Methodology for risk-free discount rates and CPI assumptions for accounting valuation purposes

Consultation document for methodology and assumptions for June 2013.

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1 Executive summary

Background and purpose

From June 2010 The Treasury has been providing ACC and other Crown Entities with risk free rate and CPI assumptions for accounting valuation purposes. These assumptions are an important input into the valuation of ACC's Outstanding Claims Liability (OCL).

The Treasury contracted PricewaterhouseCoopers (PwC) to assist with the establishment of the methodology and initial determination of the long-term assumptions. PwC was also involved with the two subsequent reviews of the long-term assumptions, which took place in 2012 and 2013. The three PwC Reports are available on The Treasury's web site[1].

ACC and other affected parties were consulted in each case. This paper documents advice provided by ACC for the 2013 review.

The following discussion is drawn from the advice provided by ACC in May and June 2013. Therefore references to the "existing" or "current" approach relate to the long-term risk free discount rate and valuation assumptions before the changes arising from the 2013 review were implemented. Similarly the interest rate levels etc. have not been updated.

Outline

This executive summary:

- Illustrates the long horizon for ACC's payments.
- Identifies key issues for the review.
- Summarises recommended changes to the methodology and assumptions.
- Illustrates the recommended approach.
- Compares the projected real forward rates for New Zealand with the 'market' real forward rates for the United States and the United Kingdom.

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[1] The original report dated July 2010:
http://www.treasury.govt.nz/publications/guidance/reporting/accounting/discountrates/methodology

The first review dated May 2012:
http://www.treasury.govt.nz/publications/guidance/reporting/accounting/discountrates/methodology-rlea/14.htm

The second review, dated June 2013:
http://www.treasury.govt.nz/publications/guidance/reporting/accounting/discountrates/methodology-rlea-2013

This executive summary focuses on real discount rates, as these are the primary driver of the present value of inflation sensitive cashflows.

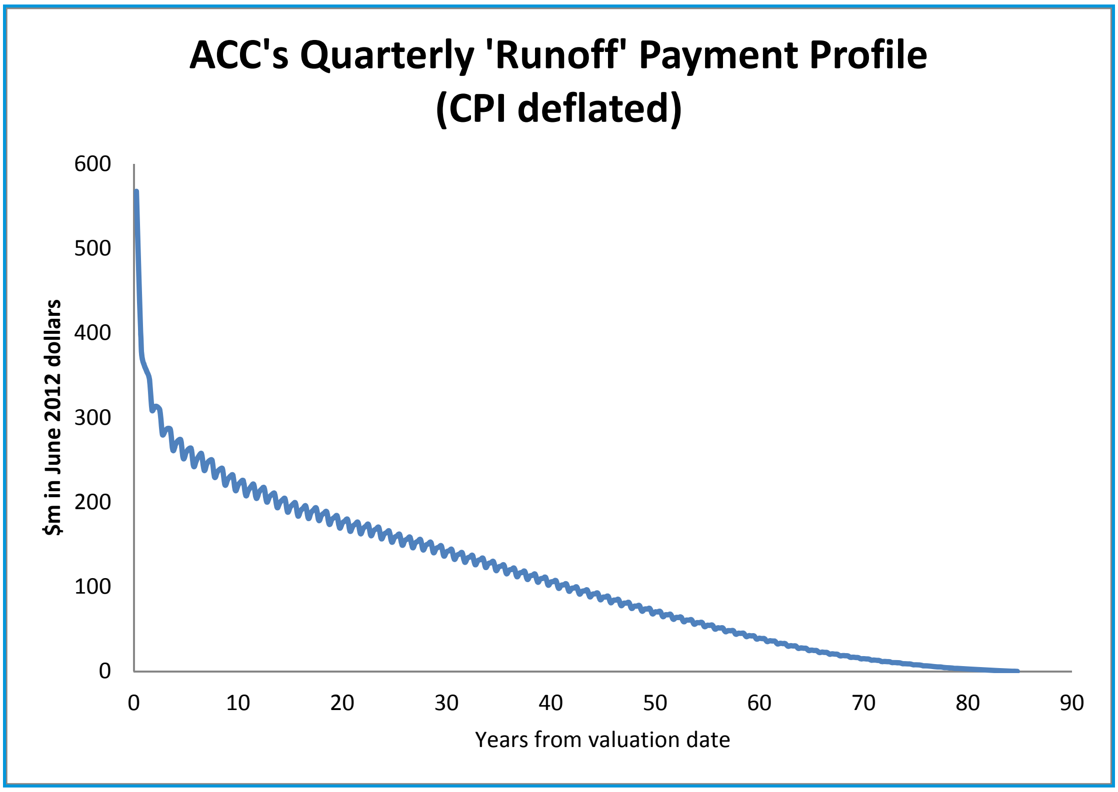
Section 2 provides more detail on issues relating to real discount rates and provides the rationale for recommended changes. Section 3 focuses on the inflation assumptions. Section 4 makes a few comments on nominal rates.

ACC's long dated payment profile

ACC's outstanding claims liability relates to payment obligations for injuries that have occurred up to the valuation date. These payments are projected to extend out at least 80 years - well beyond the maturity of the longest bond issued by the New Zealand government. The longest such bond matures in a little over 12 years.

The graph below shows the payment profile associated with ACC's June 2012 outstanding claims liability. These payments are shown in real terms (discounted by expected CPI inflation) before discounting to a present value basis. *On this basis around 65% of ACC's projected payments in respect of past claims extend beyond the maturity of the longest government bond.*

Figure 1



Key issues for review

The key issues considered in this paper are as follows:

- How the methodology should take into account the re-issuance of long-dated inflation indexed bonds by the New Zealand government (which started after the May 2012 review).
- How the assumptions should be extrapolated beyond the maturity of the longest New Zealand government bonds. In particular:
  - How many years in the future it should be assumed that the long-term real forward rate is reached.
  - What the numerical value of the long-term real rate assumption should be, and how this should be amended over time. In particular, the need for the long-term real rate assumptions to be amended each year using an approach that *systematically* links changes in the long-term assumptions to various market factors. This is in contrast with the existing approach, which tends to leave the long-term economic assumptions unchanged until eventually a large move is required. We believe this to be inherently unstable.
  - What path should be used to interpolate between the end of the market based assumptions[2] and the long-term assumptions.

Current Approach

These issues can be considered in relation to the following graph. It shows the real[3] forward rates implied by the (28 February 2013) nominal forward rate and inflation assumptions published on The Treasury's website[4] calculated according to the existing approach (as spelled out in the first two papers referenced in footnote 1). The forward rates represent the assumed (annualised) rate for investing from one month to the next. The time horizon corresponds to the horizon for the projected payments shown in Figure 1.

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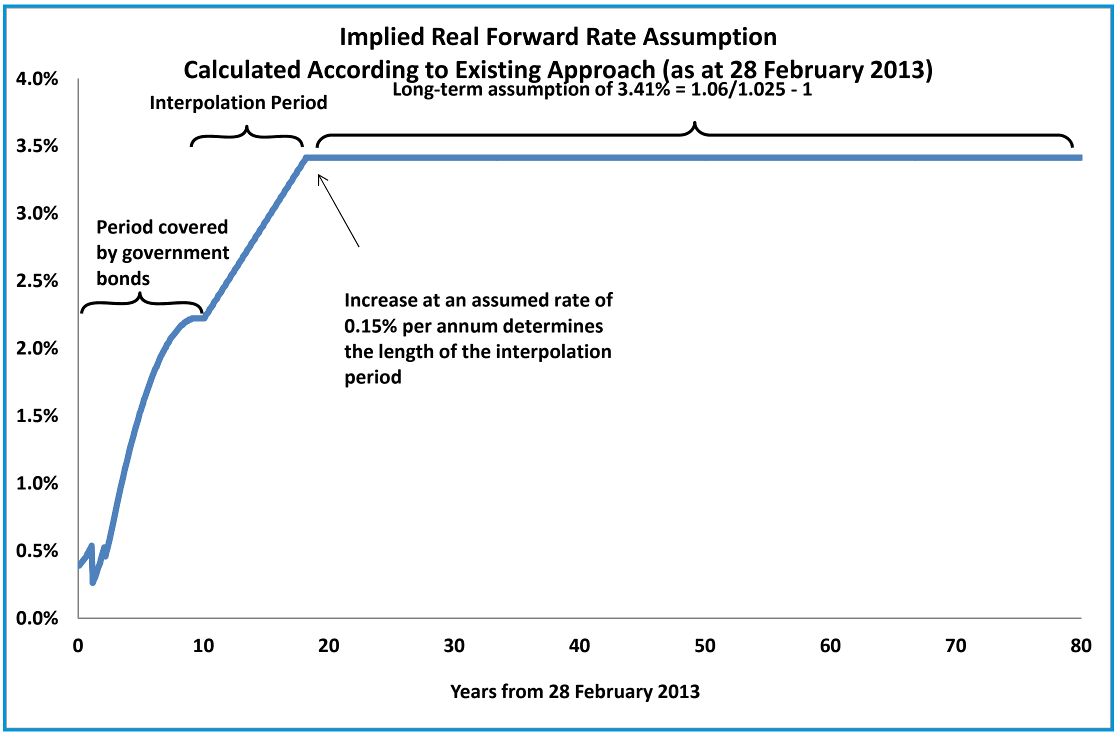
[2] Throughout this paper "market based assumptions" refers to assumptions based on observable market rates. Similarly "market rates" refers to observable market rates.

