figure 2 refer to total world saving and total world investment. In a riskless world with no impediments to capital flows, the shape and position of these world savings and investment curves would determine a single "world" real interest rate for all countries.

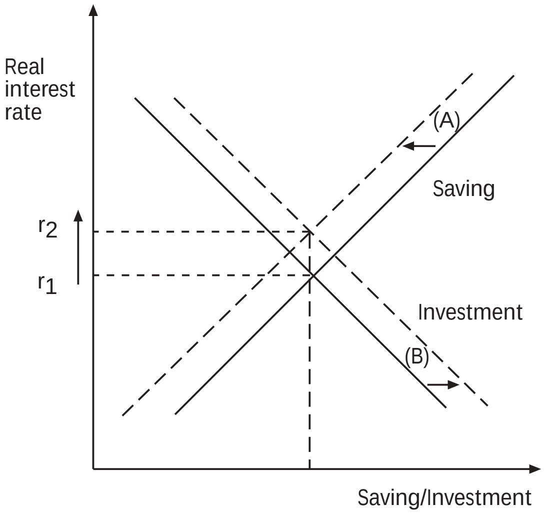
The position of the saving curve in figure 2 will depend on preferences that affect consumers' willingness to delay consumption. The standard assumption in economics is that people would rather consume today than consume the same quantity at a later date. The less willing people are to delay consumption, the higher the interest rate they will require in order to induce them to save, and the further to the left the saving curve will lie.

The position of the investment curve in figure 2 will depend on factors related to the productivity of capital, or in other words, how profitable investment in capital is. The productivity of capital will be affected by how, and in what combination, capital is used with other inputs in the production process. For example, the more labour that is available to be used with a particular level of capital stock, the more output can be produced with that capital. Similarly, advances in technology can make a given amount of capital more productive.

If capital becomes more productive we would expect the investment curve to shift to the right (and vice versa for a decrease in the productivity of capital). Thus, for example, if the position of the saving curve is unchanged, then an increase in the productivity of capital would lead to a rightward shift of the investment curve, and an increase in the real equilibrium interest rate.

In figure 3, we reproduce figure 2, identifying some of the factors that could cause the saving and investment curves to move in such a way that would be consistent with a rise in the equilibrium real interest rate from r_1 to r_2.

Figure 3
Effects of shifts in the saving and investment curves



(A) A preference change leading to a decreased appetite for saving would shift the saving curve to the left.

(B) An increase in the return to capital - eg an increase in the rate of technological progress, would shift the investment curve to the right.

5.2 Impediments to international capital flows

Previously, we assumed that capital is free to flow between countries to wherever it earns the highest (risk-adjusted) rate of return. This led to the result that, in a world without risk and without other frictions, the real interest rate would be the same in all countries. The situation changes when we relax this assumption and allow for the reality that capital will not always flow freely across countries.

At one extreme, consider a world where each economy is completely closed to capital from other countries. In this world it is not possible for a saver in one country to lend to a borrower in another country, even if such a transaction would be mutually beneficial. The interest rate in any given country would be determined by the factors that influence saving and investment in that country alone.

When capital can flow between countries it becomes possible to match the preferences of savers and borrowers in different countries. For example, funds would flow out of low interest rate countries as savers from those countries take advantage of higher interest rates elsewhere. For these countries, the supply of loanable funds decreases, causing their interest rates to rise. As funds flow into high interest rate countries, the supply of loanable funds increases and interest rates fall. Opening up capital markets would theoretically have the effect of drawing risk-adjusted interest rates across countries closer together.

In reality, in most cases there are impediments to the flow of capital across national borders so that capital does not flow across countries to the point where risk-adjusted real interest rates are equalised.[11] In some cases regulatory impediments such as capital controls or taxes will interfere with cross-border capital flows. Even where such impediments do not exist, some degree of friction will generally arise due to investor 'home bias'.

