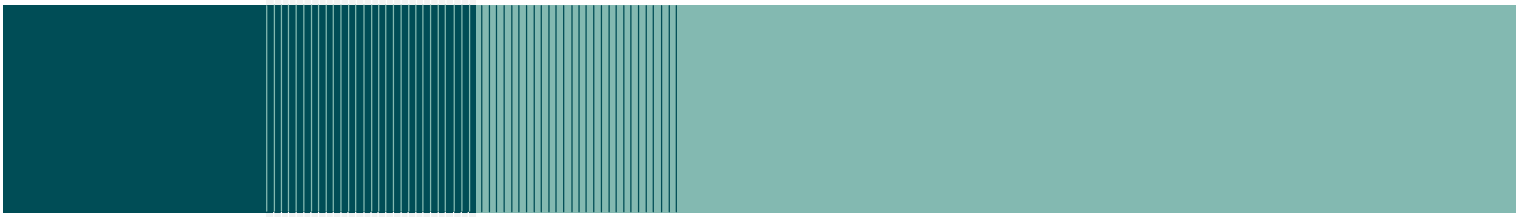
Appendix V

Bias in Indexed CGS Yields as a Proxy for the CAPM Risk Free Rate

March 2007

Bias in Indexed CGS Yields as a Proxy for the CAPM Risk Free Rate

A report for the ENA



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Summary of key conclusions

Bias in Indexed CGS relative to Nominal CGS

RBA analysis suggests that indexed CGS yields are depressed by supply and demand conditions peculiar to that bond - causing a relative bias in indexed CGS yields.

Based on bond market data, this bias first began appearing in late 2004 and currently is around 20bp.

To account for this, Australian regulators need to add 20bp to the real the cost of equity and debt (ie, to the cost that would be calculated using standard regulatory practice).

Regulatory precedent

UK regulatory precedent is of particular relevance for Australia given the similar reductions in yield on indexed government bonds and central bank commentary.

UK regulatory precedent unanimously involves adjustments to the Government indexed bond rate to set the CAPM real risk free rate. These adjustments are between 30bp and 50bp with an average of around 50bp.

Regulatory precedent in the US is similar. US regulators do not reflect historically low government bond yields in historically low equity returns.

Prior ESCV precedent also supports making an adjustment to the observed yield on government bonds.

Academic literature

It is well entrenched in the finance literature that government bonds yields are not perfect proxies for the CAPM risk free rate.

The literature identifies that government bonds have unique characteristics above and beyond their risk free characteristics. The market places a positive value on these characteristics leading to a 'uniqueness premium' - causing government bonds to be downward biased estimates of the CAPM risk free rate.

The empirical evidence strongly suggests that the uniqueness premium is inversely related to the supply of Government bonds.

Consistent with this, the empirical evidence also suggests that equity returns are not positively correlated with movements in government bond rates. (The other explanation for this is that the MRP is inversely related to government bond yields. Either way, it would be inconsistent with this literature to fully reflect historically low government bond yields in the CAPM risk free rate.)

Historically High Levels of Bias in Nominal CGS as a Proxy for the CAPM risk free rate

The 20bp bias estimate described above is ***relative*** to nominal CGS yields.

RBA commentary suggests that nominal CGS yields are also biased downwards - implying the absolute bias in indexed CGS is greater than 20bp.

Based on RBA data, the current yield on nominal CGS is downward biased as a proxy for the CAPM risk free rate by around 42-44bp. This is 27-29bp more biased than was the case in June 2003 using the same RBA data.

Further analysis is required to establish the robustness of the RBA data source.

The existence of an absolute bias has no effect on regulators' methodology for estimating the cost of debt - as this is benchmarked from nominal corporate debt. It would have an impact on the cost of equity assuming no change in the market risk premium.

1. Introduction and Summary

This report examines the extent to which the yield on indexed Commonwealth Government Securities (CGS) is a biased proxy of the 'risk free'[1] rate as used in the capital asset pricing model (CAPM). We also examine the extent to which this bias has increased in recent years both: a) in absolute terms affecting both indexed and nominal CGS; and b) in the relative bias in indexed CGS versus nominal CGS yields. It is important to be clear that discussion of 'bias' in this report is a discussion of bias in CGS yields ***as a proxy for the CAPM risk free rate***. The yield on CGS is, of course, an unbiased estimate of what investors' are willing to pay for CGS; however, it does not follow that it is equal to the rate on zero beta equity which is the measure of the risk free rate in the CAPM.

The report has the following structure:

- Section 2 quantifies the RBA's analysis suggesting a lack of supply of indexed CGS has biased these yields down ***relative*** to the yields on nominal CGS. We find that this bias is currently around 20bp.
- Section 3 examines UK regulators' response to a similar analysis by the UK central bank. We find that UK regulatory precedent is to add between 30bp and 100bp to the indexed government bond rate. Section 3 also examines the relevant US regulatory precedent.
- Section 4 summarises the academic finance literature explaining why government bond yields (both indexed and nominal) are likely to underestimate the true CAPM risk free rate (and why the supply of government bonds is likely to be a major determinant of this bias).
- Section 5 attempts to quantify the separate RBA analysis that suggests there has been an increasing bias in nominal CGS yields (itself consistent with the Bank of England analysis in the UK)
- Section 6 provides recommendations and conclusions.

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[1] The CAPM expresses the required return on a particular share as the sum of the required return on a share with zero beta risk plus a risk-premium that varies with the risk of the particular share relative to the average share. That measure of relative risk is the share's beta. The required return on a share with zero beta risk (i.e., with no relation between its future payoff and the return on the market or average share) is referred to as the risk-free rate in the CAPM. The use of this terminology does not imply that the expected return on zero beta shares is well measured by the yield on CGS securities. CGS securities may have zero beta risk, but they also have other characteristics unique to their government bond status.

2. Relative Bias in Indexed CGS Bonds

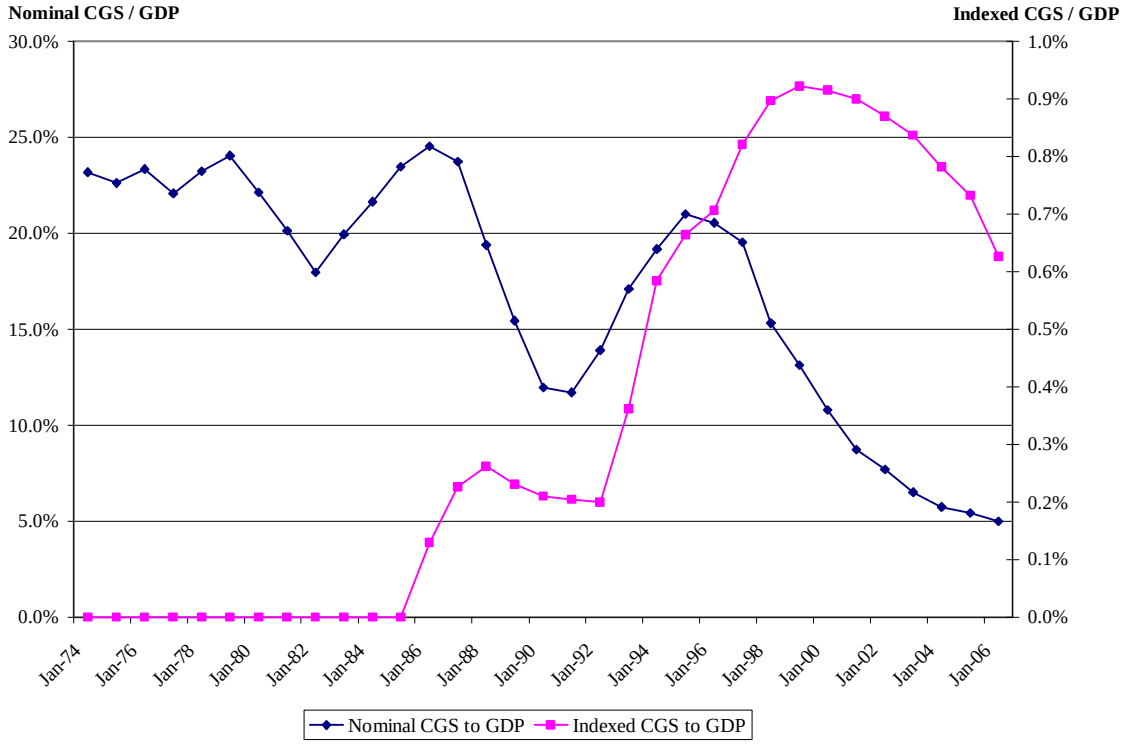
This section of our report focuses on measuring the bias in indexed CGS yields ***relative to*** nominal CGS yields. Any ***relative*** bias in indexed CGS yields provides a minimum estimate of the ***absolute*** bias in using these yields as a proxy for the risk free rate in the CAPM. If both nominal and indexed CGS yields are biased, as is likely given the dramatic recent reduction in supply of all CGS, then absolute bias will be equal to the relative bias in indexed CGS yields plus the absolute bias in nominal CGS yields:

Absolute bias in indexed yields = Relative bias in indexed yields + bias in nominal yields

2.1. Reduced supply of indexed CGS

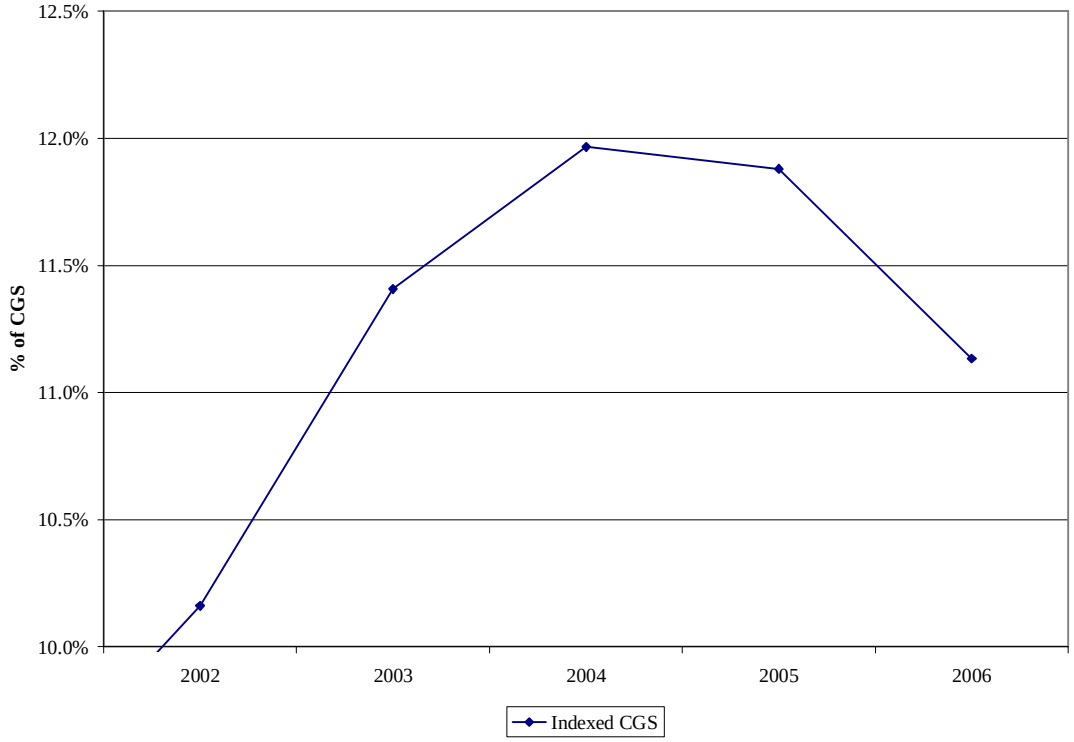
The extent to which there is any relative difference in bias between nominal and indexed CGS will depend on the interplay in demand and supply for these bonds. Both bonds have dramatically fallen in supply (measured as face value as a percentage of GDP). The left-hand scale measures the supply of Nominal Commonwealth Government Securities relative to GDP and the right-hand scale measures the supply of Indexed Commonwealth Government Securities relative to GDP.

Figure 2.1
Indexed and Nominal CGS as a % of GDP



The above graph shows that since 2000 both the value of nominal and indexed bonds have been falling as a proportion of GDP. The current value of CGS (both indexed and nominal) is at the historically low level of 5.6%. (Note that the value of nominal CGS to GDP is measured on the left hand vertical axis and the value of indexed CGS to GDP is measured on the right hand vertical axis.) The value of indexed CGS on issue grew rapidly from their introduction in 1986 and reached a peak as a percentage of GDP in 1999. Since then this value has fallen equally precipitously and are now 68% of their 1999 peak. Importantly, this reduction has been most accelerated since 2004 with indexed CGS falling 20% as a percentage of GDP in two years. This has also been associated with a reduction in supply of indexed CGS as a percentage of total CGS on issue.

Figure 2.2
Indexed CGS as a % of Total CGS



2.2. Increased demand for indexed CGS

The dramatic reduction in indexed CGS in 2004 (and the resulting reduction in indexed CGS relative to nominal CGS) occurred at the same time when our data suggests that indexed CGS yields became ***relatively*** more downward biased than nominal CGS yields (see below). It also came at a time when, according to the RBA, institutional demand for indexed CGS increased as super funds and other institutions with inflation-indexed long-dated liabilities attempted to match those liabilities with inflation indexed CGS.