[3] In order to facilitate the internal consistency of the assumptions, throughout this document real rates are defined according to the relation (1 + real rate) = (1 + nominal rate) / (1 + inflation rate), rather than by subtraction. In the Treasury reviews the real rate is defined by subtraction. Expressed on a subtraction basis the long term real rate assumption is 3.50%. This paper also quotes all yields on an annualised basis. This is slightly different to market convention, whereby index-linked bonds are quoted on the basis of quarterly compounding yields, and nominal bonds are expressed on a semi-annual compounding basis.

[4] http://www.treasury.govt.nz/publications/guidance/reporting/accounting/discountrates

Figure 2



The assumed forward rates span three periods:

- The initial period, corresponding to the maturity of New Zealand government bonds.
- An interpolation period.
- The final period, over which the long-term assumption applies.

Summary of recommended changes

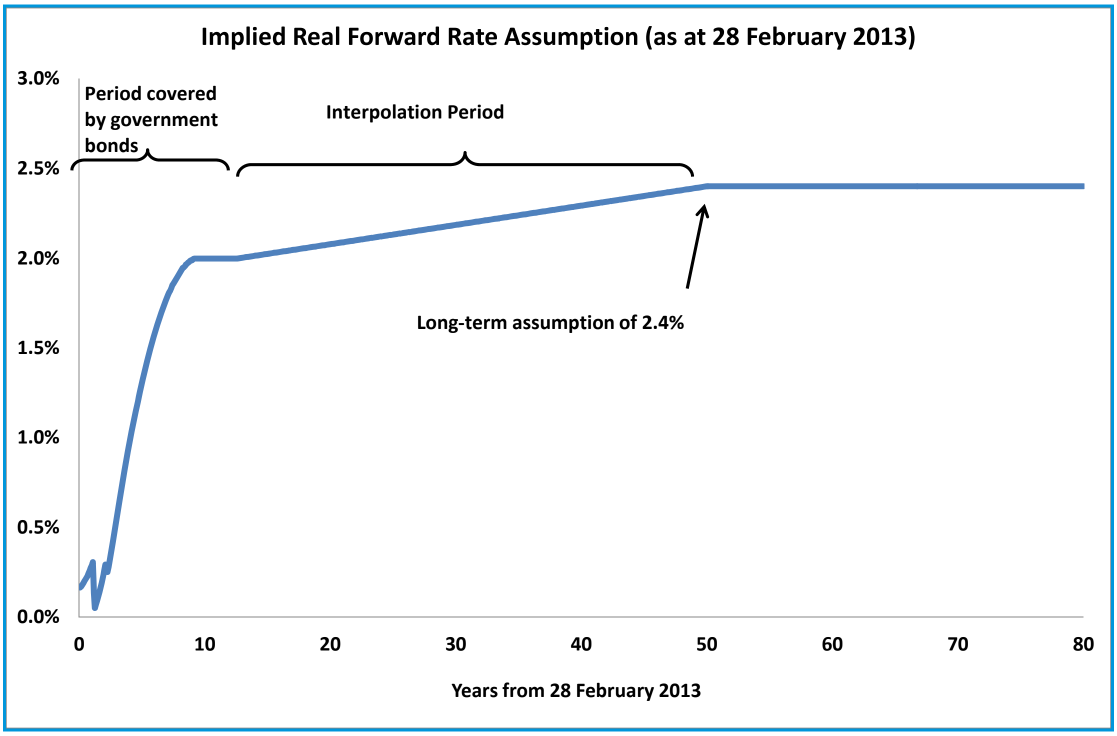
In summary, the changes recommended in this paper are as follows:

- Modify the methodology to ensure that the real forward rate assumptions are consistent with the market pricing for long-dated inflation indexed bonds issued by the New Zealand government.
- Modify the methodology so that the long-term assumptions are assumed to be reached 50 years from the valuation date.
- Use a much lower numerical value for the long-term real rate assumption, currently an assumed value of 2.4% (although this would be updated each year).
- Specify guidelines as to how, over time, this long-term real rate assumption should be updated by using a specified linkage to relevant market variables.
- Interpolate on a straight line basis between the market based assumptions and the long-term assumptions.

Illustration of the recommended changes

The graph below illustrates the recommended approach (applied to 28 February 2012 for comparison with published Treasury assumptions).

Figure 3



In Figure 3 the assumed real forward rates over the initial period are around 20 basis points (0.2%) lower than for Figure 2. This change has been made so that the assumed real forward rates in Figure 3 are consistent with the market price (on 28 February) of the Government's 2025 inflation indexed bond[5].

Examples for the last three June balance dates are shown in Appendix 1. These examples highlight that our recommended approach does not keep the long-term real rate assumption fixed, and instead adjusts the long-term real rate assumption systematically in response to changes in relevant market variables. The particular approach we have recommended is spelled out in the next section.

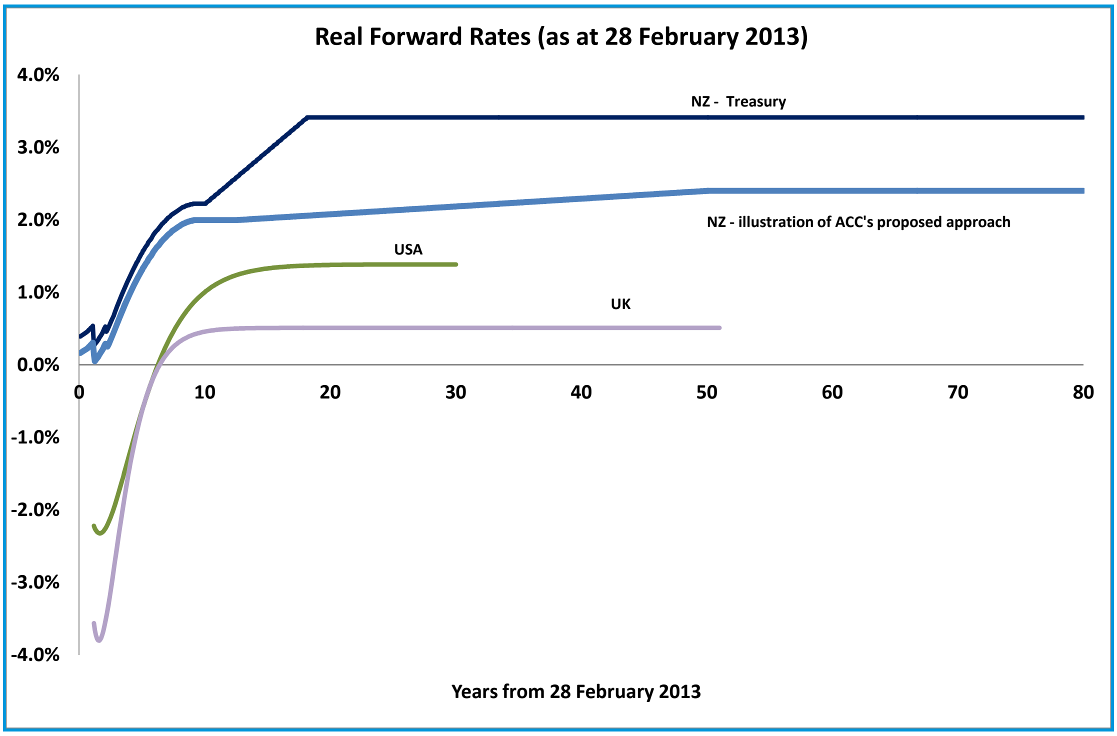
[5] Note that for Figure 3 the initial period covers the period out to the maturity of the longest inflation indexed bond maturing in 2025, whereas for Figure 2 the initial period covers the period out to the maturity of the longest nominal bond maturing in 2023.

Comparison with market rates for countries with longer inflation indexed bonds

In the United States the period covered by inflation indexed bonds is around 30 years, and in the United Kingdom around 50. The actual 'market' forward rates over this period are an important input when evaluating whether the projected New Zealand forward rates over this period appear reasonable.

The graph below compares the New Zealand real forward rates from Figure 1 and Figure 2 above with the actual 'market' real forward rates for the United States and the United Kingdom[6].

Figure 4



For the NZ forward rates implied by the Treasury forecasts, at ten years the gap with the US 'market' forward rates is around 1.2 percentage points, and with the UK around 1.8 percentage points. Thirty years out the gaps widens further by 0.8 percentage points and 1.1 percentage points, respectively (to 2.0 and 2.9 percentage points).

By contrast, for the forward rates consistent with ACC's recommended approach the gap with the US narrows by around 0.2 percentage points going from 10 to 30 years out, while the gap with the UK widens by only around 0.1 percentage points. This seems more plausible, and reflects an approach that deliberately gives some, but not full, weighting to the US and UK long-term 'market' forward rates.

[6] We have estimated these from market rates using the commonly used method of Nelson-Siegel. Appendix 3 shows the corresponding estimates using a 'bootstrap' approach, and estimates for some earlier time periods.

2 Real risk-free discount rate assumptions

This section:

- Provides the rationale for the recommendations summarised above.
- Spells out the particular approach we recommend for determining and systematically updating the long-term real rate assumption.