Home bias suggests that investors will accept lower returns for investing in their home country than they could obtain from investing in an equally risky asset offshore. One explanation for home bias is that investors are relatively better equipped to make decisions on where investment funds should be allocated within their home country, and by comparison are less familiar with the risk dimensions and legal frameworks of a foreign jurisdiction.

In this article we do not attempt to isolate the role of impediments to international capital flows in determining interest rates. We merely acknowledge that these impediments may be one source of cross-country differences in neutral real interest rates.

5.3 Country-specific risk factors

Until now, we have assumed that investment in all countries is equally risky. However, from an investor's perspective, some economies are inherently more risky than others. Just as savers are interested in inflation-adjusted rather than nominal returns, investors make their allocation decisions on the basis of *risk-adjusted* returns. Countries that are considered to be more risky than others must offer an additional return, known

[11] For example, see Feldstein and Horioka (1980).

as a 'risk premium', in order to attract investment funds.[12] In practice, the risk premium may vary considerably from country to country, depending on a wide range of considerations, including:

- factors that lead to an increased chance that borrowers will default on their obligations, for example large and persistent private sector or government external debt positions, poor quality balance sheets, and inadequate risk management systems in the banking and corporate sectors;
- poor quality economic policy and inadequate transparency;
- concerns that the currency may move unexpectedly in an unfavourable direction, thus eroding the returns to the investor when converted into their home currency (see Hawkesby, Smith and Tether (2000) for a discussion of the sources of currency risk premia); and
- small or illiquid markets making it more difficult or costly to pull out of an investment.

The fact that different economies have different risk profiles, and hence different risk premia, means that, even if there were no impediments to international capital flows, we would not expect interest rates to be exactly the same across all countries.

As illustrated in figure 1, the NRR is arrived at by adding country-specific risk premia and the impact of any impediments to cross-country capital flows to the long run equilibrium real interest rate.

5.4 'Cyclical' factors

As discussed earlier, the central bank adjusts nominal interest rates to lean against inflationary pressure. This means that interest rates tend to be increased in cyclical upswings and decreased in downturns. As figure 1 shows, at a given point in time, the short-term real interest rate is arrived at by adding this monetary policy cyclical factor to the NRR.

5.5 Expected inflation

The final piece of figure 1 is the influence of expected inflation. *Ex ante* real rates are obtained by subtracting expected inflation from nominal interest rates. Adding expected inflation to the real interest rate gets us back to the actual nominal interest rate – ie the interest rate one sees quoted day by day in the financial markets.

We have identified the key drivers of the neutral real interest rate as being the structural factors that affect savings and investment decisions and country-specific risk premia. We generally expect these factors to change slowly through time, implying that the NRR also changes slowly rather than varying significantly over the business cycle.

6 Estimating the NRR

Like some other variables that are relevant for monetary policy purposes, such as the output gap and the neutral real exchange rate, the NRR cannot be observed directly and may vary over time. Not surprisingly, therefore, there is no "right" way to estimate the NRR. The estimation methods that are commonly used, and which are used in this article, have their limitations. Furthermore, different estimation methods and different data yield different estimates - which is to be expected, given the practical difficulties of reliably calculating such things as the risk premium, inflation expectations, and the problems of measuring the output gap. Consequently, we are reluctant to base estimation of the NRR on any single estimation method, and we focus on a range of estimates, rather than trying to tie down a point estimate.

Our first approach to estimating the NRR involves taking observed nominal interest rates, converting these to real interest rates, and stripping out an estimate of the 'cyclical' component by averaging interest rates over the business cycle.

Our second approach to estimating New Zealand's NRR is to take estimates of the NRR for Australia and the United States

[12] In reality investors do not tend to hold a single asset but instead hold portfolios of assets. According to the 'capital asset pricing model', the returns that investors require of a given asset will depend not only on the risk characteristics outlined below but also on how the price of that asset co-moves with the other assets they hold, see Lintner (1965), Sharpe (1964). For example, investors will accept a lower return on an asset whose price is expected to be high when the prices of other assets are low, as such an asset will decrease the expected volatility of their overall portfolio.