> ***"One development of particular note over the past year or so has been the fall in yields on inflation-indexed bonds. Yields on 10-year indexed bonds fell by 85 basis points from the beginning of 2005 to mid January 2006. This took them below 2 per cent, by far the lowest level since their introduction in the mid 80s and, as a result, the spread between 10-year nominal and real yields widened to 3.2 per cent, compared with around 2.7 per cent in the first half of 2005 (Graph 49). While this spread is usually seen as a measure of expected inflation, its recent increase is at odds with other measures of inflation expectations and reflected special factors, unrelated to inflationary pressures. As noted in the earlier chapter on international markets, regulatory changes abroad have encouraged life insurers and superannuation funds to acquire long-dated bonds as an asset class that better matches their liabilities. Other investors, such as hedge funds, are said to have recognised that this process is likely to continue for some time and***

> ***have added to demand. These developments, against a background of a small, tightly-held domestic supply of indexed bonds, have seen their prices rise (yields fall) significantly. As a consequence, and despite having fallen a little in February, the current spread between yields on nominal and indexed government bonds overstates the market's expectations of inflation."***[2]

This is not the only time the RBA has made similar comments. In the November 2006 Statement on Monetary policy the RBA said:

> ***"The implied medium-term inflation expectations of financial market participants, as measured by the difference between nominal and indexed bond yields were around 3¼ per cent in early November. However, as noted in previous Statements, this measure can be affected by factors unrelated to expectations about inflation, such as changes in institutional demand for indexed securities."*** (Page 59)

The text from the May 2006 RBA Statement on Monetary Policy states:

> ***"The implied medium-term inflationary expectations of financial market participants have traditionally been calculated as the difference between nominal and indexed bond yields. This measure has continued to edge higher since the February Statement, to be around 3.2 per cent in early May. However, this rise in part reflects developments in the indexed bond market that are unrelated to inflation expectations. In particular, the limited supply of indexed securities and increasing institutional demand for these securities has pushed down their yields relative to those on conventional bonds. (Page 58)***

In the February 2007 Statement Monetary Policy the RBA states:

> ***"The implied medium-term inflation expectations of financial market participants, as measured by the difference between nominal and indexed bond yields, were a little over 3 per cent in early February. Given the institutional factors noted in previous Statements, this figure may overstate actual inflation expectations." (Page 54)***

2.3. Alternative explanations difficult to sustain

The changes the RBA is describing are illustrated in the graph below. Yields on nominal bonds are shown on the left-hand-axis. The right-hand-axis related to yields on indexed bonds.

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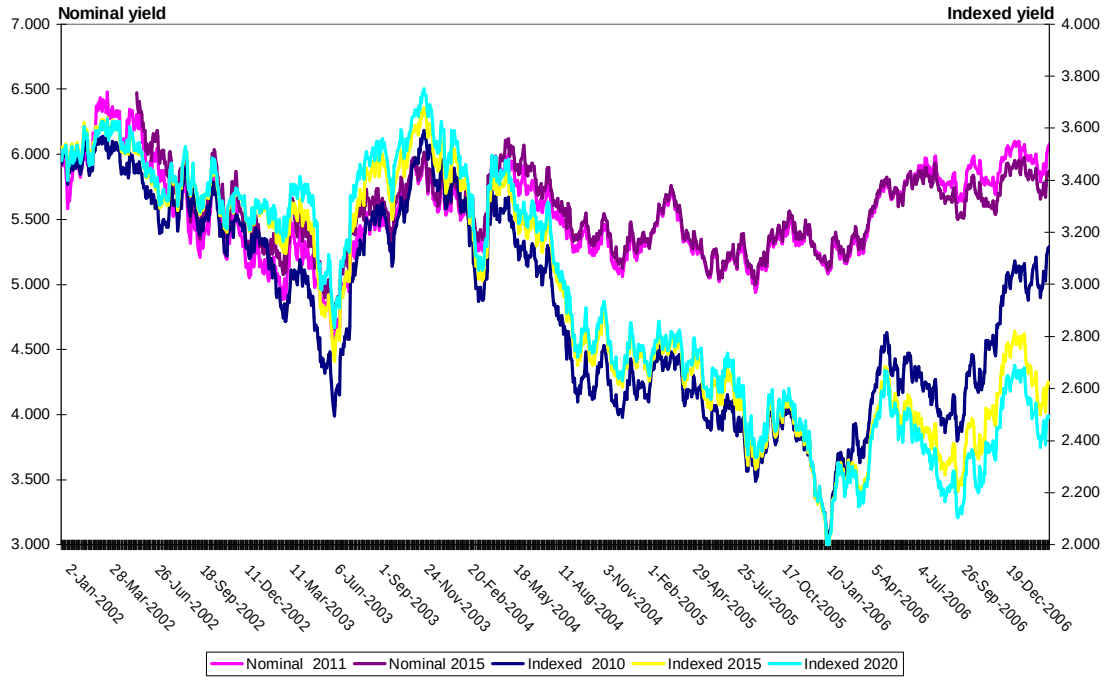
[2] RBA February 2006 Statement on Monetary policy (pages 48 to 49).

Figure 2.3
Yield on Nominal and Indexed CGS



The above demonstrates that from 2002 to late 2004 nominal and indexed bond yields followed a similar trend (measured on different vertical axes). From late 2004 onwards, nominal CGS yields (with 2011 and 2015 maturities)[3] continued to move together, however, there was a precipitous decline in indexed CGS yields. Moreover, the decline in yields on indexed CGS (with 2010, 2015 and 2020 maturities) has been most pronounced for longest dated indexed bonds. Since February 2007 the yield on longer dated indexed CGS has also started to diverge from the yield on shorter dated indexed CGS.

The above data and analysis is suggestive of a bias in indexed CGS yields ***relative*** to nominal CGS yields as a proxy for the real/nominal risk free rate. However, it is not determinative as other explanations may explain this result. The most obvious other explanation is that in late 2004:

1. Real, as opposed to nominal, CGS yields fell dramatically (as per the above graph); and
2. Inflation expectations plus any inflation risk premium increased by the almost exactly offsetting amount required to keep nominal CGS bond yields relatively constant. (Note that if there is no relative bias then nominal yields are simply equal to real yields plus expected inflation plus any inflation risk premium).

[3] No 2010 maturity nominal bonds are available.

Both events 1 and 2 must have occurred simultaneously in order to explain the data described in the above graph. This contrasts with the simpler explanation, espoused by the RBA, that falling supply and rising demand for indexed CGS depressed their yields relative to nominal CGS yields.

Moreover, in order to explain the data in the above graph in terms of events 1 and 2 above one would have to argue that:

- The long term real CAPM risk free rate has fallen by more than the short term real risk free rate (yields on 2020 indexed bonds are below 2015 which are below 2010 indexed yields);

- Long term inflation expectations exceed short term inflation expectations (nominal yields are only fractionally different by maturity date but real yields are materially different).

The second dot point involves accepting a highly unusual structure to inflation expectations. The implied inflation forecasts, assuming no relative bias or inflation risk premium, for each of the three periods 2007 to 2010, 2010 to 2015 and 2015 to 2020 are set out in the table below.[4]

Table 2.1
Implied Inflation Forecasts Assuming No Relative Bias
21 March 2007

Period	Implied inflation forecast
21 March 2007 to August 2010	2.90%
August 2010 to August 2015	3.35%
August 2015 to August 2020	3.27%

Source: CGS yields from the RBA website and NERA analysis.

The RBA, in the above February 2006 quote, suggests that it believes indexed CGS are relatively downward biased compared to nominal CGS. As a result, the RBA suggested that implied inflation forecasts were overstated. At that time, all indexed CGS were yielding approximately the same amount relative to the comparable nominal CGS security. Since

[4] The calculation of implied expected inflation from 21 March to August 2010 is based on simple application of the Fisher equation comparing yields on indexed and nominal CGS maturing on 15 August 2010. The calculation of expected inflation between August 2010 and 2015 is performed by: first, estimating the implied annual expected inflation between 21 March 2007 and August 2015 using the Fisher equation; second, using this to calculate the total percentage change in CPI from 21 March 2007; third, removing the portion of this that is due to implied inflation to August 2010; fourth, calculating an average annual rate of inflation over 5 years that is consistent with this. The same sort of analysis is then used to calculate implied inflation between August 2015 and August 2020.

then, yields on long dated indexed CGS have fallen below those on shorter dated CGS without a commensurate relative reduction in long dated nominal CGS yields. The net result is that, if there has been no change in relative bias or inflation risk premium, implied expected inflation in the distant future has increased relative to the near future. One important implication of this is that, in order to defend the position that the differences in yields purely reflect differences in inflation expectations, one must argue that investors believe average inflation from 2010 to 2020 will be well above the RBA's range of 2 to 3%. Moreover, investors must hold this view despite also believing that over the next 3 ½ years inflation will only be 2.90%.

Such predictions are inconsistent with professional economists' current forecasts of future inflation. Credible economic forecasters universally predict inflation will fall below the RBA's target range from 2008/09 onwards and will continue within (or below) that range over the foreseeable future.

Table 2.2
Inflation Forecasts

Forecaster	07/08	08/09	09/10	10/11	11/12	12/13	13/14
Econtech	3.1	2.9	2.5	1.8	1.1	1.5	3
Access Economics	2.1	2.8	2.2	2.4			
ANZ	2.4	2.6					
Westpac	2.6	2.5	2.5	2.5			
Comm Bank	2.3	2.6					
RBA	2.5-3	2.5-3					
Treasury (Budget)	2.5	2.5					
OECD	2.7	2.3					

Sources: See references at appendix A

In our view, the above analysis creates an extremely strong '***prima facie'*** case that the yield on long term indexed CGS are biased downward relative to nominal CGS. However, it is a more difficult matter to estimate the extent of this relative bias. This is the subject of the next sections.

2.4. Estimating the relative bias in indexed vs nominal CGS yields

For corporations with both index linked and nominal bonds we examine the relative movement in the spreads to similar maturity CGS bonds. If both nominal and indexed CGS are equally biased (or are both unbiased) then the spread to corporate bonds issued by an identical corporation and with an identical maturity/duration should also be identical. That

is, both nominal and indexed corporate bonds should have the same spread to nominal and indexed CGS.

However, if index linked CGS are more biased than nominal CGS (ie, the market will pay a higher premium for indexed CGS) then this will depress the yield on indexed bonds more than nominal bonds - causing the observed corporate spread to these bonds to rise above the observed spread to nominal bonds.[5]

If this empirical test is to support the RBA's analysis then it will show two things:

1. That current spreads of indexed corporate securities to indexed CGS are greater than spreads of nominal corporate securities to nominal CGS. This finding will support the RBA's view that indexed CGS yields are currently relatively more downward biased than nominal CGS yields; and

2. That this phenomenon will have developed in late 2004 and 2005 when falls in indexed CGS yields began outstripping falls in nominal CGS yields (as observed by the RBA above).

Put simply, if falling supply and increased demand creates a relatively stronger bias for indexed than nominal CGS, then corporate spreads to indexed CGS should rise relative to corporate spreads to nominal CGS.

This is precisely what we do observe when we examine spreads on indexed and nominal bonds issued by both Electranet and Envestra. As demonstrated in the following graphs, prior to late 2004 spreads on indexed corporate bonds were around the same (or less) than spreads on corporate nominal bonds. However, in late 2004 spreads on indexed corporate bonds began rising relative to spreads to nominal corporate bonds and indexed bond spreads have since remained 15 to 20bp higher than nominal bonds spreads.

The corporate bond yield data used below was sourced from both the ABN AMRO and Macquarie data set available on Bloomberg. The data reported represents all the available data from these time series (noting that ABN AMRO has a longer time series). The yield data for CGS bonds was sourced from the RBA website. All figures present a 20 day moving average. The data used ends at 21 March 2007 and final results on that date are also presented at the end of this section.