Rationale for linking the market pricing to inflation indexed bonds

The first recommendation is to:

- Modify the methodology to ensure that the real forward rate assumptions are consistent with the market pricing for long-dated inflation indexed bonds issued by the New Zealand government.

The Treasury's 2010 review of the methodology for risk-free discount rates and CPI assumptions for accounting valuation purposes placed the New Zealand accounting standards at the top of the hierarchy of literature for consideration. The rationale for making the real forward rates consistent with the market pricing of long-dated, New Zealand government inflation indexed bonds is primarily based on ACC's interpretation of these accounting standards.

The discounting requirements for financial reporting of insurance contracts are specified in NZ IFRS 4 Appendix D:

> "Discount rates
>
> 6.1 The outstanding claims liability shall be discounted for the time value of money using risk-free discount rates that are based on current observable, objective rates that relate to the nature, structure and term of the future obligations.
>
> 6.1.1 The discount rates adopted are not intended to reflect risks inherent in the liability cash flows, which might be allowed for by a reduction in the discount rate in a fair value measurement, nor are they intended to reflect the insurance and other non-financial risks and uncertainties reflected in the outstanding claims liability. The discount rates are not intended to include allowance for the cost of any options or guarantees that are separately measured within the outstanding claims liability.
>
> 6.1.2 Typically, government bond rates may be appropriate discount rates for the purposes of this Appendix, or they may be an appropriate starting point in determining such discount rates."

Paragraph 6.1.2 indicates the use of government bonds, but does not distinguish between nominal and inflation indexed bonds. This is done implicitly in paragraph 6.1, which requires - note the word "shall" - that the risk-free discount rates relate to the nature, structure and term of the future obligations.

Essential to the *nature* of ACC's insurance obligations is that they are sensitive to generalised price inflation (along with relative price movements that are more specifically related to ACC's payment obligations[7]). Hence it is inflation indexed bonds not nominal bonds that are most closely related to the nature of ACC's obligations.

Prior to the issuance of the new 2025 CPI-linked maturity, the sole 2016 CPI-linked maturity had become so short dated that it failed to qualify as relevant to the term of ACC's future obligations. But the new 2025 maturity is now the longest dated government bond on issue. And although these bonds are newly issued, they are not in short supply, providing frequent opportunities for market pricing in volume. The Government announced in the June Budget an intention for inflation indexed bonds to make up at least half of the bond issuance programme for 2013/2014.

The paragraphs from NZ IFRS 4 Appendix B quoted above refer to discounting in a general sense. We believe that The Treasury's May 2012 methodology review document is incorrect in stating that "accounting standards place most emphasis on the nominal risk-free rate"[8]. In our opinion the Accounting standards make no reference to nominal rates nor do they imply that discounting need be done in nominal rates.

Under our interpretation of the Accounting standards, it doesn't matter whether the discounting is done in nominal or real terms, provided that there is internal consistency between the assumptions for real (CPI deflated) forward rates, [9]inflation rates, and nominal forward rates. If the discounting is to be based on real yields for inflation indexed bonds, but discounting is done using nominal discount rates derived from the yield curve for nominal government bonds, then internal consistency requires that the CPI inflation expectations are 'break-even inflation rate forecasts'. These are the market determined inflation rate forecasts that would equate the return on nominal government bonds with the return on inflation indexed government bonds.

The implications for the inflation forecasts are discussed in Section 3.

Actuarial standards also emphasise the use of risk free rates for assets that are matched to the liabilities.

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[7] That is, ACC's various payment obligations can be considered to grow at the rate of CPI inflation plus marginal rates in excess of the rate of CPI inflation. Hence, although ACC's payment obligations do not grow at the rate of CPI inflation, they are sensitive to the general level of price inflation (as measured by CPI inflation) unlike payments that are fixed in nominal dollar terms.

[8] Ibid, paragraph 3.1.2, page 10.

[9] It is common actuarial practice to determine the value of the outstanding claims liability by starting with projected real cashflows, inflating them, then discounting the nominal cashflows using nominal discount rate assumptions. An alternative discounting approach would be to deflate projected nominal cashflows using the CPI inflation assumptions, and then discount these CPI deflated cashflows using real (CPI deflated) discount rate assumptions. If this latter approach were used, the discounting could be done with real discount rate assumptions based on yields for government inflation indexed bonds. Exactly the same valuation results can be obtained using the first approach - provided that there is an internal consistency between the real discount rates assumptions, the CPI inflation assumptions, and the nominal discount rate assumptions.

New Zealand Society of Actuaries (NZSA) PS4 for General Insurance Business states “The risk-free rate of return, which is the rate of return on a portfolio of assets matched to the liabilities, must be the starting point for determining the appropriate discount rates…”(4.14)

Institute of Actuaries of Australia PS300 for general insurance business (PS300) states that discount rates used must be based on “. The redemption yields of a Replicating Portfolio as at the valuation date.” (8.2.2) or “If the projected payment profile of the future Claim Payments cannot be replicated (for example, for Classes of Business with extended runoff periods), then discount rates consistent with the intention of Paragraph 8.2.2 must be used” (8.2.3).

Given that ACC’s liabilities are sensitive to inflation, it is inflation indexed bonds that are the best match to the liabilities, and are the most applicable to the notion of a replicating portfolio.

In conclusion, there are compelling grounds for changing the methodology so as to ensure that the assumed real forward rates are consistent with the pricing of the new long-dated New Zealand inflation indexed bonds.

Philosophical underpinnings

The philosophical underpinnings of the accounting standard requirement have important implications for the determination of the real rate assumptions over the period covered by observable market yields, and also for the longer-term assumptions.

In essence the requirement is that a stream of cash flows should be valued the same way regardless of which side of the balance sheet it is on. If the market would purchase inflation linked bonds at a particular price, then the same pricing is relevant to the valuation of the liability cash flows. This is consistent with the valuation being based on the market pricing of a notional matching portfolio. Whilst we acknowledge that in some cases there may be valid arguments for adjusting market rates, we consider that the onus lies with justifying any move away from observable market rates; they are not merely another source of useful information.

By this logic, long-term assumptions must be an estimate of what would be reflected in the pricing of very long dated ‘matching’ securities, if they existed.

Rationale for the recommendations relating to long-term real forward rates

The recommendations relating to the long-term real forward rates are:

- Modify the methodology so that the long-term assumptions are assumed to be reached 50 years from the valuation date.

- Use a much lower numerical value for the long-term real rate assumption, currently an assumed value of 2.4% (although this would be updated each year).

- Specify guidelines as to how this long term assumption should be determined in the future, by systematically linking the long-term real rate assumption to relevant market variables.

- Interpolate on a straight line basis between the market based assumptions and the long-term assumptions.

The rationale for adopting a lower long-term rate - and assuming that the long-term rate is reached over a much longer horizon - is based on international practice and a macroeconomic perspective.

The Treasury's 2010 and 2012 reviews refer to the approach recommended by the European Insurance and Occupational Pensions Authority (EIOPA), formerly CEIOPS. According to the 2010 Treasury review: "CEIOPS is a level-3 committee of the European Union which is participating in the wider process to develop financial service industry regulations used by the European Union. Consequently the CEIOPS views carry considerable weight and can be regarded as authoritative".

EIOPA's approach is to assume that every country in the world will have a real rate of 2.2% in the distant future (70-120 years)[10]. They refer to the long-term rate assumption as the 'ultimate forward rate" (UFR). Their rational for assuming the same real rate for all countries is that "..a high degree of convergence in forward rates can be expected when extrapolating at these long-term horizons. From a macro economical point of view it seems consistent to expect broadly the same value of the UFR around the world in 100 years.[11]"

Although the May 2012 Treasury Review explicitly refers to EIOPA's 2.2% assumption, curiously it does not make any reference to EIOPA's approach of using the same real rate for every country. Instead the Review says: "As with the US rate, a country risk premium would need to be added to this to give a rate comparable to a New Zealand rate. If we used 1% then this would imply a real return of 3.2%".

This highlights a key feature of the current methodology: it implicitly assumes that New Zealand real rates will permanently contain a substantial country risk premium.

There is no doubt that New Zealand real rates have been higher than real rates in the major developed economies for a couple of decades. But how long this is likely to persist depends on why New Zealand rates have been higher over this period.

One hypothesis is that New Zealand interest rates incorporate a "risk premium". This is said to compensate international investors for the foreign exchange risk associated with New Zealand's large net international investment position (as a percentage of GDP).

But as discussed in a recent paper[12] by Michael Reddell, this interpretation fails to accord with the corollaries that we should have seen if this hypothesis were valid. As noted in that paper:

- Concerns about New Zealand's indebtedness would not have kept up short term interest rates, as these have largely been set by the Reserve Bank

[10] QIS 5 Risk-free interest rates – Extrapolation method, pages 4-5.
11 Ibid, p3.
[12] 'The long-term level "misalignment" of the exchange rate: Some perspectives on causes and consequences", Paper prepared for the Reserve Bank/Treasury exchange rate forum Wellington, 26 March 2013. Michael Reddell works for the Reserve Bank of New Zealand, although the views expressed in this paper are those of the author and should not be attributed to the Reserve Bank or The Treasury.

consistent with its inflation target. Hence concerns ought to have been manifested in higher long-term rates relative to short term rates, but this has not been the case.

- If creditworthiness concerns were not reflected in a higher margin between shorter term and longer term interest rates, then under a floating exchange rates concerns should have manifested in a lower level of the currency. Apart from brief periods this has not happened.