Table 1
Estimates of New Zealand's NRR

	NRR estimate	Average NRR estimate
Method 1:		
Estimates based on historical real interest rates over the period 1992 to 2000		
Real interest rate estimated by deflating nominal 90 day interest rate with:		
Consensus forecast inflation	5.3	
Reserve Bank survey of inflation expectations	5.3	
National Bank survey of inflation expectations	4.6	
Headline CPI inflation	5.5	
GDP deflator	5.6	5.1
Non-tradables inflation	4.3	
Estimates based on Taylor rule using		
Headline CPI inflation	5.2	
Method 2:		
Estimates based on the NRR for Australia, United States		
*Resident expert estimate + HST estimate of risk premia**		
Estimate of NRR for Australia + risk premium		
3.5 + (0.0 to 1.5) =	3.5 to 5.0	4.3
Estimate of NRR for the United States + risk premium		
(2.0 to 2.8) + (0.8 to 2.8) =	2.8 to 5.6	4.2
**HST estimates are taken from Hawkesby, Smith and Tether (2000)*		

and add a risk premium to account for New Zealand-specific risk factors.

The table above summarises the results obtained using these two methods. These methods are discussed in detail below. Approaches to estimating concepts of neutral real interest rates that correspond less directly to the NRR, as defined in this article, are discussed in the appendix.

Method 1: Estimates based on historical interest rates

Monetary theory and evidence suggests that monetary policy can only affect the real economy in the short or perhaps medium run. In the long run, monetary policy is neutral. This means that in the long run monetary policy can affect nominal variables such as prices, but not real variables such as the actual quantity of goods and services produced by a country or the long run equilibrium real interest rate.

Suppose we can assume that over long periods of time monetary policy leans against disinflationary pressure roughly as often as it leans against inflationary pressure. Then it follows that if we compute the average level of the real interest rate over a long period of time, the cyclical component of interest rates should average out to zero. The average would therefore give us an estimate of the NRR. Estimates of the NRR constructed using this approach are presented in the top section of table 1.

We also derive estimates of the NRR by a using a version of the "Taylor rule" with the standard weight settings suggested by Taylor (1993). This rule was put forth as a simple description of how the United States Federal Reserve sets interest rates in response to deviations of inflation from the inflation target, and the level of spare capacity in the economy, as proxied by estimates of the output gap. We specify the Taylor rule as:

$$i = NRR + inflation + 0.5(inflation - inflation\ target) + 0.5(output\ gap) + residual$$

where *i* is the historical nominal short-term interest rate, and all the variables in the equation are contemporaneously related. The *residual* term picks up the difference between the nominal interest rate implied by the Taylor rule, and the behaviour of the nominal interest rate over history.

If we plug in values for the nominal interest rate, inflation, the inflation target, and an estimate of the output gap, then we can solve for the term that is required to make this equation hold at each point in time. This term is equal to the NRR plus the residual, and we take the average of this term as an estimate of the NRR. This method assumes that the Taylor rule, as specified above, gives an unbiased estimate of the policy response of the central bank at each point in time, so that the average of the residual terms is zero.

Two main issues arise when using historical interest rates to estimate the NRR:

i What time period should be used?

Ideally, we would average the real interest rate over a number of complete business cycles in order to estimate the NRR. However, structural change in the New Zealand economy means that data from the period prior to the economic and financial reforms undertaken in the mid-1980s is often an unreliable source from which to make inferences about the economy today. In particular, in the years prior to 1992, the Reserve Bank held interest rates high in order to bring inflation down within the then 0 to 2 per cent target band. This period of unusually high interest rates is not matched by a period of unusually low interest rates, and would therefore cause an upward bias in our estimate of the NRR. For this reason, we select 1992 as the start of our sample period.