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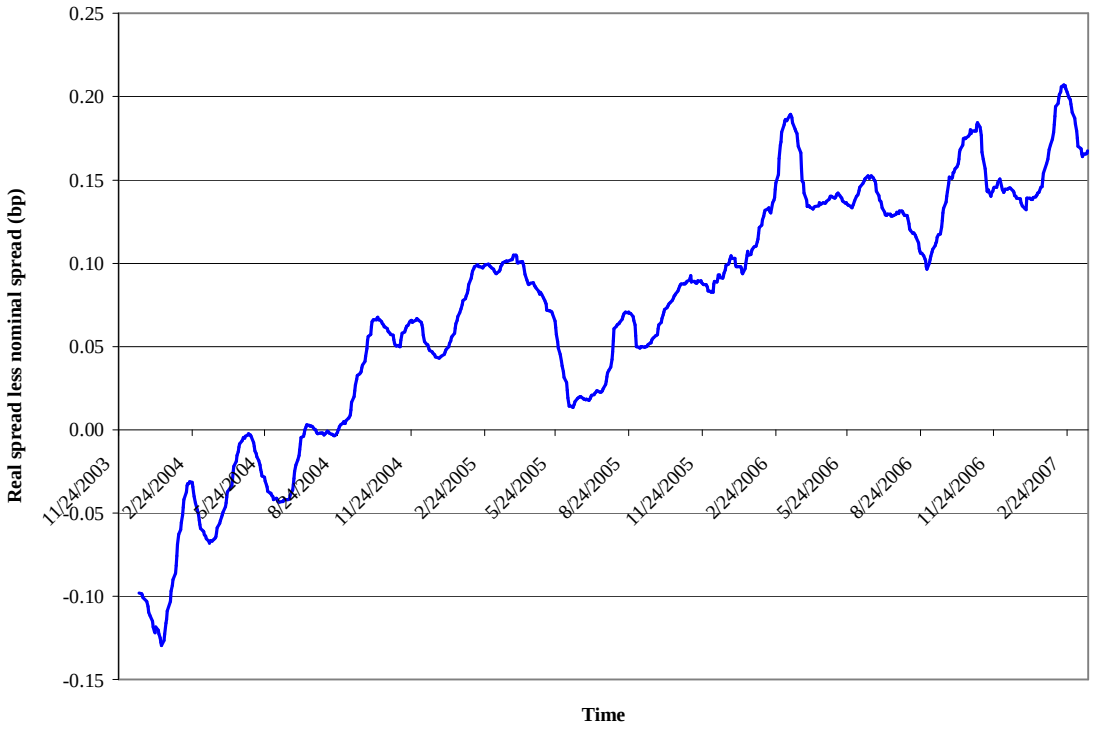
[5] In reaching this conclusion we assume that corporate indexed bonds are not affected by a reduced supply / increased demand for indexed CGS. That is, we assume that there is no 'spill over' of demand from indexed CGS to indexed corporate bonds. This is a conservative assumption because it is likely that some excess demand for indexed CGS will spill-over into highly rated indexed corporate bonds

Figure 2.4
Spread to CGS of Electranet's Indexed 2010 versus Nominal 2009
Data source: ABN AMRO

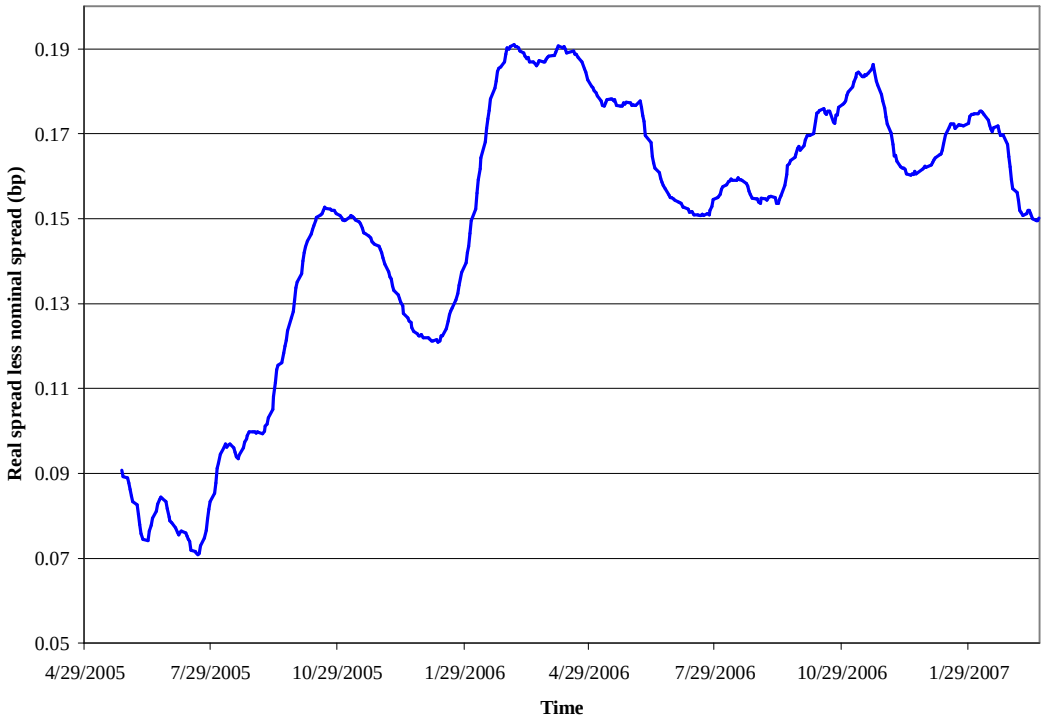


The above graph reports a 20 day moving average of the difference in spreads on Electranet's indexed bond maturing on 20 August 2010 (4.905% coupon) with the spread on Electranet's nominal bond maturing on 17 November 2009 (coupon 6.5%).

The spread on the indexed corporate bond is measured relative to the yield on CGS maturing on the same date (20 August 2010) with a coupon of 4%. The spread on the nominal corporate bond maturing on 17 November 2009 is measured relative to the yield on the nominal CGS with 15 September 2009 maturity (7.5% coupon).

As illustrated in Figure 2.4, the real spread less the nominal spread shows a positive trend as it moved from approximately -3bp in March 2004 to 19bp on 21 March 2007 (20 day moving average is 17bp). As predicted the divergence developed in 2004 when indexed CGS fell as a proportion of total CGS (see figure 2.2). This is consistent with the reduction in supply combined with the increased demand discussed in 3.2, forcing the price of indexed CGS upwards and simultaneously pushing down the yield. As a result a higher and growing spread to CGS is observable on inflation indexed bonds in comparison to nominal bonds.

Figure 2.5
Spread to CGS of Electranet's Indexed 2010 versus Nominal 2009
Data source: Macquarie Bank



The above graph reports the same 20 day moving average as figure 2.4 with the exception that it is based on yield data sourced from Macquarie Bank. (ABN AMRO and Macquarie bank provide the only historical data series available on Bloomberg that have yields for ***both*** of the Electranet nominal and Electranet indexed bonds.) The above figures depict all the available data from these time series; ie, data from the Macquarie Bank time series only goes back to only to mid 2005.

The observation of an increasing relative bias in the ABN AMRO data is confirmed by the Macquarie Bank data (noting that the Macquarie data covers a shorter period).

While the corporate and CGS bonds we compare have similar, or identical, maturity dates they do have different coupons. If two bonds have an identical maturity but one pays a higher coupon then it is said to have a shorter duration (on average cash is received earlier). For example, despite having identical maturity dates, the duration on the Electranet indexed bond is shorter than the duration on the matched indexed CGS bond because of its higher coupon rate (4.9% vs 4%). By contrast, the coupon on the nominal Electranet bond is lower than for the nominal CGS (6.5% vs 7.5%). This means that despite the Electranet bond maturing 2 months after the matched nominal CGS, its actual duration was much closer or even longer than the matched CGS over the relevant period.

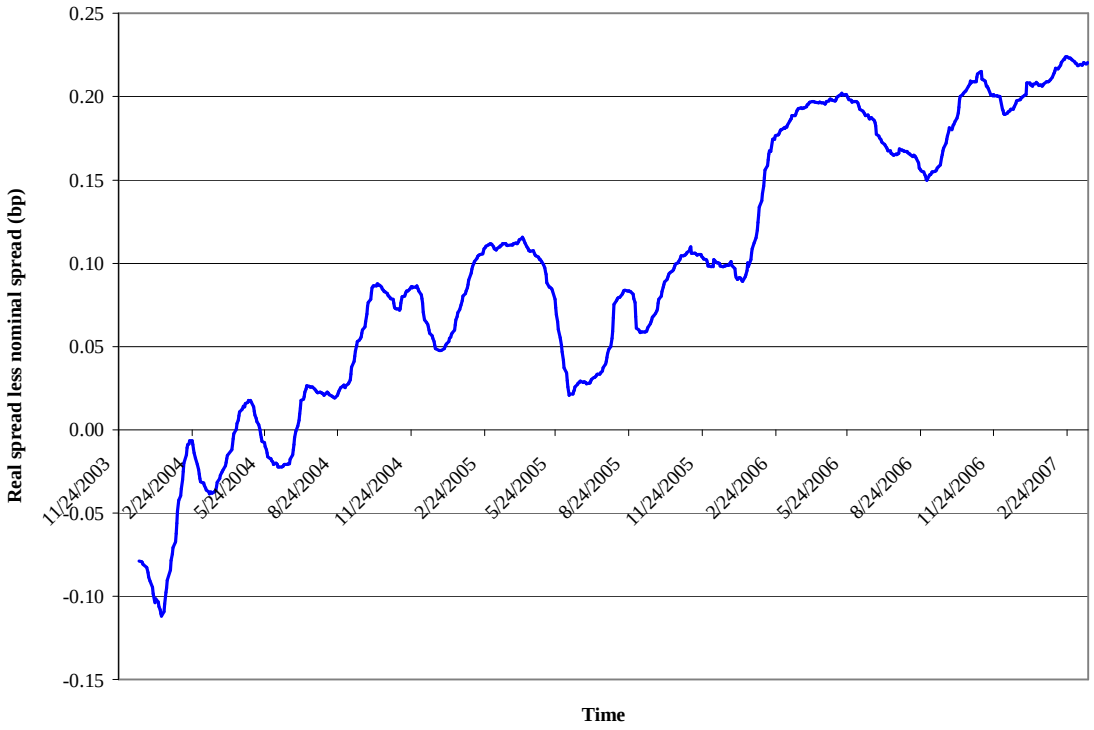
Had we accounted for difference in durations induced by the difference in coupons, then the estimated bias would have been greater than described in the above figure. This reflects the fact that currently, and over much of the period covered above, the term structure (both real and nominal) was downward sloping. Thus even if Electranet's bonds were default free we would expect a higher yield on Electranet's nominal debt than on equivalent maturity date but longer duration CGS nominal debt and a lower yield on Electranet's real debt than on equivalent maturity date but shorter duration CGS real debt. The effect on the relative default spreads of Electranet's nominal and real debt is in the opposite direction to what is observed and hence the higher relative spread to CGS on Envestra real bonds cannot be attributed to this cause.

This observation holds true of all other bonds we examine – see Table 2.3 below. Namely, the coupons on the indexed corporate bonds are higher than for the matched CGS and the coupons on the nominal corporate bonds are lower than the matched nominal CGS.

It is also true that the indexed corporate bond examined above matures 9 months later than the nominal corporate bond examined. That is, while there is a very close matching of maturity / duration ***within*** bonds of each type (indexed and nominal) there is only an imperfect matching of maturity ***across*** bond types. This mismatch cannot be resolved by interpolating between yields on nominal Electranet bonds because pricing for only one such bond is available on Bloomberg (from either ABN AMRO or Macquarie Bank sources). However, the above results are not sensitive to differences in maturity ***across*** bond types. Specifically, the spread on the Electranet 2015 maturity indexed bond is, on average, only 0.8 to 2.5bp[6] higher than on the Electranet 2010 indexed bond. That is, if a five year longer maturity only increases the spread by 0.8 to 2.5bp then a 9 month mismatch between maturity on indexed and nominal bonds can be assumed to have an immaterial impact on the measure of relative bias.

[6] Depending on whether Macquarie or ABN AMRO data is used.

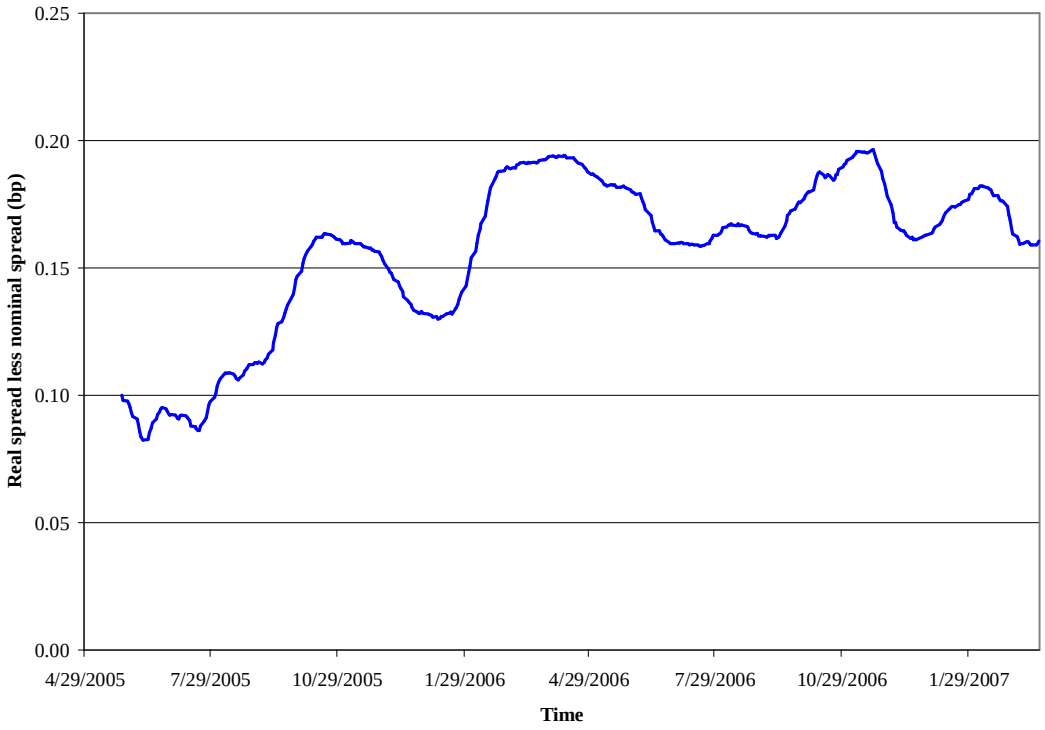
Figure 2.6
Spread to CGS of Electranet's Indexed 2015 versus Nominal 2009
Data source: ABN AMRO



The above graph reports a 20 day moving average of the difference in spreads on Electranet's indexed bond maturing on 20 August 2015 (5.205% coupon) with the spread on Electranet's nominal bond maturing on 17 November 2009 (coupon 6.5%).[7] The spread on the indexed corporate bond is measured relative to the yield on the 20 August 2015 indexed CGS (coupon 4%) as reported on the RBA website. The spread on the nominal corporate bond is measured relative to the yield on the nominal CGS with 15 September 2009 maturity (7.5% coupon).