The alternative explanation advanced in Mr Reddell's paper seems compelling. New Zealand has had higher real interest rates than the norm for developed economies over the last couple of decades because there has been excess demand in the economy, which could either have manifested in rising inflation (had the Reserve Bank maintained short term interest rates at the levels prevailing in developed economies) or higher interest rates in New Zealand than in other developed economies. Given New Zealand's inflation targeting regime, the Reserve Bank has chosen the latter.

Viewed from this perspective it is highly implausible that New Zealand will experience excess demand pressures indefinitely. As New Zealand moves towards equilibrium in this regard, New Zealand real interest rates should converge on the levels (then) prevailing in other developed economies. Given that the extent of global convergence is a matter for some debate, in our recommended approach for determining the numerical value of the long-term real rate assumption, spelled out below, we have not placed full weight on global convergence.

Nevertheless, the logic for assuming a significant degree of convergence is the main rationale for using a lower long-term real rate assumption than the current assumption of 3.4%, in conjunction with a longer time horizon before the long-term assumption is reached[13].

The recommendation in this paper, to assume the long-term real rate assumption is reached 50 years from the valuation date, is shorter than the 70-120 years recommended by EIOPA. Using a period less than 70-120 years results in somewhat less sensitivity to changes in short-term market rates,and a period of 50 years seems long enough for the logic of global convergence to apply.

A period of 50 years is in the ballpark of the time to convergence indicated in the conclusion of a recent paper by Mulquiney and Miller: "The rate of reversion is slow.

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[13] The issue of horizon is relevant to both reversion and convergence. Reversion relates to the process by which the assumed New Zealand real forward rates move towards the long term real rate assumption. Convergence is a process in which a risk premium is assumed to be eliminated from New Zealand rates (i.e. a reduction in the long-term target towards which the assumed forward rates are reverting). The approach we have recommended assumes reversion over 50 years, towards a long-term assumption that incorporates some, but not full convergence with global real rates. (The extent of convergence is implicit in our recommended method for determining the numerical value of the long-term real rate assumption.) The price today for a New Zealand 50-year inflation indexed bond, if it existed, would be influenced by the extent to which convergence was reflected across the market-implied real forward rate profile, out to the maturity date of the bond.

We believe term 40 is about the minimum point to reversion based on the bond markets examined, with a central estimate closer to term 60.[14]"

The rationale for using straight line interpolation out to 50 years is for the benefit of simplicity. We note that the paper by Mulquiney and Miller referred to above concludes that "Linear path reversion is plausible, with other approaches possible.[15]"Appendix 2 compares the straight line approach with two other extrapolation approaches in the literature, those recommended by EIOPA and by Barrie and Hibbert in a 2008 paper[16].

Recommended method for determining the numerical value of the long-term real rate assumption

A number of observations may inform our judgement on the most appropriate long term real rate to use when valuing ACC's liabilities. Rather than tying this assumption to a single observation, the most stable approach would be to link the long term real rate to a weighted average of key factors that should be relevant in making this assumption. Although we acknowledge that different specifics to the ones we have suggested are possible, we consider that no relevant factors should be given a zero (or negligible) weight. Also, it is important that we move towards a systematic approach.

We would argue that the following factors are relevant in determining the most appropriate real long term rate for valuing ACC's liabilities and recommend that the following weightings be given to them when determining the long-term real rate assumption:

1. The historical geometric average real return from investing in bonds across all countries[17] since 1900 (weighted by GDP). Based on Dimson, March & Staunton's dataset, this Implies a real yield of 1.8%. We suggest that this observation have a 30% weighting.
2. The historical geometric average real return from investing in bonds across all countries over the past 50 years (weighted by GDP). Based on Dimson, March & Staunton's dataset, this Implies a real yield of 4.3%. We suggest that this observation have a 20% weighting.
3. The historical geometric average real return from investing in NZ government bonds over the past 50 years. Based on Dimson, March & Staunton's dataset, this Implies a real yield of 2.8%. We suggest that this observation have a 20% weighting.
4. The average of the long term (10 year +) real forward rates implied by market pricing of real bonds in the United States and the United Kingdom[18]. As shown in Appendix 3, this currently implies a real yield of 0.8% (simple

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[14] Mulquiney, P and Miller H, 'A topic of interest – how to extrapolate the yield curve', p7. This paper was presented to the Actuaries Institute General Insurance Seminar 12-13 November 2012, Sydney.
[15] Ibid, page 27.
[16] A framework for estimating and extrapolating the term structure of interest rates', September 2008.
[17] All the countries in the Database of Dimson, March & Stanton. The historical returns are published annually in the Credit Suisse Global Investment Returns Yearbook.
[18] The rates for these countries are use here because they have very long dated inflation indexed bonds.

average of US & UK). We suggest that this observation have a 15% weighting.

5. The forward NZ real interest rates from the period for 7+ years into the future (up to the maturity of the longest nominal bond), as calculated using ACC's methodology for determining real discount rates for the period up to the maturity of the longest bond. This currently implies a yield of 1.9%. We suggest that this observation have a 15% weighting.

A weighted average of these various observations currently implies a long term real rate of 2.4%. We note that this compares with the 2.2% long term real rate recommended for all countries by EIOPA.

3 Inflation assumptions

Current approach

The current approach uses a combination of surveyed inflation forecasts and Treasury/RBNZ inflation forecasts for the first four years, and a long-term inflation rate assumption for the fifth year onwards.

Recommended approach for the projection period covered by government bonds

As discussed in section 2, over the projection period covered by government bonds the inflation expectations should by implication be market determined 'break-even inflation rate forecasts' when:

1. Discounting of the liabilities is to be based on yields for inflation indexed government bonds; and

2. The discounting is done using nominal forward rates consistent with the yield curve for nominal government bonds.

If the profile of real forward rates could be obtained by fitting the inflation indexed bond yield curve, it would be a simple matter to 'back out' the corresponding break-even inflation rates. These would be implied by the combination of the real forward rate profile and the nominal forward rate profile over this period,

As a practical matter there are too few New Zealand inflation indexed bonds to properly fit the real forward rate profile over this period, using just the yield curve for inflation indexed bonds. The problem arises because the market pricing of the 2025 inflation indexed bond provides an indication of the 'average' real forward rate over the period to 2025, but not the specific profile consistent with this 'average'. Hence other information needs to be taken into account in order to determine the specific profile.

The approach we recommend is to start with the profile of real forward rates determined under the existing methodology, then adjust the level so that the adjusted profile is consistent with the market pricing of 2025 inflation indexed bond.

This is the approach we used to determine the real forward rates in figures 2 and 3 of the executive summary. When the profile of real forward rates is determined in this manner, the corresponding profile of market implied inflation expectations can be backed out, using the profile of nominal forward rates.

When the government begins issuing new longer dated inflation indexed bond maturities, these will enable better identification of the real forward rate profile near the end of the period covered by the maturity of government bonds. Although this will improve the extent to which the forward rate profile can be 'fitted' to the yield curve for inflation indexed bonds, as with all yield curve fitting, some judgment will need to be applied.

Long-term inflation assumption

Given our conclusion that the risk free discount rate that most closely matches the nature of ACC's liabilities is the real rate (that is, the yield that would prevail on long duration government index linked bonds, if they existed), our long term inflation expectation will ultimately be irrelevant for the valuation of ACC's liabilities. For whatever assumption we make about future inflation, the imposition of a real discount rate will mean that the implied nominal discount rate will adjust for that inflation expectation. Nonetheless, we believe it useful for presentation purposes that future cashflows are projected using a sensible assumption for long term inflation.

In this context it is reasonable to include an allowance for inflation risk in the long-term inflation assumption, as holders of nominal bonds are exposed to the risk that inflation turns out to be higher than expected. The inclusion of an inflation risk premium means that the long-term inflation assumption should be higher than inflation expectations that do not include a risk premium.

Furthermore, we consider that this risk premium should be added to a long-term inflation expectation that represents the *mean* (or probability weighted average) rather than the median of the distribution of possible New Zealand inflation outcomes. For long-horizon inflation expectations we believe that the mean is higher than the median, due to the potential for changes to the inflation regime and an upside skew to the distribution of possible inflation outcomes.

Hence we agree with the conclusion in the 2012 Treasury review that the inflation assumption should be higher than the 2% rate that CPI inflation is meant to average under the current Reserve Bank Policy Target Agreement.

We consider 2% to be akin to a median expectation, and then adjust this upwards to reflect a mean expectation, and then further adjust upwards to include compensation for inflation risk. On this basis the current long-term inflation assumption of 2.5% seems to us to be about right.

We note that this is higher than the 2.0% assumption recommended by EIOPA for most countries (which does not allow for the upside skew to inflation or for the inclusion of an inflation risk premium).

Inflation assumptions over the interpolation period

As for the interpolation for real forward rates, a straight line approach is recommended on the grounds of simplicity.

4 Nominal rate assumptions

There are few comments to make here, given that the changes we have discussed in the previous sections would flow through to the nominal forward rate projections for the period beyond the maturity of government bonds.

Under the current approach the long term nominal rate assumption is determined by combining the long-term real rate assumption with the long-term inflation assumption. We believe this approach should be continued, as it is consistent with the discounting being determined by the real rate assumption.

The implied long-term nominal rate assumption would be 4.96% (that is 1.024 x 1.025 -1).

