AusNet Transmission Group Pty Ltd

Transmission Revenue Review 2017-2022

Revised Revenue Proposal

Appendix 6F: Best Estimate of Expected Inflation, September 2016

Submitted: 21 September 2016

COMPETITION ECONOMISTS GROUP

Best estimate of expected inflation

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September 2016

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COMPETITION ECONOMISTS GROUP

1 Executive summary

1. Expected inflation is used by the AER as an input to the Post Tax revenue Model (PTRM) wherein it is used to convert the nominal allowed rate of return into a real allowed rate of return which is embedded in allowed revenues. The removal of expected inflation from regulated revenues set in by the PTRM in the immediate regulatory period is consistent with the fact that the compensation for inflation occurs subsequently primarily via indexation of the regulatory asset base (RAB) in the AER's RAB roll forward model (RFM).

2. Broadly speaking the rationale for the current approach is to avoid double counting of inflation. Absent any decrement for expected inflation in the PTRM (step ii), the regime would provide double compensation for inflation:

   a. once through the nominal rate of return allowed (step i at paragraph 15); and

   b. once through the inflation indexation of the RAB across regulatory periods (as per the AER's RAB Roll forward model (RFM)) (step iiib at paragraph 15).

3. The AER's methodology for estimating 10-year inflation results in an estimate that is currently much higher (around 70bp) than expectations implied in bond market prices. It also results in a significantly negative real risk free rate (around -50bp) applied in its regulatory decisions. This is contrary to investors being able to earn a positive guaranteed real return on inflation indexed Commonwealth Government Securities (CGS).

4. In our view, break-even inflation is a better estimate of expected inflation than the method associated with the AER's estimate. The AER's methodology assumes that investors expect that inflation will be in the middle of the RBA target range (2.5%) at horizons beyond 2 years. While this may have been a reasonable assumption historically (and may be in future years) it:

   - cannot always be presumed to be reasonable; and
   - is not a reasonable assumption in current market circumstances.

5. In current circumstances the AER's estimate of inflation, in particular the assumption that investors expect inflation to average 2.5% beyond 2 years, is at odds with all of the available evidence. Namely:

   - Break-even inflation estimates (1.7%) are well below AER forecasts (2.4%) even at a horizon of 10 years. The RBA itself is forecasting inflation out to December 2018 to be below the bottom of its target range out to the end of the RBA forecast horizon.
   - In the current monetary policy environment, where policy rates are close to the zero lower bound, the greatest risks to inflation are to the downside. This risk is

not theoretical, all western developed countries currently have monetary policy settings with policy rates close to zero and all are currently undershooting inflation targets.

- Expected inflation is the actuarially expected inflation (average of all possible inflation outcomes weighted by their probability). So, even if investors perceived that the most likely expected inflation was 2.5%, expected inflation would be below this once the greater downside risks were appropriately weighted.
- The AER's estimate of expected inflation implies that investors expect a negative real return on the risk free rate. The fact that they can achieve a positive guaranteed real risk free return simply by buying inflation indexed CGS demonstrates this is clearly not the case; and
- Break-even inflation forecasts have been more reliable than the AER's forecasting methodology in recent years. Break-even inflation forecasts accurately predicted the recent fall in inflation below the bottom of the RBA's target range while the AER's methodology did not;
- An expectation that Australian inflation will jump to 2.5% at the end of the RBA forecast period is inconsistent with the fact that Australian (and global) inflation rates have been persistently below target for many years, with instances of deflation in Australia (March quarter CPI), US, Japan, the UK and the Eurozone.
- Falling 10-year break-even inflation is a statistically significant explanatory variable when regressed against nominal CGS yields – suggesting that most of the recent fall in nominal CGS yields is due to falling inflation expectations (not falling required real returns as implicitly assumed by the AER).