[7] The yield data for these bonds was sourced from the ABN AMRO data set available on Bloomberg. The above data represents all the available data from these time series.

Figure 2.7
Spread to CGS of Electranet's Indexed 2015 versus Nominal 2009
Data source: Macquarie Bank

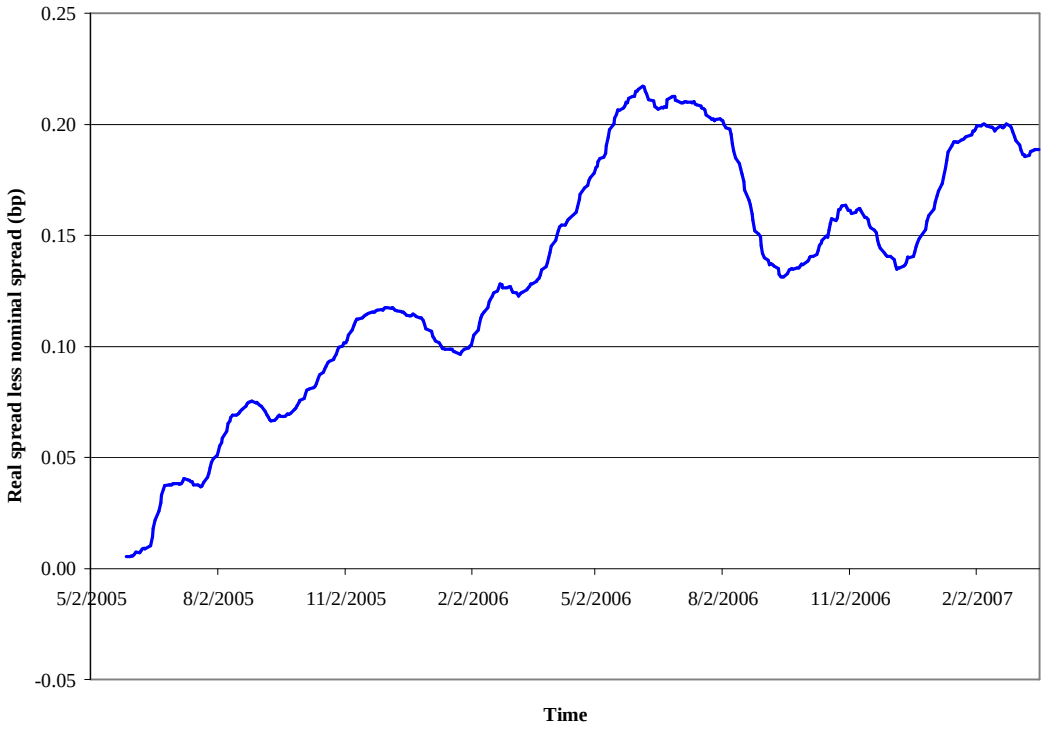


As in figure 3.43, the above graph reports a 20 day moving average on the real spread less the nominal spread. The difference is that this is based on yield data sourced from Macquarie Bank[8].

This data tells a similar story to the data on the Electranet 2010 indexed bond examined immediately above. That is, the difference between the spread to CGS on real bonds and nominal bonds grows following the reduction in indexed CGS as a proportion of total CGS in 2004.

[8] These are the only historical data series available on Bloomberg that have yields for ***both*** of the Electranet nominal and indexed bonds. The above data represents all the available data from these time series (ie, data from the Macquarie Bank time series goes back to only to mid 2005)

Figure 2.8
Spread to CGS of Envestra Indexed 2011 versus Interpolated Envestra Nominal 2011
Data source: Macquarie Bank



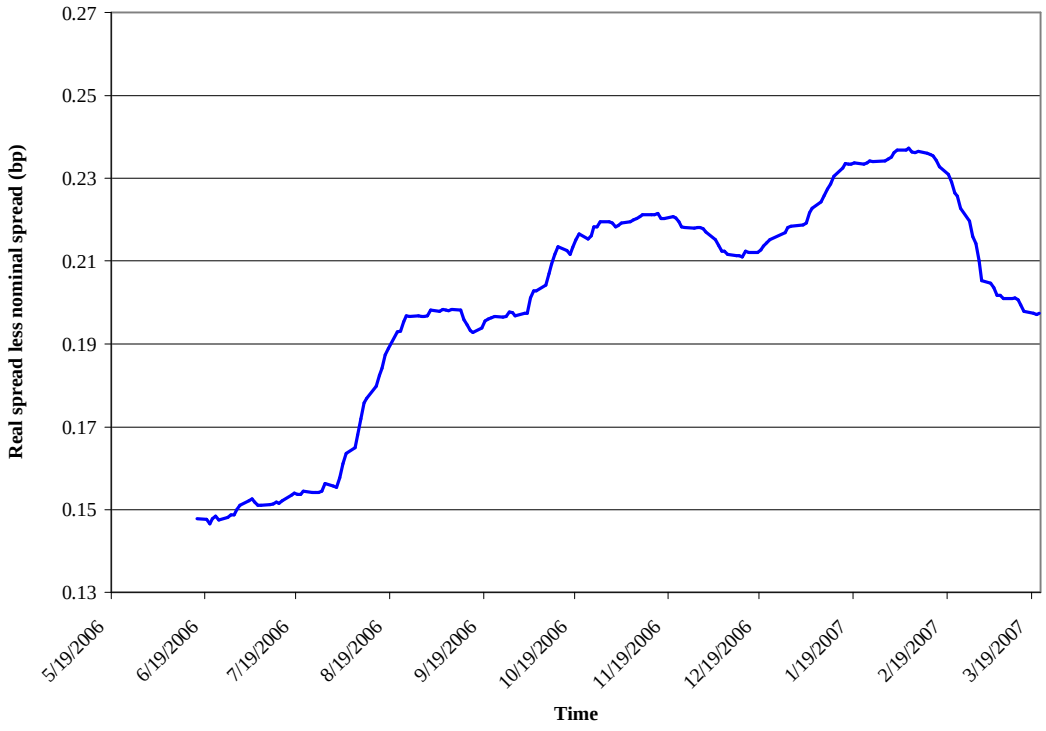
The above graph reports the difference in spreads on Envestra's indexed bond maturing on 20 May 2011 (4.255% coupon) with the spread on a hypothetical Envestra nominal bond maturing on 20 May 2011. The spread on the indexed corporate bond is measured relative to the linearly interpolated yield on indexed CGS (coupon 4%) - where interpolation occurs between the 20 August 2010 and 2015 indexed CGS yields. In order to estimate the yield on a hypothetical Envestra nominal bond of 20 May 2011 maturity we have linearly interpolated between the yields on Envestra's 21 February 2008 and 14 October 2015 nominal bonds (coupons 5.75% and 6.25% respectively)[9]. The spread on this hypothetical 20 May 2011 bond is then calculated relative to the yield on the nominal CGS maturing on 15 June 2011 (coupon 5.75%).[10]

[9] Only Macquarie Bank historical yield data was available for both Envestra real and nominal bonds.

[10] No interpolation of nominal CGS is used as the maturity dates of the nominal Envestra bond and the nominal CGS bond are less than 1 month apart.

This data illustrates that over time, the difference between the real spread and the nominal spread has grown. This confirms the results for the Electranet 2010 and 2015 indexed bonds discussed above.

Figure 2.9
Spread to CGS of Envestra Indexed 2025 versus Extrapolated Envestra Nominal 2025
Data source: Macquarie Bank



We have also attempted to perform a similar analysis for the Envestra indexed bond with 2025 maturity. The usefulness of this analysis is somewhat limited by the lack of pricing for other bonds (CGS and nominal Envestra bonds) with similar maturity. The latest-dated CGS bonds are 2020 (indexed) and 2019 (nominal) and the latest-dated Envestra bond with historical pricing on Bloomberg is 2015. Thus, in order to draw conclusions on 2025 yields we must extrapolate rather than interpolate - this reduces our confidence in the results generated.

Nevertheless, employing extrapolation techniques tends to confirm the earlier more robust analysis. The above figure, Figure 2.9, shows the difference in:

- Spread on Envestra's indexed bond maturing on 20 April 2025 (3.04% coupon) to a straight line extrapolation of indexed CGS yields[11]; and

- the spread on Envestra's 14 October 2015 nominal bond to the 15 April 2015 nominal CGS (both with a coupon of 6.25%).

The above graph is consistent in both trend and level with the results discussed previously.

2.5. Bias is not an 'inflation risk premium'

It is important to note that the bias in CGS examined here is a separate issue to any inflation risk premium. An inflation risk premium exists where investors require more than just expected inflation to compensate them for the exposure to inflation associated with nominally defined debt repayments.

We have shown that that the difference in yields between nominal and indexed corporate bonds is around 20bp higher than the difference in yields between nominal and indexed CGS. This can not be explained by an inflation risk premium as an 'inflation premium' must be explained by inflation and not by who issues the bond. Rather, the explanation must be that something other than the 'inflation premium' is driving indexed CGS yields lower (specifically a lack of supply relative to demand for indexed CGS).

An implication of our work is that there is something other than an inflation risk premium that currently explains the difference between indexed and nominal CGS. That does not mean to say that there is no inflation risk premium. Our work is not intended to shed any light on that issue one way or the other.

2.6. Summary of results

Table 2.3 below summarises the data and results used in the above graph as at 21 March 2007.

[11] The longest dated indexed CGS is 2020 maturity. A hypothetical 2025 maturity CGS is created by straight line extrapolation between the 2015 and 2020 maturity indexed CGS yields.

Table 2.3
Summary of Data and Results at 21 March 2007

	Inflation indexed			Nominal		
	Corporate	Govt		Corporate	Govt	Nearest Govt maturity
Electranet 20 August 2010	4.905	4%	**Electranet 17 Nov 2009**	6.50%	7.50%	15-Sep-09
Electranet 20 August 2015	5.205	4%	**Electranet 17 Nov 2009**	6.50%	7.50%	15-Sep-09
Envestra 20 May 2011	4.255	4%	**Envestra 21 Feb 2008**	5.75%	8.75%	15-Aug-08
Envestra 20 April 2025	3.04	4%	**Envestra 14 Oct 2015**	6.25%	6.25%	15-Apr-15

	Real yield	Matched TIB	Nominal Yield	Matched CGS	Real Premium	Nominal Premium	Relative Bias	Real and nominal maturity matched?
Electranet 2010								
ABN AMRO	3.94	3.145	6.793	6.195	0.79	0.60	0.19	Yes**
Mac bank	3.92	3.145	6.803	6.195	0.78	0.61	0.17	Yes**
Electranet 2015								
ABN AMRO	3.46	2.620	6.793	6.195	0.84	0.60	0.24	No
Mac bank	3.42	2.620	6.803	6.195	0.80	0.61	0.19	No
Envestra 2011								
Mac bank	3.89	3.039	6.645	6.010	0.85	0.64	0.21	Yes
Envestra 2025								
Mac bank*	3.28	2.322	6.453	5.713	0.95	0.74	0.21	Yes

* Debt premium on 2025 bond (calculated relative to extrapolated 2025 TIB) and debt premium on extrapolated 2025 Nominal Bond (calculated relative to extrapolated 2025 CGS).
** No interpolation but real perfectly matched and nominal only 2 mths out

As the above table indicates, indexed corporate bonds have a clearly higher spread to CGS than nominal corporate bonds. Based on the analysis of Electranet's 2010 and 2015 indexed bonds and Envestra's 2011 and 2025 indexed bonds, a bias in the range of 17-24 basis points is observable.

Conclusion: Bias in Indexed CGS relative to Nominal CGS

Based on market data, the spread between indexed corporate bonds and indexed CGS has risen relative to the spread between nominal corporate bonds and CGS.

This confirms the RBA's analysis that indexed CGS yields are depressed by supply and demand conditions peculiar to that bond. The bias began appearing in late 2004 and currently is around 20bp.

3. Regulatory precedent and implications

3.1. UK regulatory precedent

3.1.1. Central Bank Analysis

In the UK the supply of and yields on indexed linked government bonds (indexed linked 'gilts' (ILGs) - similar to indexed CGS in Australia) have also fallen dramatically. As in Australia, the UK central bank (the Bank of England (BoE)) has ascribed this fall, at least in part, to supply and demand conditions peculiar to the market for ILGs.

> ***"The Minimum Funding Requirement led to strong institutional demand for ILGs. The combination of strong and rather price-insensitive demand (largely from pension funds) with limited supply, has pushed real yields down, perhaps more than in the conventional gilt market. Consequently, real yields in the ILG market may not be a good guide to the real yields prevailing in the economy at large"***[12]

Importantly, the BoE has gone on to argue that nominal gilt yields are also depressed by a lack of supply - suggesting that the absolute bias in ILG yields is higher than the bias relative to nominal gilts.

> ***Long-dated gilt yields are currently well below the comparable German and US government bond yields for the first time in many years. This article considers what factors are likely to have contributed to these changes in nominal rates of return. We conclude that much of the decline in long gilt yields can be attributed to a decline in UK inflation expectations since the mid-1970s. However, we find evidence to suggest that gilt yields have more recently also fallen in response to a significant reduction in net gilt issuance combined with an increase in demand for gilts from UK institutional investors***.[13]

3.1.2. Regulatory Decisions

UK regulatory precedent is arguably of most relevance to Australia. Regulatory regimes in the countries are similar and the CAPM is the accepted theoretical framework for determining the regulatory cost of capital. The UK and Australia also share the experience of dramatically falling indexed government bond yields and central bank analysis suggesting that these yields are biased downward.