Over the period covered by the maturity of government bonds, it makes good sense to continue to fit the nominal forward rates assumptions to the yield curve for New Zealand nominal government bonds.

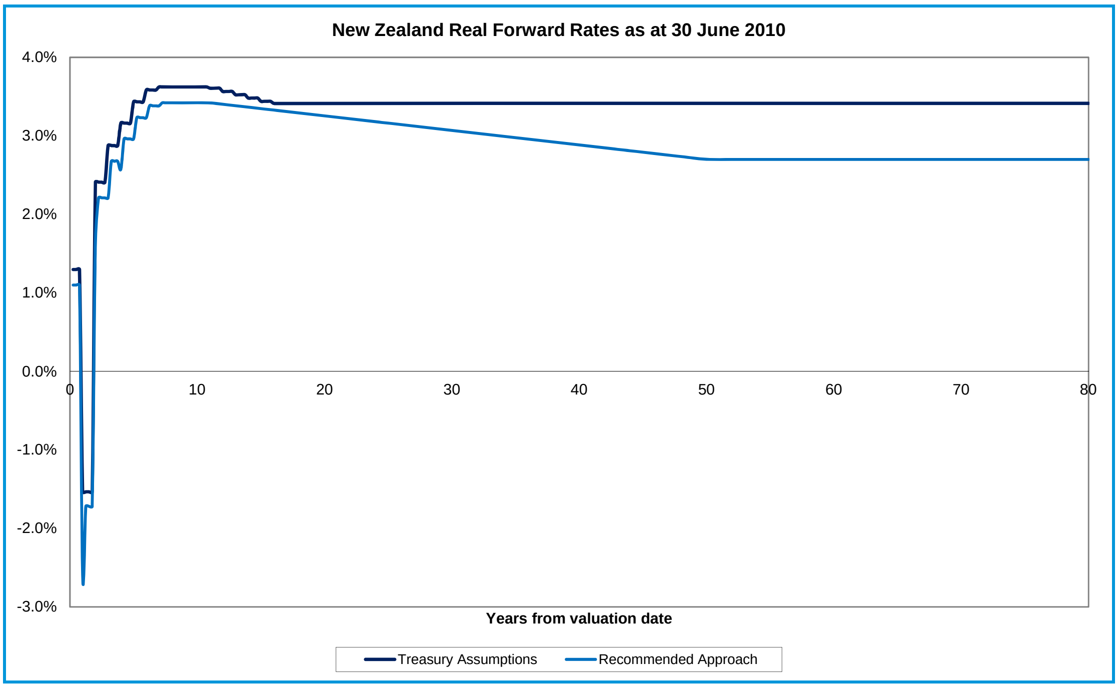
Over the interpolation period, the nominal forward rates would be implied by:

- The interpolated real forward rates; and
- The interpolated inflation rates.

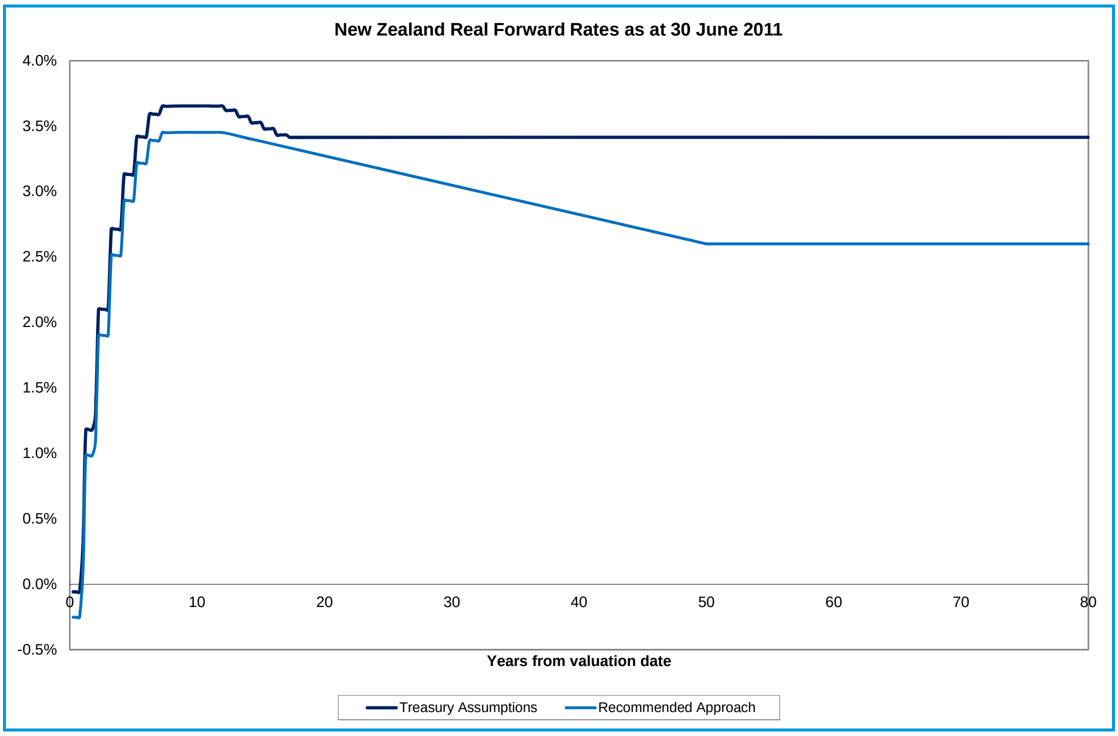
Appendix 1 Real Forward Rates at the Last Three June Balance Dates

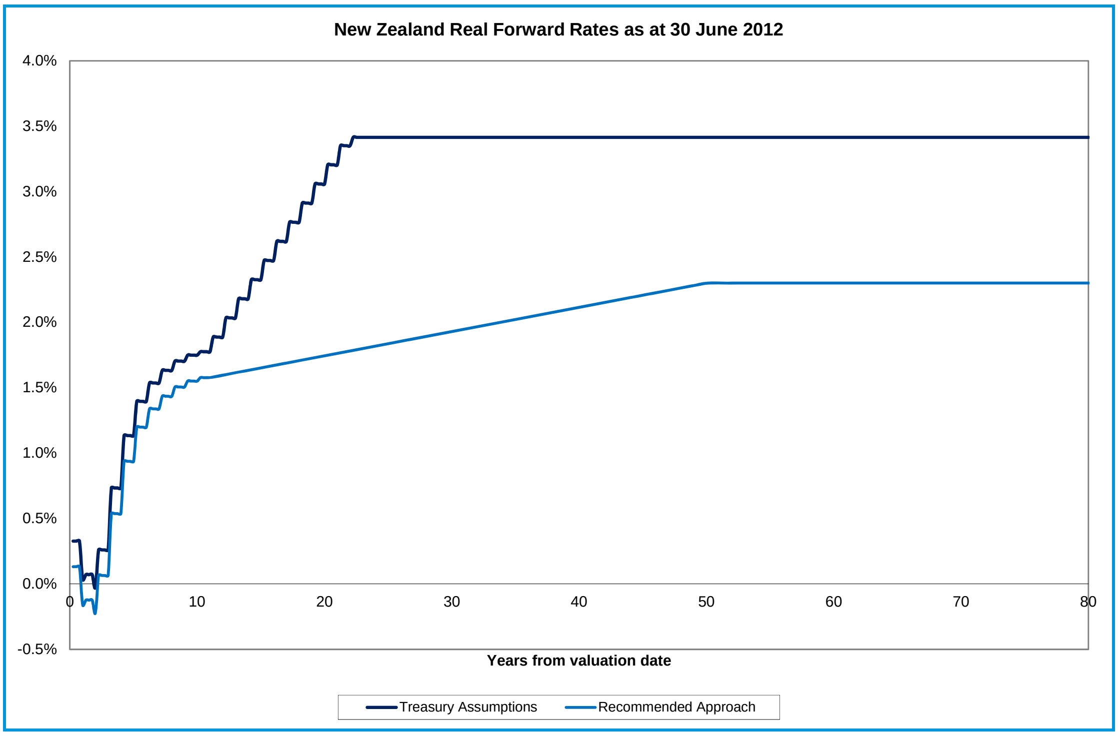
Figures 1 and 2 of the executive summary show the real forward rates implied by The Treasury assumptions, and the recommended approach as at 28 February 2013, respectively.

The graphs below show the corresponding real forward rates as at the last three balance dates: June 2010, June 2011 and June 2012[19]. Note that the long term rate assumption has been calculated separately for each date, using the recommended approach spelled out in section 2. Note also that the scale differs for the first graph to accommodate the low real forward rates in the initial period (associated with a pending increase in the rate of GST).



[19] The recommended approach involves making the real forward rates consistent with the market price for any long dated inflation indexed bonds issued by the New Zealand government. As there were no such inflation indexed bonds over this period, the 'back cast' of the recommended approach can only be an approximation. In the graphs shown here the real rates over the period covered by government bonds are based on the implied real rates from The Treasury forecasts, but have been lowered by 20bp (i.e. the same adjustment as used for the 28 February 2013 example).