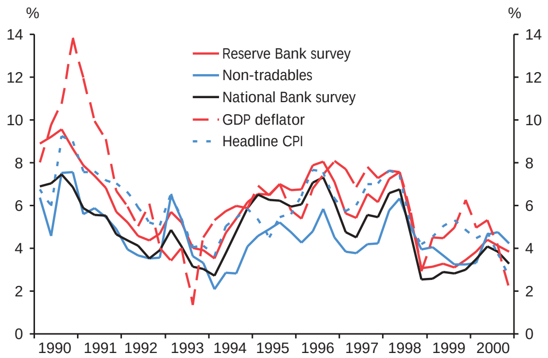
ii What measure of inflation/inflation expectations should be used?

Conceptually, real interest rates should be calculated using expected inflation over the life of the asset concerned. In this article, we convert historical nominal interest rates into *ex ante* real interest rates using three alternative measures of CPI inflation expectations. These are average one year-ahead CPI inflation forecasts published by *Consensus*,[13] and one year-ahead CPI inflation expectations as measured by the *National Bank Business Outlook* and the *Reserve Bank Survey of Expectations* surveys.

However, there are a variety of survey measures, which lead to different estimates of real interest rates, and it is debatable which measure of inflation or inflation expectations is the most appropriate. Because measures of expectations are not readily available for alternative measures of inflation, we also calculate *ex post* real interest rates using actual data for the GDP deflator, inflation in non-tradable goods prices, and inflation in the headline CPI. In table 1 we present results calculated using both *ex ante* and *ex post* measures of real interest rates.

Figure 4 illustrates the sensitivity of our estimates of the real interest rate to the measure of inflation that is used to convert nominal interest rates into real interest rates. Figure 4 also shows that real interest rates appeared unusually high in the period from 1990 to 1992, as we would expect given that this was a period of disinflation.

Figure 4
Estimates of New Zealand's real 90 day interest rate calculated using selected inflation measures



It is possible that the estimates of the NRR produced using the methods described above overstate the current NRR. Our sample period only includes one complete business cycle, and it is possible that this business cycle was characterised by more inflationary shocks than disinflationary ones. This would mean that, on average, policy had to be tighter than the 'true' NRR over this period. For example, Brook, Collins and Smith (1998) argue that the period from 1991 to 1997 was characterised by two inflationary shocks of unusually

13 Every month, *Consensus Economics Inc* conducts a survey of economic forecasters in New Zealand, asking them for their forecasts of, among other things, inflation. They then compute the average forecast of all respondents. We use the *Consensus* average one-year-ahead inflation forecast to construct an estimate of the real interest rate.

large magnitude. These were the rapid rise in immigration from 1992 to 1996 and the sharp increase in household debt levels that resulted from financial sector deregulation. Of course, the disinflationary impact of the Asian crisis of the late 1990s may counter-balance the impact of these inflationary shocks to some extent.

Alternatively, we may think of the deregulation and subsequent increase in debt holdings as an example of structural change that influenced the level of the NRR over the 1990s. Given the new structure of the economy, new choices that better reflected household preferences over saving and consumption became available, and these conditions may have had an upward influence on the NRR over that period.

Another reason to argue that the NRR estimated from the 1992-2000 sample period may overstate the current NRR is that during the early 1990s the Reserve Bank's formal inflation targeting approach was still quite new. During this time inflation expectations may have been less well-anchored and hence more easily destabilised if inflation were to move out of the target range, particularly if it were to go through the top of the range. Thus, for a given level of inflationary pressure, the Reserve Bank probably had to set interest rates further above neutral than would be required now that inflation expectations are better anchored.

Method 2: Estimates based on the NRR for other countries

The second method takes estimates of the NRRs for Australia and the United States and adjusts these for New Zealand-specific risk factors.[14] As we have noted earlier, cross-country differences in NRRs could be due to country-specific risk premia, or differences in fundamentals that influence savings and investment, which are not eliminated by international capital flows.

The estimates of the risk premium that we use in this article are taken from Hawkesby, Smith, and Tether (2000).[15] A key feature of their work was identifying the considerable uncertainty that surrounds estimates of the currency risk premium. Naturally, this uncertainty also affects our estimates of the NRR. Hawkesby et al assume that there is no default or liquidity premium between short-term interest rates in New Zealand and those in Australia and the United States. The currency risk premium was then derived from actual interest rate differentials between New Zealand and Australia and New Zealand and the United States.