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12 ***BoE,*** 1999 ***Quarterly Bulletin,*** May.

13 BoE, 2000, ***A comparison of long bond yields in the United Kingdom, the United States, and Germany***

All UK economic regulators have headed the BoE's statements and universally set the real risk free rate in excess of the prevailing yields on ILGs. Ofcom, the UK telecommunications regulator, has stated:

> ***"the nominal rate for 5-year gilts has fallen over the last year and mechanistically applying a 3 month average of the most recent data would lead to a risk free rate of 4.5% or less. Such an estimate would, however, be low by historic standards, and Ofcom believes that some weight should be given to a longer-term perspective, suggesting that the use of a slightly higher risk free rate would be more appropriate."…***
>
> ***"Taking account of both current and recent historical evidence, Ofcom's view is that it is appropriate to use a value of 4.6% for the nominal risk free rate. This is somewhat higher than the current rate of about 4.2% to 4.3% (which are lower than historic averages), but consistent with a longer term averages and a real risk free rate of 2.0% and a rate of inflation of 2.5%."***[14] (Emphasis added.)

This decision involved an increase to the nominal (real) WACC of 30 to 40 bp (20 bp) above what it would otherwise have been had Ofcom simply adopted the mechanistic approach that has, to date, been used by Australian regulators.

Ofwat, the UK water regulator, has similarly argued that it would be inappropriate to fully reflect historically low interest rates in the regulatory cost of capital.

> ***"Real yields on medium maturity index-linked gilts (maturity of ten years and above) have averaged just under 2% over the last six months and just above 2% over the last five years. Consequently, the short-term data supports a risk-free rate of just 2.0%. Current gilt yields are significantly below the long-term average. Analysis of time series data confirms a shift from yields in the range of 3-4% to yields of just over 2% from late 1998. The average gilt yield is 2.5% if averaged over eight years; it is 3.0% if averaged over 13 years. Over the period since 1980, real returns have averaged 4.2%***
>
> ***…***
>
> ***"Our estimate for the risk-free rate is in the range 2.5% to 3%. It is based on the longer run level of yields on medium term index-linked gilts rather than the current rate which the evidence suggests is historically low. Since our draft determinations, real yields have declined further, albeit very marginally. We do not think this is sufficient to warrant a change in our approach and***

[14] Office of Communications, Ofcom's approach to risk in the assessment of the cost of capital, 23 June 2005, p 15.

to simply take account of the current market spot rate would not lead to a sustainable WACC over the medium term."[15]

This amounts to a 50bp to a 100bp increment to the then prevailing yield on ILGs. Ofwat has also stated:

"Recent regulatory determinations have placed little weight on the current very low gilt rates. The Competition Commission has also noted that current yields should be used with caution when estimating the risk-free rate due to the volatility of the markets. In its most recent decision the Competition Commission adopted a range of 2.5% to 2.75% compared with a range of 2.75% to 3.25% which it adopted in its decisions on the price limit referrals of Mid Kent and Sutton & East Surrey in 2000. The Smithers (2003) study undertaken on behalf of the regulators concludes that a reasonable assumption for the risk-free rate is 2.5%.

"In its March 2004 document on the price control for the distribution network operators Ofgem concluded that it could be appropriate to adopt a slightly wider range than the most recent Competition Commission decision using a range for the risk free rate of 2.25% to 3.0%.

Our estimate for the risk-free rate is in the range 2.5% to 3%. It is based on the longer run level of yields on medium term index-linked gilts rather than the current rate which the evidence suggests is historically low

We also note that the interest rate history described above is very similar to Australian experience. Ofwat was recently supported by the UK Government for this decision:

"At this Periodic Review, Ofwat has recommended that there is no strong case for setting the cost of capital for the industry as a whole any lower than it did in 1999, as set out in Setting water and sewerage price limits for 2005-10: Overview of companies' draft business plans. Although debt finance is currently available at historically low interest rates, Ofwat believes a cautious view towards current market data on the cost of debt is necessary."[16]

The Competition Commission (a UK appeals body) also added a premium to the estimate of the risk free rate[17] to reflect this concern.

"In the most recent (2003) inquiry into call termination charges, the Commission estimated a real risk free range of 2.50% - 2.75%, which represented an upward adjustment of 0.3% - 0.55% to the prevailing ILG yield of 2.2%."[18]

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15 Ofwat, Future water and sewerage charges 2005-10: Final determinations, Appendix 5, Cost of Capital.

16 http://www.publications.parliament.uk/pa/cm200304/cmselect/cmenvfru/420/42004.htm

17 This is, in effect, equivalent to adding an amount to the estimate of the equity premium to reflect the belief that it is higher when the risk free rate is lower.

Ofgem (the UK energy regulator) has similarly decided not to reflect the full reduction in the risk free rate in the cost of capital.

> ***"Also, it had been argued that yields on government bonds were at historically low levels. In setting the cost of capital modeling assumption for Initial Proposals, Ofgem therefore used a cost of debt figure above that implied by current market rates."***

In Ofgem's December 2006 Final Proposals for the [gas and electricity] Transmission Price Control Review it states:

> ***"In setting the cost of capital modeling assumption, we therefore used a cost of debt figure above that implied by current market levels. Our analysis of long term average spreads supports a debt premium within the range 1.0 to 1.5 per cent." (Page 53)***

Ofgem also sets the real risk free rate at 2.5%[19] on the advice of Smithers and Co (discussed below) despite this being more than 50bp higher than the yield on prevailing yield on ILGs.[20]

The UK adjustments can be summarised in the below table. They range from 30bp to 100bp with an average of around 50bp.

Table 3.1
UK regulatory precedent

UK Regulator	Adjustments to the risk free rate (bp)
Ofcom	+30 to +40
Ofwat	+50 to +100
Competition Commission	+30 to +55
Ofgem	+50

18 Competition Commission (2003) "Reports on references under Section 13 of the Telecommunications Act 1984 on the charges made by Vodafone, O2, Orange and T-Mobile for terminating calls from fixed and mobile networks"

19 See table on page 55 of Final Proposal.

20 See chart 8.2 on page 40 of Smithers and Co (2006)

3.1.3. U.K. Academic Advice to Regulators

The above decisions are also consistent with academic advice sought by regulators. UK regulators have jointly sought the advice of academic experts on contentious cost of capital issues. In 2003 the economic regulators[21] in the UK commissioned a report from professors Mason and Miles and Dr Wright provided under the banner of Smithers and Co.[22] In 2006 Ofgem commissioned an update of this report from Smithers and Co.[23][24]

In those reports the authors describe the problem's associated with measurement of the of the risk free rate. In their 2003 report, Smithers and Co counseled against simply adopting the prevailing ILG yield as the appropriate measure of the risk free rate:

> ***"However, information from indexed bonds should be treated with some caution." (Page 42)***

Smithers and Co argue that variations in the observed government bond yield should not be mechanistically passed through into higher or lower equity returns. In effect, they advise that when the government bond rate is historically low the market risk premium (measured relative to that bond rate) is likely to be historically high. The end result is that movements in the government bond rates should not be mechanistically reflected in the cost of equity by calculating the required return on the market as the sum of the government bond rate and a constant equity risk-premium.

> ***"A commonly used estimate of the equilibrium short-term rate (based on a sample of data from around 1980) is of the order of 2 ½ %. Using this figure, the implied equity risk premium is of the order of 3 percentage points (geometric) and 4-5 percentage points (arithmetic). Given our preferred strategy of fixing on an estimate of the equity return, any higher (or lower) desired figure for the safe rate would be precisely offset by a lower (or higher) equity premium, thus leaving the central estimate of the cost of equity capital unaffected." (Page 49)***

An important implication of this conclusion is that the currently historically low yields on indexed CGS should not be fully passed through in historically low regulated returns on equity.

In their 2006 advice Smithers and Co are more definitive on the bias in prevailing ILG yields.

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21 Office of Fair Trading, The Civil Aviation Authority (CAA), Office of Water Services (OFWAT), Office of Gas and Electricity Markets (Ofgem), Office of Telecommunications (Oftel), Office of the Rail Regulator (ORR) and Office for the Regulation of Electricity and Gas (OFREG).

22 A Study into Certain Aspects of the Cost of Capital for Regulated Utilities in the U.K, Smithers and Co 2003.

23 Report on the Cost of Capital, Smithers and Co 2006 (professors Mason, Miles, Satchell, Hori and Baskaya)

24 This time from professors Mason and Miles plus professors Satchell, Hori and Baskaya

> ***"Recent yields on UK indexed bonds give a distorted impression of real yields. Regulated companies still predominantly issue nominal bonds. Thus, given the evidence of bias in indexed yields, risk-free government nominal bonds should be used to provide a benchmark estimate of the term premium." (Page 37)***

Smithers and Co proposed that nominal bond yields less a forecast of inflation based on the BoE target inflation range be adopted.

> ***"If the term premium is indeed close to zero, the best current market-based estimate of the forward-looking real interest rate is the nominal yield on medium-dated bonds, less the Bank of England's inflation target of 2%: thus a figure of around 2 to 2 ½%…." (Page 37)***

Smithers and Co eschew forecasts of inflation based on differences in yields between ILGs and nominal gilts on the basis that ILG yields are biased downwards.

> ***"The recent path of the implicit inflation forecasts lends some support to the widely held suspicion that indexed yields are providing an unduly depressed picture of forward-looking real returns (the usual explanation being the funding requirements on major pension funds). In 2003 the Bank of England's inflation target was officially lowered from 2 ½% to 2%, yet in the period since this change implicit inflation forecasts have risen rather than fallen, to a figure closer to 3%. The most likely explanation is that the gap between nominal and real yields is not purely a forecast of inflation, but also contains a risk premium element (or, put another way, that indexed bonds have traded at an increasing risk*** *discount****). Since regulated companies issue barely any indexed debt this suggests that using indexed yields as a benchmark in setting the cost of capital may tend to bias the cost of debt downwards, and that it would be more appropriate to focus on nominal yields, and their associated term premia." (Page 39)***

The latter finding is particularly relevant in the current Australian circumstances. As we have already shown, the relatively more inversely sloped indexed CGS yield curve implies that either long term inflation is expected to accelerate well outside the RBA's target range or indexed CGS yields are biased down relative to nominal CGS yields.

3.2. U.S. regulatory precedent

In the US it is standard regulatory practice to set the required return on equity by reference to the dividend growth model. This requires regulators to estimate the total CAPM required return on equity directly rather than attempting to estimate its component parts (ie, risk free rate, beta and market risk premium). This is done by estimating the market's best estimate of future dividends and calculating the discount rate (being the return on equity) that equalises this with current equity prices.

The fact that the dividend growth model jointly estimates the equity premium and the risk free rate means that changes in government bonds yields due to changes in supply and demand conditions peculiar to that market have no effect on the cost of capital ***per se***. This

can be illustrated by reference to the following table that lists all US regulatory decisions for energy distributors between January 2003 and September 2005. A casual examination of the final column reveals that the highest equity premiums (measured relative to the government bond yield) tend to occur in decisions that have the lowest interest rates.

Table 3.2
US Regulatory Authorised Equity Returns

Date	Company (State)	ROE %	Government bond yield	Equity premium
31/01/2003	South Carolina Electric & Gas (SC)	12.45	4.00	8.45
28/02/2003	Madison Gas and Electric (WI) - G	12.30	3.71	8.59
6/03/2003	PacifiCorp (WY)	10.75	3.67	7.08
7/03/2003	Rochester Gas & Electric (NY)	9.96	3.63	6.33
3/04/2003	Wisconsin Power and Light (WI) - G	12.00	3.93	8.07
15/04/2003	Interstate Power & Light (IA) - U	11.15	3.98	7.17
25/06/2003	Aquila (CO)	10.75	3.38	7.37
26/06/2003	Public Service of Colorado	10.75	3.55	7.2
9/07/2003	Public Service Electric & Gas (NJ)	9.75	3.73	6.02
16/07/2003	Rockland Electric (NJ)	9.75	3.97	5.78
1/08/2003	Jersey Central Power & Light (NJ)	9.50	4.44	5.06
26/08/2003	PacifiCorp (OR)	10.50	4.50	6
3/09/2003	Maine Public Service (ME)	10.25	4.60	5.65
17/12/2003	Connecticut Light & Power (CT)	9.85	4.19	5.66
17/12/2003	PacifiCorp (UT)	10.70	4.19	6.51
18/12/2003	Montana-Dakota Utilities (ND)	11.50	4.16	7.34
19/12/2003	Wisconsin Power and Light (WI) - G	12.00	4.15	7.85
19/12/2003	Wisconsin Public Service (WI) - G	12.00	4.15	7.85
13/01/2004	Madison Gas and Electric (WI) - G	12.00	4.05	7.95
2/03/2004	PacifiCorp (WY)	10.75	4.05	6.7
26/03/2004	Nevada Power (NV)	10.25	3.85	6.4
5/04/2004	Interstate Power & Light (MN)	11.00	4.24	6.76
18/05/2004	PSI Energy (IN)	10.50	4.74	5.76
25/05/2004	Idaho Power (ID)	10.25	4.73	5.52
27/05/2004	Sierra Pacific Power (NV)	10.25	4.60	5.65
30/06/2004	Kentucky Utilities (KY) - G	10.50	4.62	5.88
30/06/2004	Louisville Gas and Electric (KY) - G	10.50	4.62	5.88
25/08/2004	Aquila (CO)	10.25	4.26	5.99
9/09/2004	Avista Corp. (ID)	10.40	4.22	6.18
9/11/2004	Narragansett Electric (RI) - E	10.50	4.22	6.28
23/11/2004	Detroit Edison (MI)	11.00	4.19	6.81
14/12/2004	Interstate Power & Light (IA)	10.97	4.14	6.83