New Zealand Real Forward Rates as at 30 June 2011
4.0%
3.5%
3.0%
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
-0.5%
0
10
20
30
40
50
60
70
80
Years from valuation date
Treasury Assumptions
Recommended Approach


New Zealand Real Forward Rates as at 30 June 2012
4.0%
3.5%
3.0%
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
-0.5%
0
10
20
30
40
50
60
70
80
Years from valuation date
Treasury Assumptions
Recommended Approach

Appendix 2 Illustration of Different Extrapolation Approaches

This appendix illustrates two other approaches for extrapolating forward rates beyond the longest market rates. The first is the approach recommended by EIOPA (as set out in a document called "QIS 5 Risk-free interest rates – Extrapolation method"). The second is an approach suggested by Barrie and Hibbert in a 2008 paper[20].

The illustrations are for a June 2010 balance date, which corresponds to the first graph in Appendix 1. Note that these illustrations use a long-term real rate assumption of 2.7% (consistent with the recommended approach for determining the long-term real rate assumption specified in Section 2, applied back to a June 2010 date).

EIOPA approach

EIOPA recommends the use of the so called Smith-Wilson technique, which fits discount factors from the market yield curve and extrapolates beyond the market rates.

The Smith-Wilson technique involves the use of specific functional form that is too complex to summarise succinctly here. But the approach can be readily applied in practice.

The following two graphs show New Zealand real forward rates derived from this approach (but using a long-term real rate assumption of 2.7%)[21]. Both graphs show forward rates as at 30 June 2010 (as for the first graph of Appendix 1).

The first graph below shows a comparison with the straight line approach recommended in this paper.

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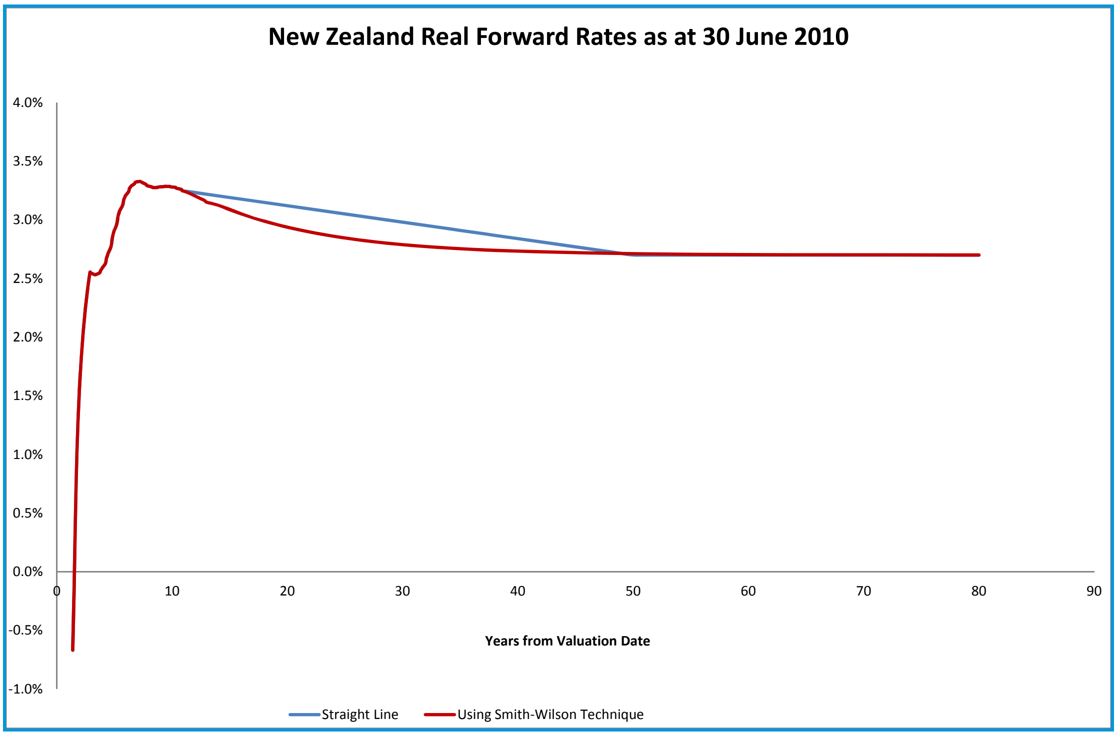
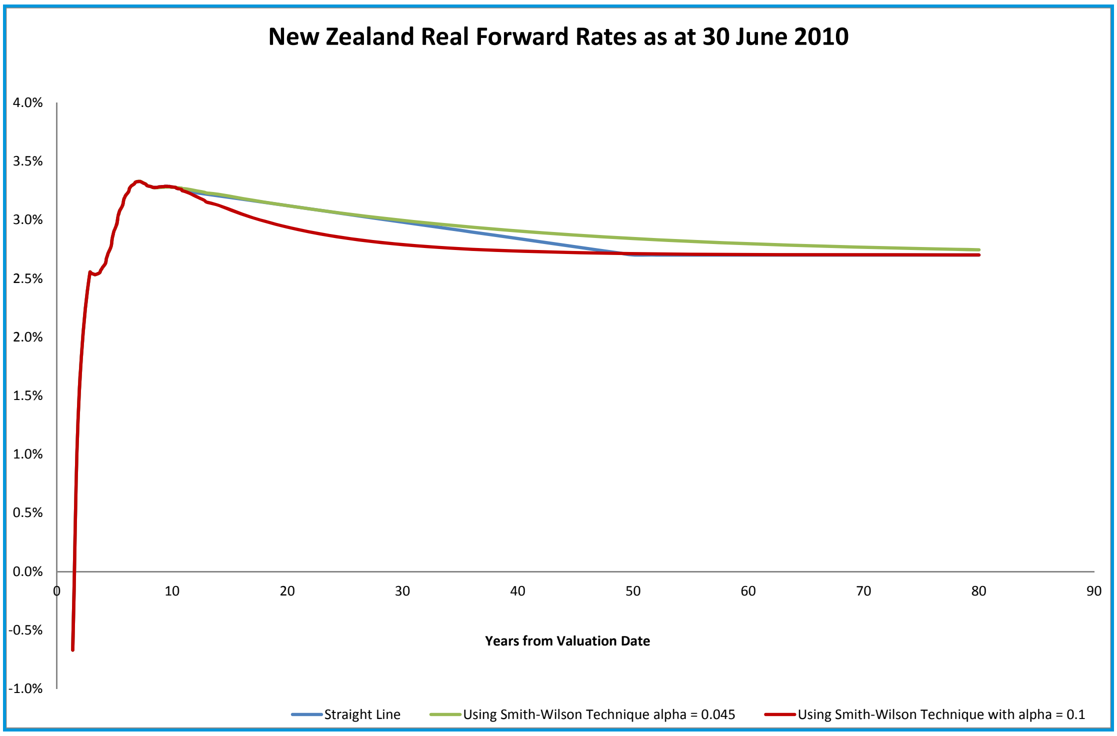
[20] A framework for estimating and extrapolating the term structure of interest rates', September 2008.

[21] The example shown here involves a two step-approach. In the real forward rates implied by The Treasury assumptions are used to generate real zero coupon discount rates corresponding to the maturities of the various nominal New Zealand government bonds. In the second step these are fed into the Smith Wilson approach, applied to real rates.



The rate of convergence under the Smith-Wilson technique is sensitive to a convergence parameter, “alpha”. The graph above uses the default value recommended by EIOPA. They recommend the use of this default value, unless at the 90 years the extrapolated forward rate would be more than 3 basis points away from the long-term assumption.

The green line in the graph below shows what the curve looks like with a lower rate of convergence (in this case chosen so the real forward rate is 3 basis points from the long-term assumption at 90 years).



This graph shows that the straight line approach recommended in this paper (the blue line) more closely resembles the slower rate of convergence (green line) than the faster rate of convergence (red line).

Curve of Barrie and Hibbert (2008)

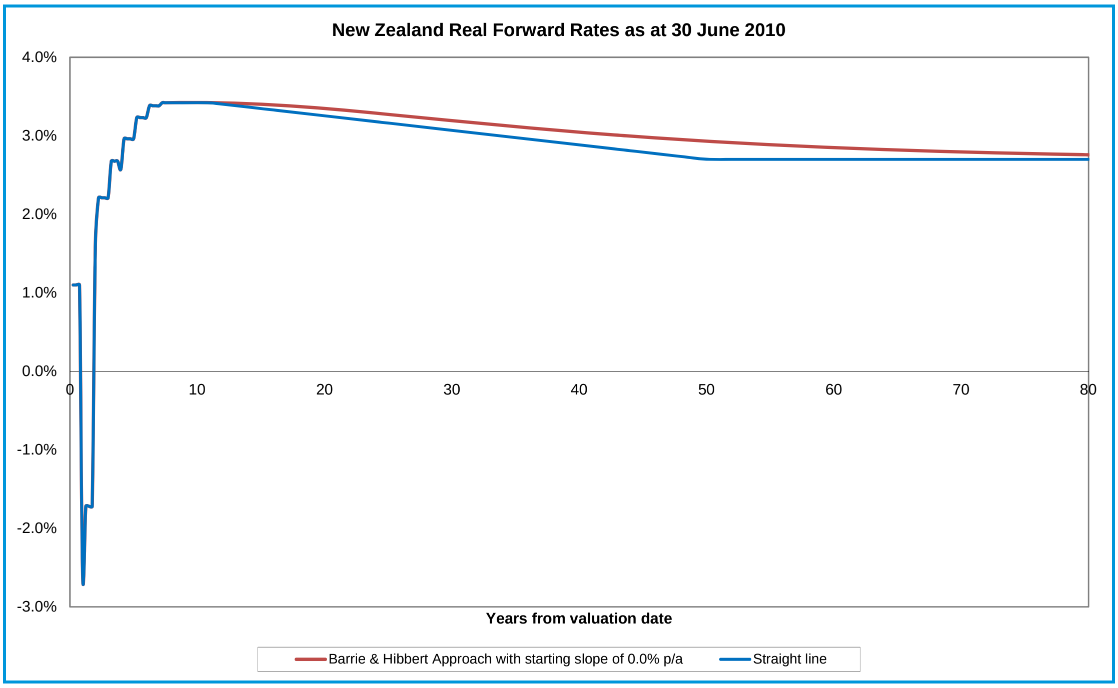
Barrie and Hibbert (2008) suggest that forward rates be extrapolated beyond the end of the market data using the functional form of Nelson-Siegel[22]. This functional form can be expressed as:

$$F(t) = B_0 + B_1 * \exp(-Phi * t) + B_2 * t * \exp(-Phi * t)$$

The term B_0 corresponds to the long-term forward rate assumption. The term B_1 corresponds to the difference between the last market-determined forward rate and the long-term assumption. The term B2 can be adjusted in order to match the slope at the start of the extrapolation period to the slope of the fitted forward rates at the end of the market determined period.