We do not explicitly allow for the possibility that the NRR could differ across countries due to differences in fundamentals, such as consumption/saving preferences, that are not eliminated by international capital flows. However, because the estimates of the risk premium from Hawkesby et al are derived from actual interest rate differentials, they are likely to capture both true risk factors and cross-country differences in fundamentals, to the extent that capital market imperfections allow these to persist.

Australia

We take 3.5 per cent as a point estimate of the NRR for the Australian economy.[16] When we add Hawkesby et al's estimates of the risk premium of New Zealand's short-term assets over equivalent Australian assets, we obtain estimates of the New Zealand NRR that range from 3.5 per cent to 5 per cent (see table 1).

United States

Estimates of the NRR cited by economic commentators in the United States generally range between 2.0 and 2.75 per cent.[17] Adding Hawkesby et al's estimates of the risk premium on interest rates for New Zealand short-term assets relative to equivalent US assets implies that New Zealand's NRR ranges from 2.8 to 5.6 per cent. The range of estimates of the New Zealand NRR based on the NRR for the United States is very wide, encompassing both the highest and the lowest of all of our estimates. However, the mid-point of this range is

14 The NRR estimates for these other countries are subject to the same uncertainties surrounding estimates for the New Zealand NRR that are derived directly from New Zealand data.

15 Here we eliminate the estimates of the risk premium that Hawkesby et al identified as unreliable.

16 For example, 3.5 per cent is the NRR embedded in the Reserve Bank of Australia's macroeconomic model, see Beechey et al. (2000).

17 See for example, *The Economist* (March 2001), *Financial Times* (April 2001), Judd and Rudebusch (1998).

close to the mid-point of the range of estimates based on Australian data.

7 Summary and conclusions

The estimates of the NRR that we discuss in this article cover a wide range, from around 2.8 per cent to around 5.6 per cent. The concept of the NRR used in this article, or any definition of a neutral real interest rate for that matter, is just one of the many unknowns with which monetary policy-makers must contend. Research is continually being undertaken to improve our understanding of how such unobservable variables might best be estimated. Unfortunately, there are no conclusive answers.

One way that monetary policy-makers could learn that the estimate of the NRR implicit in their policy decisions is incorrect would be by observing the feedback from monetary policy settings to inflation and activity outcomes. For example, an estimate of the NRR that is *significantly* higher than the actual NRR would lead the policy-maker to consistently set policy tighter than intended and this would tend to lead to inflation outcomes that were consistently lower than the policy-maker's expectations. However, given the number of unknowns that the policy maker has to make judgements on, it will still be difficult for them to correctly identify what is causing persistent inflation 'surprises' in the inflation rate, once such surprises are observed.

The Reserve Bank, like other central banks, must therefore continue to operate on the basis of well-informed, but inherently subjective, judgements about unobservable economic variables such as the NRR. Because of the uncertainty involved, the Reserve Bank must also avoid placing excessive reliance on the NRR, or on any other single indicator, when formulating monetary policy and deciding on the appropriate level for the official cash rate.

References

— "Rates going down." *Economist,* 22 March 2001.

— "Steady as she goes." *Financial Times*, 25 April 2001.

Allsopp C, and A Glyn (1999), "The assessment: real interest rates," *Oxford Review of Economic Policy*, 15, 2.

Beechey M, N Bharucha, A Cagliarini, D Gruen and C Thompson (2000), "A Small Model of the Australian Macroeconomy," *Reserve Bank of Australia Research Discussion Paper,* 2000-05.

Blinder A (1999), "Central banking in theory and practice," The MIT Press.

Brook A, S Collins and C Smith (1998), "The 1991-1997 business cycle in review," *Reserve Bank of New Zealand Bulletin*, 61, 4, pp 269-90.

Cass D (1965), "Optimum growth in an aggregative model of capital accumulation," *Review of Economic Studies*, 32, pp 233-40.