Date	Company (State)	ROE %	Government bond yield	Equity premium
21/12/2004	Wisconsin Public Service (WI) - G	11.50	4.18	7.32
22/12/2004	PPL-Electric Utilities (PA)	10.70	4.21	6.49
22/12/2004	Madison Gas and Electric (WI) - G	11.50	4.21	7.29
6/01/2005	South Carolina Electric & Gas (SC)	10.70	4.29	6.41
28/01/2005	Aquila Networks-WPK (KS)	10.50	4.16	6.34
18/02/2005	Puget Sound Energy (WA)	10.30	4.27	6.03
25/02/2005	PacifiCorp (UT)	10.50	4.27	6.23
10/03/2005	Empire District Electric (MO)	11.00	4.48	6.52
20/03/2003	Wisconsin Public Service (WI) -G	12.00	4.01	7.99
24/03/2005	Consolidated Edison of New York (NY)	10.30	4.60	5.7
29/03/2005	Central Vermont Public Service (VT)	10.00	4.60	5.4
31/03/2005	Texas-New Mexico Power (TX)	10.25	4.50	5.75
7/04/2005	Arizona Public Service (AZ)	10.25	4.49	5.76
18/05/2005	Entergy Louisiana (LA)	10.25	4.07	6.18
25/05/2005	Jersey Central Power & Light (NJ)	9.75	4.08	5.67
26/05/2005	Atlantic City Electric (NJ)	9.75	4.08	5.67
19/07/2005	Wisconsin Power and Light (WI)-G	11.50	4.20	7.3
5/08/2005	Cap Rock Energy (TX) - Hy	11.75	4.40	7.35
15/08/2005	AEP Texas Central (TX)	10.13	4.27	5.86
28/09/2005	PacifiCorp (OR)	10.00	4.26	5.74

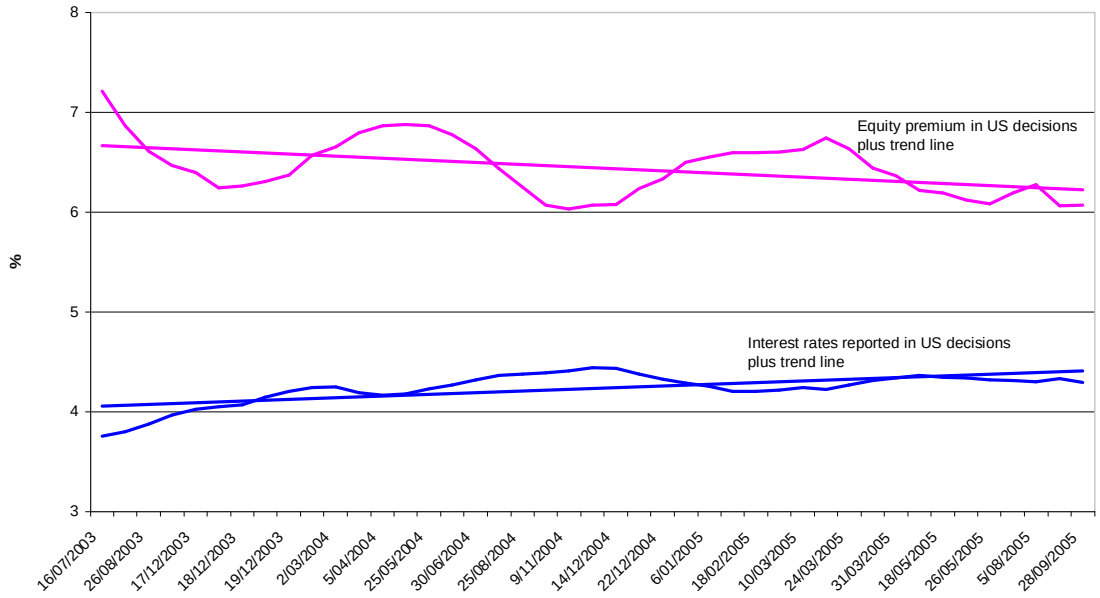
† The data is a combination of the rates of return contained in two reports from Regulatory Research Associates, Inc. ie, 14 January 2005, ***Major Rate Case Decisions – January 2003 – December 2004 Supplemental Study*** and 4 October 2005, Major Rate Decisions – January – September 2005.

‡ The Federal Reserve Board, ***Statistics: Releases and Historical Data*** h15 Daily yields on ten year Treasury securities.

The casual observation referred to previously is confirmed in the following graph which plots the moving average (based on the ten most recent regulatory decisions) of government bond yields and equity premium in US regulatory decisions. This clearly shows that US regulators have responded to an upward trend in US government bond yields by allowing an almost identical inverse trend in equity premium.

Figure 3.1

Relationship between Equity Premium and Interest Rates in US Energy Decisions (2003 to 2005)



It is important to note that the above inverse relationship in US regulatory decisions is not a statistical artefact but is the result of deliberate and explicit policy decisions on behalf of US regulators. In the words of the Californian regulator, which is responsible for regulated assets in excess of the value of Australian regulated assets:

> "***We consistently consider the current estimate and anomalous behavior of interest rates when making a final decision on authorizing a fair ROE. In PG&E's 1997 cost of capital proceeding we stated "Our consistent practice has been to moderate changes in ROE relative to changes in interest rates in order to increase the stability of ROE over time"***
>
> ***"…consistent with the Commission's practice of adjusting ROE's by one half to two-thirds of the change in the benchmark interest rate."***[25]

3.3. Australian regulatory precedent

The most relevant Australian regulatory precedent in this regard comes from the Victorian ESC's most recent electricity decision (EDPR 2006-2010). In that decision the ESC accepted that the yields on indexed CGS can be a biased estimator of the true risk free rate. It accepted that its original sampling period (the last 20 trading days in August 2005) may have been affected by a 'one off event', namely, the maturity of Treasury Indexed Bond (TIB)

[25] Californian PUC, Decision 00-12-062 December 21, 2000, ROE for Sierra pacific Power Company.

402 on August 20, 2005 - which reduced the number of indexed CGS issues in the market from four to three.

> ***"In order to address the downward bias the Commission considers that it is appropriate to make an adjustment to the real risk-free rate. Subsequently, the issue to be addressed is to determine the most appropriate approach to adjust for the bias."*** (Page 343 of Final Decision EDPR 2006-2010.)

The ESC rejected a proposed correction to this bias associated with the use of an econometric model developed by the Commonwealth Bank of Australia. Instead, it proposed to adopt a sampling period that was one month earlier and therefore excluded the 'one off event'.

In making this decision the ESC has accepted that a reduction in the supply of indexed CGS led to a reduction in yields on these securities - a reduction that does not reflect a reduction in the true real risk free rate. The reason this is important can be seen by noting that the reduction in the maturity of TIB 402 is just one of many maturities that has led to a reduction in the supply of indexed and nominal CGS.

Figure 3.2
Recent Declines in CGS on Issue

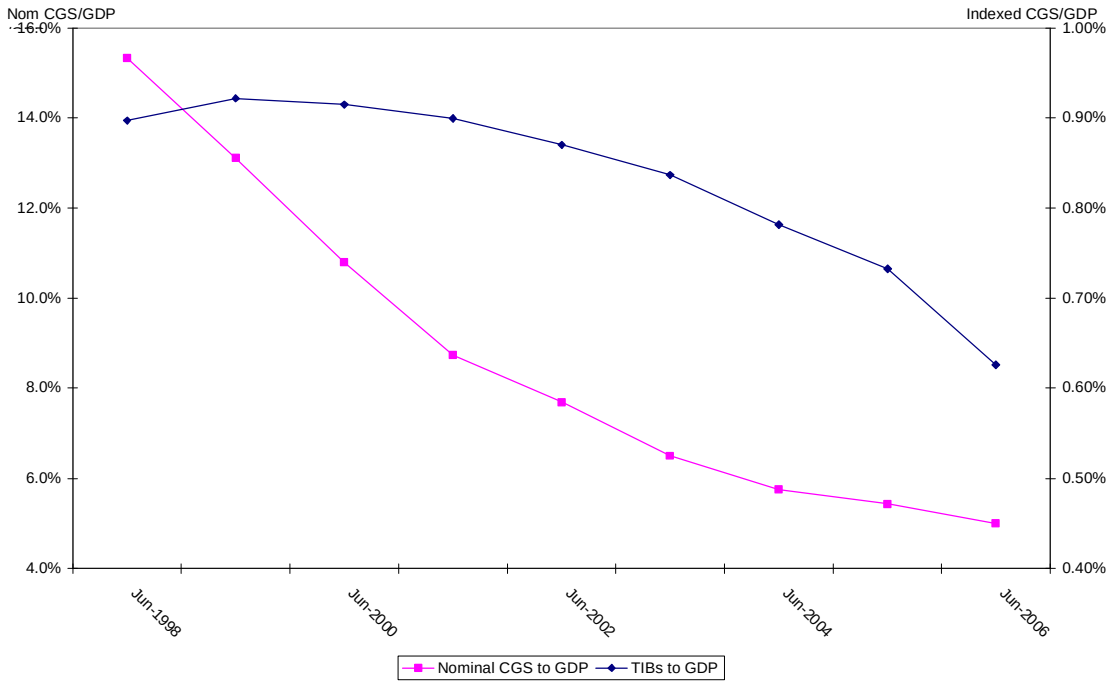


Figure 3.2 above illustrates that the supply of both nominal and indexed CGS has fallen dramatically over the last ten years. The maturity of Treasury Indexed bond (TIB) 402 is just one of a long line of reductions in supply. If the removal of TIB 402 had an impact on yields then one might expect other reductions in supply have had similar impacts. Indeed, this is

precisely what central banks (discussed above) and finance academics (discussed below) believe.

In order to conclude that the fall in supply of CGS has had no impact on CGS yields then the ESC would either need to conclude that it was wrong in its electricity determination or that falling supply only has a 'temporary' impact on CGS markets - with the yield on CGS returning to the CAPM risk free rate after a short delay.

3.4. Conclusion

Conclusion: Regulatory precedent

UK regulatory precedent is of particular relevance for Australia given the similar reductions in yield on indexed government bonds and central bank commentary.

UK regulatory precedent unanimously involves adjustments to the risk free rate of between 30bp and 50bp with an average of around 50bp.

Regulatory precedent in the US is similar. US regulators do not reflect historically low government bond yields in historically low equity returns.

Prior ESC precedent also supports making an adjustment to the observed yield on government bonds.

4. Review of the Relevant Finance Literature

There is a large body of academic empirical work which argues that the CAPM zero-beta rate, the CAPM risk-free rate, is generally materially above the yield on government securities. The great majority of empirical research has come to the conclusion that rates on nominal government bonds are downward biased measures of the benchmark nominal risk-free rate used by participants in capital markets. Government securities have unique characteristics that cause investors to be willing to hold them even though they offer yields below the rates available on other default-free instruments. These unique characteristics include:

1. the high liquidity of Treasury securities relative to other securities;

2. the preference of foreign and domestic government authorities for investing in Treasury securities in preference to non-government securities;

3. the acceptance of treasuries as collateral for stock loans and as margin "good-faith money" for positions in futures markets; and

4. their surety and simplicity that makes them a preferred habitat for less sophisticated investors.

These unique characteristics imply that government bonds are, to some extent, in a separate market to other assets - with their prices affected by supply and demand conditions peculiar to that market. The overwhelming conclusion of academic studies is that only a small amount of the spread of corporate rates to government bond rates is explained by default risk with the remainder reflecting a price premium investors are willing to pay for the unique characteristic of government bonds. An implication of this premium's existence is that the yield on government bonds overestimates the true risk free rate. Quantifying this bias, based on current market evidence in Australia, is addressed elsewhere in this report.

The RBA's statements (reproduced in section 2) rely on precisely this analysis. Increased foreign demand for CGS would not depress the discount rate underlying all investment decisions (ie, the CAPM risk free rate). If increased foreign demand for CGS did depress the discount rate underlying all investment decisions then the fall in CGS yields would not cause spreads to corporate bonds to rise: a fall in the CGS rate would cause an identical fall in corporate bond yields (other things constant). The RBA has expressed precisely the opposite view in the context of analysing the true default premium embedded in corporate debt. In its March 2004 Financial Stability Review the RBA expressed the view that spreads between corporate debt and nominal CGS overestimated default risk due to downward bias in nominal CGS yields.

> *"**Premia for credit default swaps (CDS), which measure the cost of insurance against a specific company defaulting, have fallen sharply in the past year and spreads between corporate bond and swap rates have also fallen (Graph 21). In contrast, interest rate spreads between corporate bonds and Commonwealth Government securities (CGS) have risen over the past six months, although this appears to reflect strong demand for CGS, particularly from overseas investors, rather than a judgment about credit quality in the Australian corporate sector**." **(Page 15)***

Most strikingly, other things were not equal in the period analysed by the RBA. In that period credit risk premia attached to corporate bonds, as measured by CDS premia, were falling. Despite this, spreads to CGS were rising. These facts are inconsistent with the yield on CGS representing the CAPM risk free rate. The RBA's commentary only makes sense if one accepts that yields on CGS are equal to the risk free rate less a 'uniqueness' premium determined by supply and demand conditions peculiar to the CGS market.