The term Phi determines how quickly the forward rates converge towards the long-term forward rate. A larger value of Phi implies a more rapid convergence. Barrie and Hibbert (1998) suggest a value for Phi of 0.06, based on their estimation of the term structure of forward rate volatility. As with the Smith-Wilson technique, forward rates approach the assumed long-term forward rate asymptotically.

The graph below illustrates the Barrie and Hibbert approach for New Zealand forward rates as at June 2010, again in comparison with the straight line approach. A value of 0.06 is used for Phi, and the long term rate has been set at 2.7%



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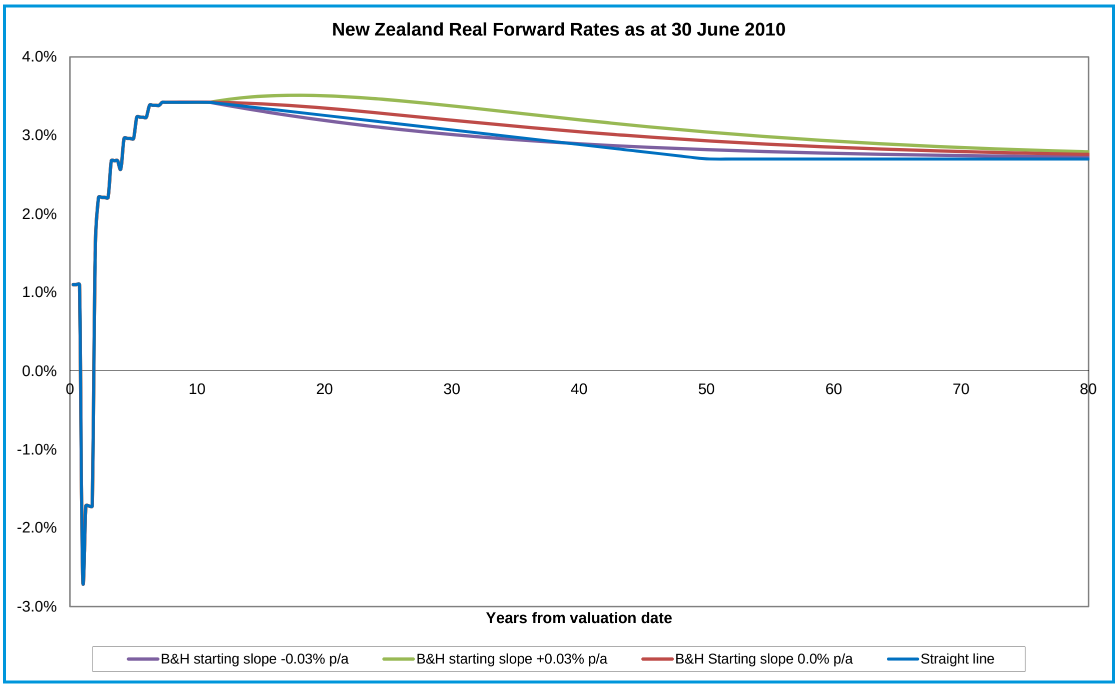
[22] While the use of a Nelson-Siegel functional form may seem to give this approach theoretical 'legitimacy', in normal usage the Nelson-Siegel formulation applies to all maturities, rather than to maturities beyond a certain point.

The rate of convergence under the Barrie and Hibbert approach is not just sensitive to the convergence factor Phi. It is also sensitive to the assumed slope at the start of the extrapolation period (i.e. the slope at the end of the market rates). The graph above assumes that this slope is zero. The graph below holds phi constant but includes curves for starting slopes of +0.03% per annum and -0.03% per annum.



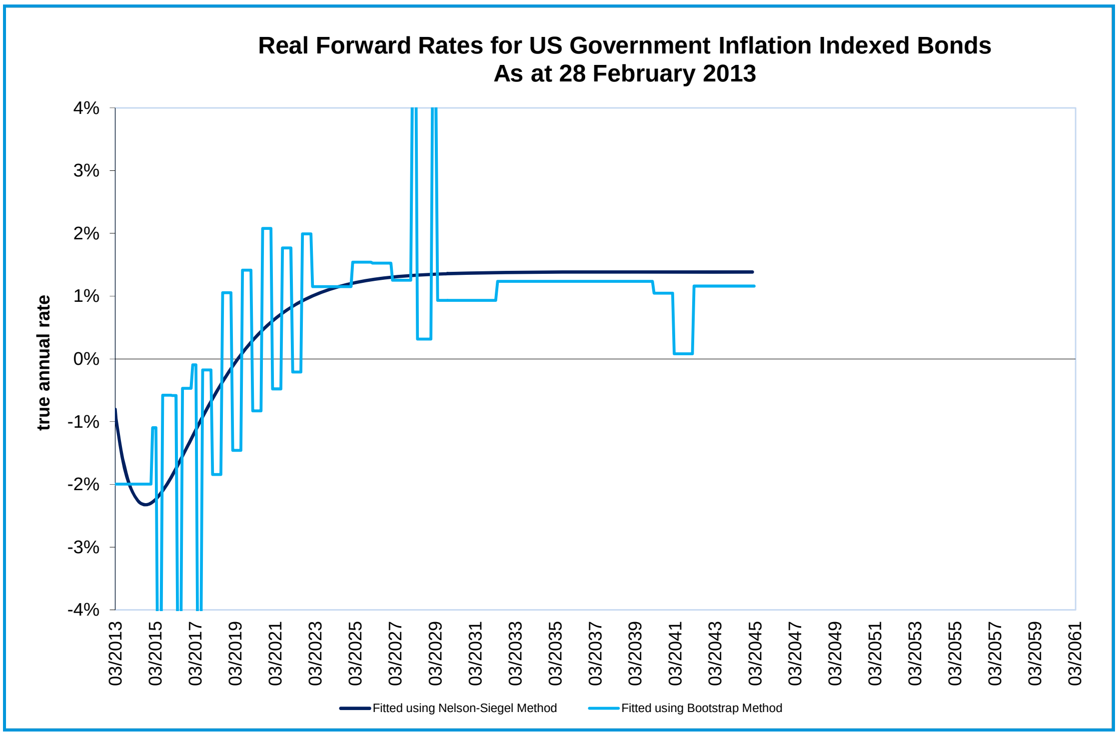
In conclusion, there are different ways of extrapolating beyond the end of the market rates. If other methods are used than the straight line approach recommended in this paper, an important issue is the parameter choice that determines the rate of convergence. We consider straight line sufficient for the purpose.

Appendix 3 Real Forward Rates for US and UK Inflation Indexed Bonds

Figure 3 in Section 2 of the paper shows real forward rates fitted to the yield curves for US and UK inflation indexed bonds, as at 28 February 2013. The real forward rates were fitted using the widely used method of Nelson-Siegel, which involves fitting parameters for a particular functional form[23].

The two graphs below compare these with real forward rates fitted using a particular 'bootstrap' approach. Under this bootstrap approach the real forward rates are assumed to move in a stepwise manner, with the step changes coinciding with the maturity of each bond. The size of the step changes are fitted so that the resulting forward rates are consistent with market prices for all of the bonds[24].

The forward rates derived from the bootstrap approach tend to be 'noisy', because yield differences between adjacent maturities can result in large swings in the corresponding forward rates. Nevertheless it is useful to consider averages over the period where the real forward rates tend to flatten out (e.g. the average of all bootstrapped forward rates 10 years plus).