Choy W (2000), "Determinants of New Zealand national and household saving rates: a cointegration approach," *Paper for presentation to the New Zealand Association of Economists Conference Wellington.*

Claus I, P Conway and A Scott (2000), "The output gap: measurement, comparisons and assessment", *Reserve Bank of New Zealand Research Paper,* No 44.

Conway P (2001), "Where are interest rates most likely to be?" *Westpac Institutional Bank, New Zealand and Australia Markets Report*, 8-9.

Feldstein M, and C Horioka (1980), "Domestic saving and international capital flows," *The Economic Journal*, 90, 358, pp 314-29.

Hall R (2000), "Monetary policy with changing financial and labour-market fundamentals" *Paper prepared from conference on Asset Prices and Monetary Policy, Sveriges Riksbank.*

Hawkesby C, C Smith and C Tether (2000), "New Zealand's currency risk premium," *Reserve Bank of New Zealand Bulletin*, 63, 3, pp 30-44.

Judd J, and G Rudebusch (1998), "Taylor's Rule and the Fed: 1970-1997," *Federal Reserve Bank of San Francisco Economic Review*, 3, 3-16.

Koopmans T (1965), "On the concept of optimal economic growth," in *The Econometric Approach to Development and Planning,* Amsterdam, North Holland.

Lintner J (1965), "The valuation of risky assets and the selection of risky investments in stock portfolios and capital budgets," *Review of Economics and Statistics* 47 February, 1-31.

Nelson E, and K Neiss (2001), "The real interest rate gap as an inflation indicator," *Bank of England Working Paper.*

Ramsey F (1928), "A mathematical theory of saving", *The Economic Journal*, 38, 152, pp 543-59.

Sharpe W (1964), "Capital Asset Prices: A theory of market equilibrium under conditions of risk," *Journal of Finance,* 19 *September*, pp 425-42.

Solow R (1956), "A contribution to the theory of economic growth," *Quarterly Journal of Economics*, 70, 1, pp 65-94.

Svensson L (1997), "Inflation targeting in an open economy: Strict or flexible inflation targeting?" Public Lecture held at Victoria University of Wellington, New Zealand, November, *Victoria Economic Commentaries* 15-1 (March 1998).

Swan T (1956), "Economic growth and capital accumulation," *Economic Record*, 32, pp 334-361.

Taylor J (1993), "Discretion versus policy rules in practice," *Carnegie-Rochester Series on Public Policy* 39, pp 195-214.

Wicksell K (1907), "The influence of the rate of interest on prices," *The Economic Journal,* 17, Issue 66 June, pp 213-20.

Appendix

There are alternative estimation approaches suggested in the literature, which are not adopted in this article because they do not completely accord with our medium run NRR definition. For example, one approach to estimate what we characterise as a long-run concept of neutral is to use an estimate of the steady state growth rate for an economy. This method was used by Taylor (1993) in estimating the "equilibrium" real rate used in his policy rule (discussed in section 5 above). Conway (2001) recently used this method to produce an estimate of 3.3 per cent for New Zealand. Theoretically this approach can be motivated from growth theory models, such as Solow (1956) and Swan (1956), or the model of Ramsey (1928), Cass (1965) and Koopmans (1965). However, note that some care should be taken here, as although these models imply a link between the steady state growth rate of output and the real interest rate, they do not imply that one can take the steady state growth rate of output as a direct estimate of the long run equilibrium real interest rate.

Nelson and Neiss (2001) also take an approach that fits better with a long run concept of neutral. Their paper takes the "natural" rate as the real interest rate that would prevail in an environment of completely flexible prices. They create a historical series for their natural real interest rate by modelling it as being determined by demand and technology shocks.

Other approaches include Hall (2000) who uses the Taylor rule intercept to consider how the real interest rate may have changed over time. A possible approach using a time-series statistics technique would be to treat the NRR as an unobservable variable in a state-space modelling framework, and then to use the Kalman filter to estimate the behaviour of the NRR over time.