4.1. Credit spreads on corporate bonds are wider than is implied by default risk

One part of the literature examines credit spreads on corporate debt (i.e., the difference between the yields on corporate bonds and the yields on Treasury bonds). Collin-Dufresne, Goldstein and Martin (2001) and Huang and Huang (2003) recognize that if there is, say, a 1% chance of default on a particular corporate bond in any year and a 50% recovery rate in the event of default (meaning that the bondholders will eventually recover one half of what they are owed) then that corporate bond would have to offer at least ½% more than an equivalent maturity Treasury bond.[26] The research concludes that credit spreads are simply too high to be explained by the likelihood of default and the risk premium associated with default. The researchers conclude that a major part of observed credit spreads, and almost all the spread on high grade AAA bonds, is actually due to unique characteristics of Treasury bonds that make them particularly appealing investment vehicles and cause them to offer yields below the rate on a "benchmark risk-free security" where a "benchmark risk-free security" is a risk-free security without the characteristics unique to government bonds. The rate on a benchmark risk-free security is the CAPM zero beta risk-free rate.

Collin-Dufresne, Goldstein and Martin (2001) conclude that "[v]ariables that should in theory determine credit spread changes have rather limited explanatory power. … Our results suggest that monthly credit spread changes are … independent of both credit-risk factors and standard proxies for liquidity." Huang and Huang (2003) consider the complete set of structural models used to analyze corporate bond yields and conclude that "for investment grade bonds (those with a credit rating not lower than [BBB]) of all maturities,

[26] The research also recognizes that because default is more likely to occur in recessions and hence an investor in a corporate bond is actually purchasing a positive beta asset, the corporate bond would have to offer not only ½% more but an additional premium to compensate the holders for the beta risk they bear.

credit risk accounts for only a small fraction—typically around 20%, and, for [BBB]-rated bonds, in the 30% range—of the observed corporate-Treasury yield spreads, and it accounts for a smaller fraction of the observed spreads for bonds of shorter maturities."

4.2. Swaps rates imply that the CAPM zero beta rate (ie, the reference risk-free rate) exceeds the rate on Treasury securities

The 10-year swap rate is defined as the fixed rate on a 10-year fixed for floating swap, where the floating component is the rate on AA bonds and is similar to the rate on a AA-rated fixed rate bond. It is not the same because a AA-rated bond might suffer a downgrade over a 10-year period, while the fixed component of the swap has less credit risk. The fixed component of the swap reflects the credit risk inherent in a bond that is rated AA throughout its entire life. Duffie and Singleton (1997) show how to price the credit risk inherent in the fixed rate component and conclude that the spread between the swap rate and the Treasury rate has a significant non-default component. Liu, Longstaff and Mandell (2006) and Feldhütter and Lando (2006) have subsequently reached the same conclusion. Feldhütter and Lando (2006) conclude that "A convenience yield from holding Treasuries …. is by far the largest component of spreads" between swap rates and Treasury rates. These papers conclude that the reference risk-free rate used in capital markets when pricing swaps is only around 10 basis points below the rate on similar maturity AAA bonds; i.e., the CAPM zero beta rate exceeds the rate on CGS securities.

4.3. Credit default swap spreads imply that the reference risk-free rate exceeds the rate on Treasury securities

Perhaps the cleanest measure of the rate on a benchmark risk-free interest that lacks the unique characteristics of Treasury securities is provided by considering a portfolio of a corporate bond and an insurance policy that guarantees that in the event of the corporate bond's default the policy will pay off in full. Such insurance policies are termed credit default swap (CDS) agreements and the insurance premium is paid annually. The insurance premium is referred to as the CDS spread. A five-year contract on ***XYZ Corp*** with a principal of $10 million and an annual insurance premium of $30,000 (30 basis points) would give the buyer of the insurance the right to sell bonds with a face value of $10 million issued by ***XYZ Corp*** in the event of a default by ***XYZ Corp***. If ***XYZ Corp***'s bonds offer a yield of 8.0%, the buyer of ***XYZ Corp*** bonds who enters a CDS agreement can earn a riskless rate of return of 7.7% (= 8.0% ─ 0.3%) per annum.

Grinblatt (2001) and Hull, Predescu and White (2004) are careful to recognize two features of a CDS agreement: (1) a CDS agreement only insures the principal and not the accrued interest on a bond and (2) counterparty risk. Counterparty risk is the low risk that not only does ***XYZ Corp*** default, the seller of the insurance policy also defaults. Taking both these features into account these authors conclude that the benchmark risk-free rate on a default-free security that lacks the unique features of Treasury securities was on average about 10

basis points lower than the swap rate over the period January 1998 to May 2002. (The 'swap rate' was explained in the preceding section.)

Blanco, Brennan, and Marsh (The Journal of Finance, 2005) examine the efficiency of the CDS market in pricing credit risk. They find that CDS prices lead spreads to swaps in the price discovery process and that there is parity between CDS and spreads to swaps in equilibrium. Importantly, in the context of our report, they note that:

> ***"…it is well known that government bonds are no longer an ideal proxy for the unobservable risk free rate"***[27]

Nonetheless they test this empirically in their sample and find:

> ***"We compute credit spreads using swap rates rather than government bonds as the proxy for the default-free interest rates in our subsequent analysis"***[28]

It is likely that the current CDS rate reflects particularly low probabilities of default given strong growth and growth prospects for the Australian economy. This is consistent with the RBA reporting a CDS rate on AA bonds of 20bp in 2003 (the first year it began reporting this rate) - despite a healthy economy in 2003. It seems reasonable to assume that average historical CDS rates prior to 2003, had they existed, would have been materially larger. It also appears likely that the low probabilities of default on corporate bonds today are not fully reflected in low spreads to CGS due to an increased downward bias in CGS yields (reflecting the historically low supply of Treasury securities).

4.4. The empirical analysis of Krishnamurthy and Vissing-Jorgensen

One pertinent recent study by Krishnamurthy and Vissing-Jorgenson (KV) has shown that the spread from corporate to government bonds in the US (Treasuries) is strongly inversely related to the level of supply of government bonds. The lower the supply of Treasuries (measured as a percentage of GDP) the higher the spread - as per the below figure from that study.

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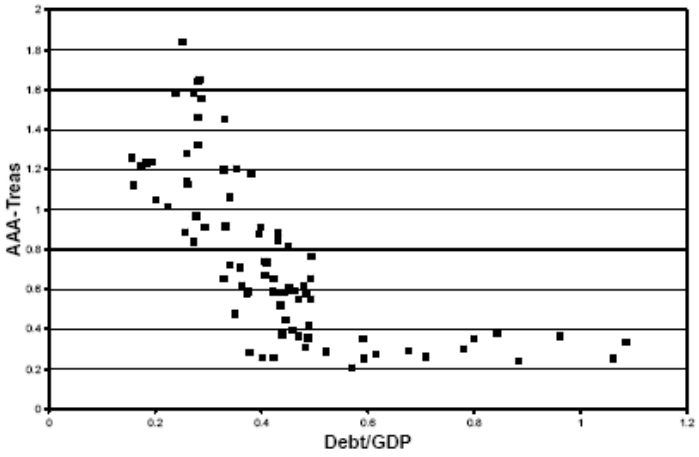
[27] Blanco, Brennan, and Marsh, ***An Empirical Analysis of the Dynamic Relation between Investment-Grade Bonds and Credit Default Swaps*** The Journal Of Finance Vol. LX, no. 5 October 2005, p2261.

[28] Ibid, ***p2265.***

Figure 4.1
Figure 1 from KV Study

Figure 1: Corporate Bond Spread and Government Debt



The corporate bond spread (y-axis) is graphed versus the $Debt/GDP$ ratio (x-axis) based on annual observations from 1925 to 2005. The bond spread is the difference between the percentage yield on Moody's AAA long maturity bond index and the percentage yield on long maturity Treasury bonds.

The author's conclusion is that this inverse relationship is explained by the fact that when supply of Treasuries is low their prices are bid up and their yields depressed. However, the reference risk free rate remains unchanged so the yield on nominal corporate bonds is unaffected and, consequently, the spread on corporate bonds increases. When supply of Treasuries is sufficiently high the price 'premium' on government bonds falls to close to zero and the spread on corporate bonds asymptotes to something close to the true default risk premium. KV perform numerous statistical tests for this relationship including controlling for variations in credit risk[29] over time. In all of there regressions the supply of Treasuries (as a percentage of GDP) is a statistically significant determinant of the corporate spread to Treasuries. One of their conclusions is that:

> ***"We have argued that the observed Treasury rate is … lower than the "true" riskless interest rate … implied by the standard discrete-time C-CAPM model."***

[29] Using the spread between AAA and BBB bonds as a proxy for credit risk.

4.5. The empirical work of Lettau and Ludvigson

Empirical work suggests that the MRP ***measured relative to the government bond rate*** is inversely related to the government bond rate. In 2001, in one of the most cited finance papers in recent times, Lettau and Ludvigson empirically tested for the determinants of variations in the prevailing MRP measured relative to government bond yields.[30] Amongst other findings, they found a strongly statistically significant inverse relationship between the change in US Treasury yields and the change in the observed MRP ***relative to Treasury yields***. That is, Lettau and Ludvigson found that when Treasury yields fell the MRP ***relative to Treasury yields*** tended to rise - leaving the overall return on equity to change by less than the underlying change in interest rates.

Such an inverse relationship held true without controlling for other potential variables that might effect the MRP (ie, a simple correlation suggested that the MRP rose 0.3% for every 1% reduction in the risk free rate). However, when Lettau and Ludvigson included controls for other variables[31] the inverse relationship between the risk free rate and the MRP strengthened. In fact, Lettau and Ludvigson found that when the risk free rate fell the MRP tended to rise by the same amount as the fall in the risk free rate and vice versa. That is, a 1% reduction/increase in the risk free rate tended to be associated with a 1% increase/reduction in the MRP (measured relative to Treasury yields)

This empirical finding is entirely consistent with a model where the reference CAPM risk free rate is constant but the government bond rate is not. When we observe a change in the government bond rate the reason we see an offsetting change in the equity premium ***relative to the government bond rate*** may be that the expected return on equity is unchanged and the reference risk free rate is unchanged. All that has happened in that our risk free rate proxy (the government bond rate) has changed.

It is worth noting that, even if one rejects the above explanation of Lettau and Ludvigson's result, one should still not reflect lower bond rates in lower returns on equity. Lettau and Ludvigson find that the return on equity is largely independent of the government bond rate. This might be because:

- The government bond rate is not the reference risk free rate; or
- The government bond rate is the true risk free rate but the true MRP is inversely related to the government bond rate.

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[30] Lettau, Martin and Sydney Ludvigson, 2001, "Consumption, Aggregate Wealth and Expected Stock Returns," ***Journal of Finance*** 56 (3), pp. 815—849.

[31] Specifically, changes in dividend yields; changes in dividend payout ratios; changes in the shape of the term structure of interest rates; and changes in the default spread on corporate bonds.

Whichever explanation holds, it would still be wrong to reflect historically low government bond rates in equally low allowed returns on equity.

Conclusion: Academic literature

It is well entrenched in the finance literature that government bonds yields are not perfect proxies for the CAPM risk free rate.

The literature identifies that government bonds have unique characteristics above and beyond their risk free characteristics. The market places a positive value on these characteristics leading to a 'uniqueness premium' - causing government bonds to be downward biased estimates of the CAPM risk free rate.

The empirical evidence strongly suggests that the uniqueness premium is inversely related to the supply of Government bonds.

Consistent with this, the empirical evidence also suggests that equity returns are not positively correlated with movements in government bond rates. (The other explanation for this is that the MRP is inversely related to government bond yields. Either way, it would be inconsistent with this literature to fully reflect historically low government bond yields in the CAPM risk free rate.)

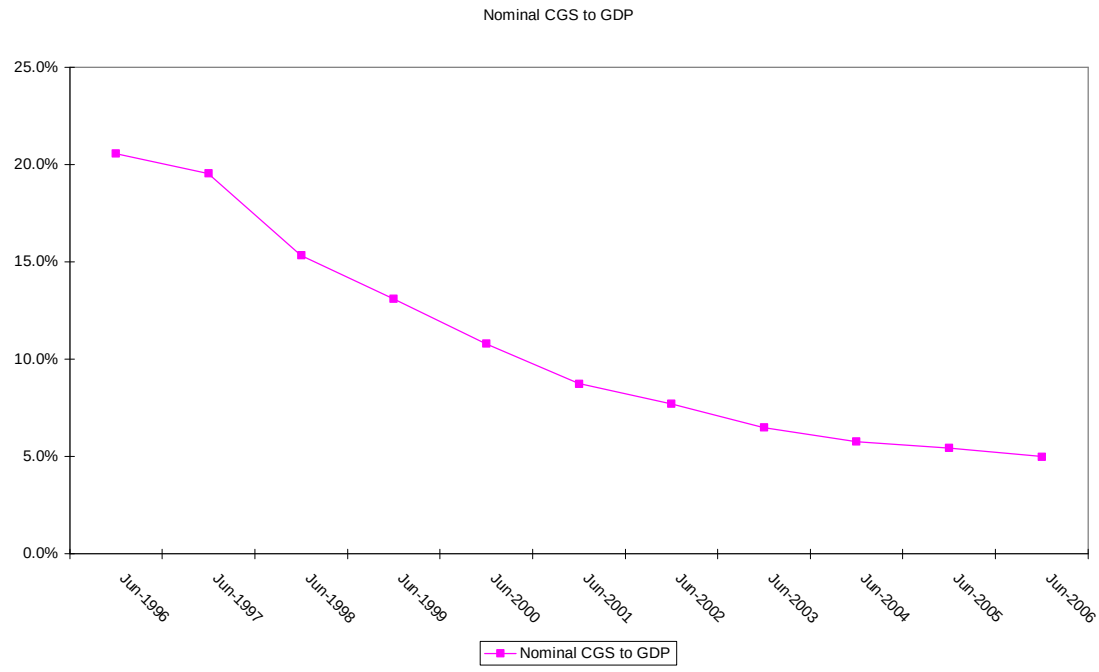
5. Absolute Bias in (Nominal) CGS Bonds

In section 2 we set out to test and quantify the RBA's belief that indexed CGS yields are downward biased ***relative*** to the yield on nominal CGS. We estimated this relative bias to be around 20bp. However, if nominal CGS yields are also biased down by a lack of supply then the absolute bias on indexed CGS bonds will be more than 20bp.