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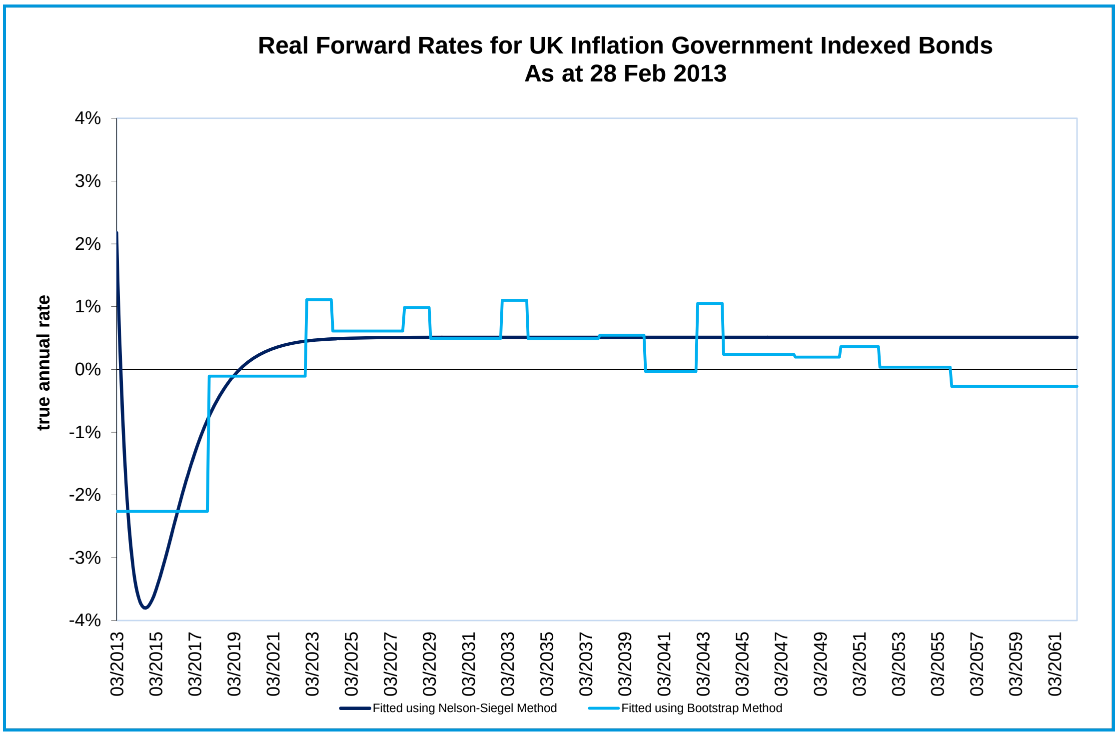
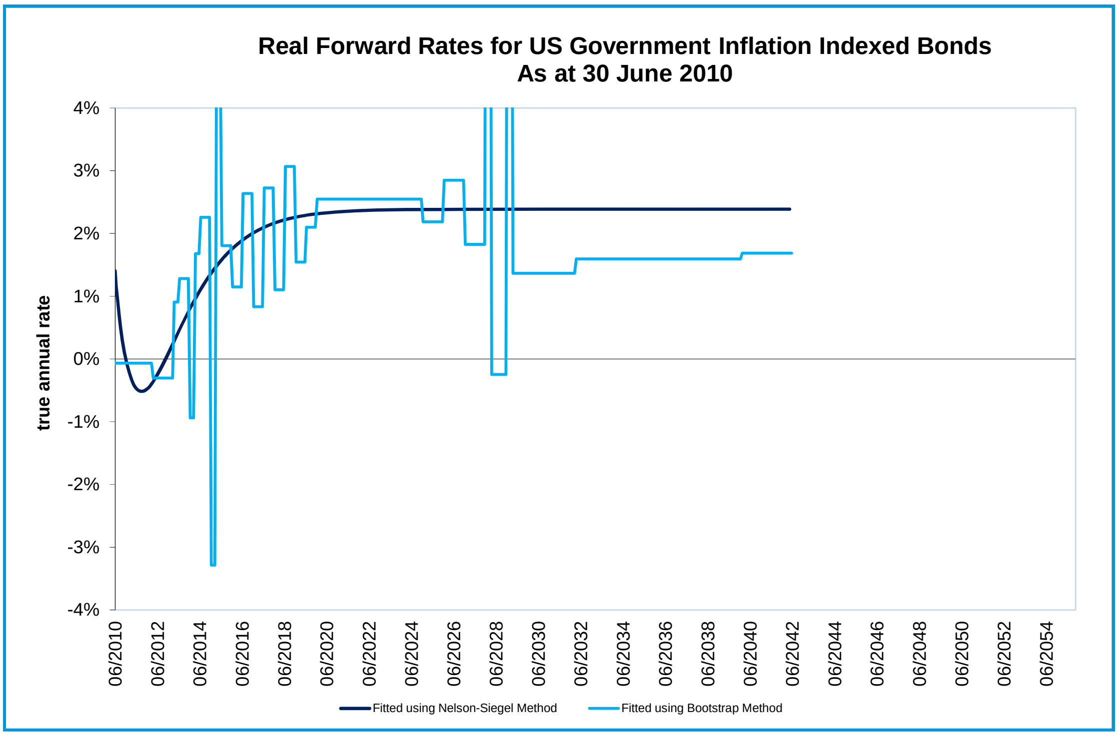
[23] The functional form can be expressed as F(t) = $B_0 + B_1$* exp(-Phi* t) + B_2* t * exp(-Phi*t), where F(t) is the forward rate (expressed on a continuously compounding basis) at time t. The approach used here to fit the parameters is akin to choosing parameters that minimise the sum of squared differences between the yields to maturity for the various bonds and the yields to maturity implied by the fitted forward rates.

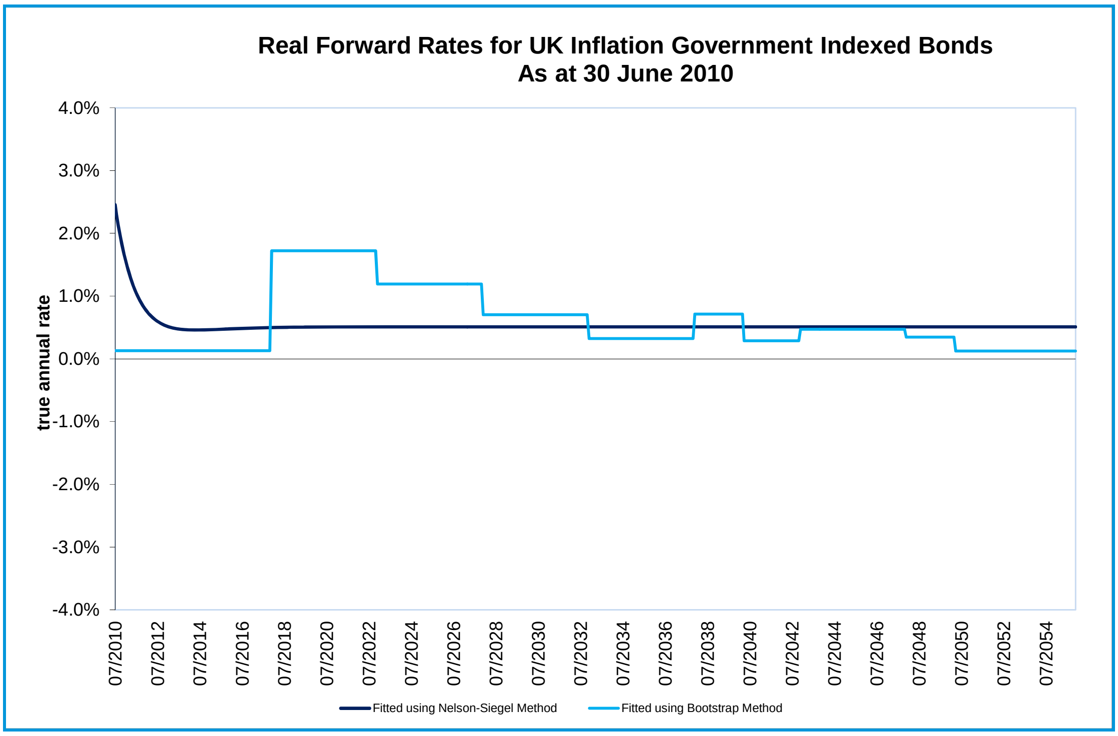
[24] This approach is based on the notion that the yield relationship between two adjacent bonds on the yield curve implies a reinvestment rate (or forward rate) for the period between their maturities. This notion need not imply that forward rates move in a stepwise fashion and such abrupt changes are theoretically implausible. Nevertheless, this simplifying assumption can be useful because it leads to a unique solution. When this assumption is used the implied forward rates should be thought of as a smoothed version of these bootstrapped forward rates.



In both cases the bootstrapped real forward rates towards the end of the horizon are somewhat below the corresponding forward rates determined from the Nelson-Siegel approach.

The next two graphs show the corresponding forward rates for a 30 June 2010 starting point (a date corresponding to the first assumptions determined using The Treasury's methodology).





The tables below summarise levels and changes for the United States and the United Kingdom:

US Real Forward Rates

	Nelson-Siegel (long end)	Bootstrap (average for 10 years+)
30 June 2010	2.4%	2.1%
28 Feb 2013	1.4%	1.2%
Change	-1.0%	-0.9%

UK Real Forward Rates

	Nelson-Siegel (long end)	Bootstrap (average for 10 years+)
30 June 2010	0.5%	0.6%
28 Feb 2013	0.5%	0.3%
Change	-	-0.3%

These two approaches show a broadly similar picture:

- The market real forward rates are lower in the UK than in the US
- US real forward rates have fallen around 1% from June 2010 to February 2013. There was a much smaller decline (if any) in the UK over this period.
- The New Zealand long-term assumption of 3.4% looks very high relative to the long-term 'market' rates in the US and the UK.