5.1. Shortage of supply relative to demand depressing nominal CGS Yields

Indeed, the reduction in the supply of indexed CGS relative to nominal CGS has been much smaller than the absolute reduction in supply of total CGS (nominal and indexed). The fall in the supply of nominal CGS over the last decade is illustrated in figure 4.1 below.

Figure 5.1
Indexed and Nominal CGS as a % of GDP



Since reaching a local peak in 1996 the supply of nominal CGS has fallen from 20.6% of GDP to only 5% in 2006. This leaves nominal CGS at historically low levels of supply (half its previous (short lived) low of 11.7% in 1991). To the extent that demand for CGS has grown in line with the level of economic activity then, other things equal, one might expect this to result in a premium being paid for a nominal CGS security (and its yield being artificially depressed as a result).

As described in the previous section, the RBA has expressed precisely this view in the relation to the ***relative*** level of indexed and nominal CGS yields. In its March 2004 Financial Stability Review the RBA ***also*** expressed the view that spreads between nominal corporate debt and nominal CGS overestimated default risk due to downward bias in nominal CGS yields.

> "***Premia for credit default swaps (CDS), which measure the cost of insurance against a specific company defaulting, have fallen sharply in the past year and spreads between corporate bond and swap rates have also fallen (Graph 21). In contrast, interest rate spreads between corporate bonds and Commonwealth Government securities (CGS) have risen over the past six months, although this appears to reflect strong demand for CGS, particularly from overseas investors, rather than a judgment about credit quality in the Australian corporate sector***."[32]

Since that time the RBA appears to have completely disregarded spreads to CGS as an indicator of credit risk. In its place, the RBA has focused primarily on the CDS premium and secondarily on the spread to the BBSW.[33] For example, since March 2004 the RBA has produced the Financial Stability Review report biannually. In each issue of that report the CDS and the spread to BBSW have been the sole indicators of the price of credit default risk. The only mention of spread to CGS has been to discount its usefulness due to yields on CGS being depressed by a shortage of supply relative to demand.

The RBA's position is supported by empirical evidence from the US. The study by Krishnamurthy and Vissing-Jorgenson (KV) discussed in section 4 is particularly pertinent. As discussed above, KV shows that the spread from corporate to government bonds in the US (Treasuries) is strongly inversely related to the level of supply of government bonds. The lower the supply of Treasuries (measured as a percentage of GDP) the higher the spread - as per the below figure from that study.

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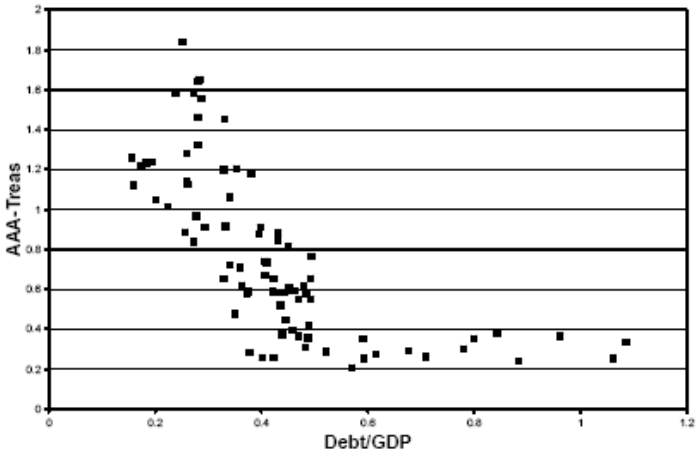
[32] Page 15.

[33] Bank bill swap rate.

Figure 5.2
Figure 1 from KV Study

Figure 1: Corporate Bond Spread and Government Debt



The corporate bond spread (y-axis) is graphed versus the $Debt/GDP$ ratio (x-axis) based on annual observations from 1925 to 2005. The bond spread is the difference between the percentage yield on Moody's AAA long maturity bond index and the percentage yield on long maturity Treasury bonds.

The author's conclusion is that this inverse relationship is explained by the fact that when supply of Treasuries is low their prices are bid up and their yields depressed. However, the reference risk free rate remains unchanged so the yield on nominal corporate bonds is unaffected and, consequently, the spread on corporate bonds increases. When the supply of Treasuries is sufficiently high (around 60% of GDP in the above graph) the 'premium' on government bonds falls to zero and the spread on corporate bonds asymptotes to the true default risk premium (between 20 and 40bp in the above graph).

5.2. Bias in nominal CGS appears to be at historic highs

Given that the supply of nominal CGS is at historically low levels then it is reasonable to expect that the 'uniqueness' premium paid for CGS may be at historically high levels (ie, the bias in CGS yields as a proxy for the CAPM risk-free rate is at historically high levels). This is precisely what the financial market data extracted from the RBA Bulletin suggest.

In the last ten to five years the market in credit insurance for corporate bonds has matured. Credit default swaps (CDSs) are essentially an insurance policy to protect against the risk that a bond's issuer will suffer credit default event (including a downgrade to its credit

status). In November 2006 the Financial Times described the growth in the CDS market as 'exponential'.

> ***"The credit derivatives market has experienced a period of exponential growth over the last few years. Since their appearance in Europe around 10 years ago, credit default swaps have won wide acceptance from many quarters – banks, asset managers, insurance companies, hedge funds and pension funds. The attraction lies in their liquidity, flexibility, and diversity, qualities in which they outstrip the physical corporate bond market. Nevertheless, CDS are derivatives, and derivatives still make many investors nervous – and with some justification.***
>
> ***"The British Bankers' Association in a survey in September this year estimated the total volume of global credit derivatives at $20,000bn (€15,639bn). This is more than double the $8000bn that was predicted for 2006 in the BBA's previous survey in 2004. The BBA estimates that by 2008 the market will have expanded a further 50 per cent to $33,000bn."***[34]

The development of the CDS market has made it simpler to estimate the degree of bias in CGS yields as a proxy for the risk free rate. Prior to the development of the CDS market it was not possible to rely on market data to split the corporate spread to CGS into a) corporate default risk premium; and b) the uniqueness premium paid for CGS. However, this has been made easier since the development of the CDS market - with the uniqueness premium being equal to the corporate spread to CGS less the CDS price. [35]

The RBA began publishing CDS premiums in the RBA Bulletin publication in 2003. As discussed above, it now relies primarily on CDS premiums as the relevant measure of the price of credit default risk. Since 2003, the rise in the 'uniqueness' premium attached to nominal CGS can be measured from market data reported in the RBA Bulletin as described in the table below.

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[34] http://www.ftmandate.com/news/fullstory.php/aid/1274/Filling_the_supply_gap_sees_massive_CDS_swell.html

[35] That said, the CDS market is still not very deep for lower credit rated bonds (below AA rated). It may be unreliable to attempt to rely on CDS for lower rated bonds as an indication of the average credit risk associated with that rating class. This is less of a problem for AA rated bond category where the CDS market is deepest.

Table 5.1
Change in Nominal CGS Bias Since 2003

	A rated bonds			A rated Bonds			
	CDS (AA)**	Spread to CGS (AA)*	Diff.	CDS (A)**	Spread to CGS (A)*	Diff.	Implied CGS Bias
June 2003	20	35	15	46	61	15	15bp to 15 bp
Jan 2007	7	49	42	19	63	44	42bp to 44bp

Source: RBA Bulletin: Table F3: Capital Market Yields and Spreads - Non Government Instruments:
****Corporate bonds used by the RBA to calculate spreads to CGS have a maturity of 1 to 5 years.***
***** CDS rates quoted by the RBA are 5-year credit default swap rates***

The above table tells us that in June 2003 the average cost of insuring for default on an AA rated bond was 20bp per annum. At the same time, the spread to CGS for the same bond was 35bp suggesting that 15bp of that spread was not a default premium (ie, reflected a 'uniqueness' premium for CGS). This suggests that the nominal CGS yield was around 15bp below the CAPM risk free rate in June 2003.

The same analysis can be performed using RBA data on A rated corporate bonds as a check on the above analysis. This should yield a similar result to using AA rated bond data. As it turns out using A rated bonds yields exactly the same result. While the spread on A rated bonds to CGS is 26bp higher for A rated bonds so is the CDS rate on A rated bonds - leaving the implied bias unchanged. This result suggests that the entirety of the additional spread to CGS on A rated bonds versus AA rated bonds is explained by higher credit risk attached to A rated bonds (as one would expect). These two results provide evidence for a 15bp estimate of bias in June 2003.

Performing the same analysis using the most recently available January 2007 RBA data suggests the magnitude of this bias is now around 42bp to 44bp. Since June 2003 the CDS rate on AA rated bonds has fallen 13bp (from 20bp to 7bp) while the spread to CGS has risen by 14bp. The combination of these two effects suggests that the CGS uniqueness premium has risen by 27bp (from 15bp to 42bp). Performing the same analysis using A rated bonds suggests that the uniqueness premium is now 44bp (ie, within 2bp of the result using AA rated bonds).

Importantly, credit risk for both A rated and AA rated bonds as implied by the CDS rate has more than ***halved*** since 2003. However, over the same period the spread to CGS has ***increased***. This is precisely the same phenomenon (falling credit risk but rising spread to CGS) which the RBA has put down to demand and supply conditions peculiar to the CGS market.

Conclusion: Historically High Levels of Bias in Nominal CGS as a Proxy for the CAPM risk free rate

Based on RBA data, the current yield on nominal CGS is downward biased as a proxy for the CAPM risk free rate by around 42-44bp.

This is 27-29bp more biased than was the case in June 2003 using the same RBA data.

5.3. Additional research required

The dramatic increase in bias over the last four years, using RBA data, is somewhat surprising. The reduction in the supply of CGS began well before 2003 and one might have expected to see higher levels of bias even in 2003. We are currently in the process of interrogating other data sources, including the underlying data sources relied on by the RBA, in an attempt to through further light on this issue.

Part of this empirical work will also involve testing whether data sources can be relied on to make adjustments to government bond yields in an attempt to determine the CAPM risk free rate. For example, it may be that the RBA CDS data, or some other form of CDS data, could reasonably be used in a transparent 'formulaic' way to inform the appropriate adjustment to the CGS rate (allowing the current regulatory reliance on transparent and prevailing market data to be retained). If this is not possible then it may be that a more ad hoc approach (similar to UK regulatory precedent) may need to be adopted.

This work should be completed in the next month or so.

6. Conclusion and Recommendations

6.1. Conclusions - empirical and theoretical

The Reserve Bank of Australia believes that the yield on both nominal and indexed CGS has been depressed in recent years due to supply and demand conditions peculiar to the CGS market. This is consistent with (indeed, can only be reconciled if one accepts) the finding of the finance literature that the government bond rate will tend to be a downward biased proxy for the CAPM risk free rate. The same finance literature suggests that the historically low supply of CGS is likely to result in a historically high level of bias in CGS yields as a proxy for the CAPM risk free rate.

In this report we have used Australian market data to test the predictions of the literature and to quantify the analysis of the RBA. We estimate, using several data sources and with considerable confidence, that the level of bias in yields for indexed CGS exceeds that for nominal CGS by around 20bp. We estimate that this ***relative*** bias appears to have developed since late 2004 (around the time that the RBA first started commenting on this).

However, this is a minimum appropriate adjustment to the indexed CGS bond yield. It is only appropriate if the nominal CGS yield is an unbiased estimate of the nominal risk free rate.[36] It appears highly likely that the nominal CGS yield is also biased down by a lack of (historically low) supply. RBA analysis and commentary suggests that this is the case. Relying on RBA data the nominal risk free rate appears to be biased downward by 42-44bp which is a 27bp increase since June 2003.

This suggests that a total adjustment to the indexed CGS of between 47bp (20+27) to 62/64bp (20+42/44) may be appropriate. The former will ensure consistency with decisions made in 2003 (ie, it will remove the increase in the bias since 2003). The latter will entirely remove the full extent of the bias. However, the latter may also require some adjustment to the MRP if the MRP is estimated relative to an historically biased risk free rate.

6.2. Qualifications to these conclusions

We believe that our estimate of the relative bias in indexed CGS is highly accurate and should be adopted by regulators. This 20bp adjustment should be added to both the cost of debt and the cost of equity.

We are less confident of our estimates of the 'absolute bias' in nominal CGS. We are performing further analysis to test this with alternative data sources.

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[36] The real risk free rate plus an premium for inflation exposure.

Even if the results based on the RBA data are proved correct, it must be noted that the level of bias on nominal CGS will not affect the cost of debt given the methodology used by regulators. This is because any increase in the nominal risk free rate will reduce the estimated debt premium by a corresponding amount (where the debt premium is estimated as the nominal yield on corporate bonds less the nominal risk free rate).

Appendix A. References

A.1. CPI forecasts

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