6. The AER has raised potential sources of bias in the use of break-even inflation. We have reviewed the relevant literature relied on by the AER (and more widely). The overwhelming conclusion of this literature survey is that the potential sources of bias alluded to by the AER are small and, in any event, are just as likely to result in an over-estimate of expected inflation as an underestimate. Certainly, it is not plausible that these account for the current around 70bp difference between break-even inflation and the AER's estimate of expected inflation.

7. In any event, the sources of potential bias in break-even inflation identified by the AER actually imply that the nominal CGS yield is a biased proxy for the risk free rate. If these sources of bias did exist to the extent claimed by the AER then the appropriate course of action would be to adopt the indexed CGS yield as the real risk free rate proxy.

8. We explain how this can be done by estimating a real cost of capital directly. The nominal cost of capital inputs to the PTRM can then be estimated by adding expected inflation to the real cost of equity and debt. Under this approach, the nominal cost of debt and equity used as inputs into the PTRM are set equal to the estimated real of debt and equity plus expected inflation. This approach has, in our view, the material

advantage that it renders the estimate of expected inflation used in the PTRM relatively unimportant to the compensation that will be provided to the regulated entity.

9. This is because, it is the real cost of capital that is, ultimately, what the PTRM uses to determine the amount of compensation for the cost of capital embedded in allowable revenues (as was set out in Section 3). Therefore, it is appropriate that this real rate of return be the central focus of a cost of capital decision by the regulator.

10. In addition, notwithstanding our view that breakeven inflation provides superior estimates to the AER's estimates, we note that this approach can also be used even if the AER's method for estimating expected inflation in the PTRM must be applied.

2 Introduction

11. I have been asked by Johnson Winter & Slattery to provide a report advising on the best estimate of expected inflation and the real cost of capital which are, or feed into, inputs to the PTRM and to respond to the AER's recent Draft Decision for AusNet Services' transmission determination.

12. The remainder of this report has the following structure:

- Section 3 discusses how expected inflation, as used in the rules and the PTRM, should be defined. We show that it is expected inflation by investors in bond markets that is relevant. Section 3 emphasises the fact that expected inflation takes into account the (probability weighted) average of all possible perceived outcomes by investors in bond markets;
- Section 4 explains why break-even inflation best captures the inflation expectations of investors in bond markets;
- Section 5 explains why we consider that break-even inflation is the best estimate of expected inflation and why it is superior to the AER's method for estimating expected inflation;
- Section 6 surveys the literature relied on by the AER as part of its decision to not give any weight to break-even inflation when estimating expected inflation;
- Section 7 discusses how to estimate the real cost of capital using the indexed Commonwealth Government Security (CGS) yield as the real risk free rate. It is explained that this approach renders the estimate of expected inflation relatively unimportant to the real compensation paid/earned by consumers/investors.

13. I acknowledge that I have read, understood and complied with the Federal Court of Australia's Practice Note CM 7, "Expert Witnesses in Proceedings in the Federal Court of Australia". I have made all inquiries that I believe are desirable and appropriate to answer the questions put to me. No matters of significance that I regard as relevant have to my knowledge been withheld.

14. I have been assisted in the preparation of this report by Johnathan Wongsosaputro and Ker Zhang in CEG's Sydney office. However, the opinions set out in this report are my own.

Thomas Nicholas Hird

3 Expected Inflation in the regulatory context

15. The current structure of the inflation compensation arrangements can be summarised as follows:

    i. Take a nominal input for the cost of debt and equity as inputs to the PTRM;

    ii. Deduct an estimate of expected inflation (also an input to the PTRM) to arrive at a real return which is then embedded in the real regulated revenue path which is the output of the PTRM;

    iii. Provide nominal compensation that is equal to:

        a. The real return derived in step ii); plus

        b. Compensate for the inflation that actually occurs over the regulatory control period as provided in the RAB roll forward model (RFM).[1]

16. In the context of step i), the rules state that the allowed rate of return is to be determined on a nominal vanilla basis.[2] In relation to step ii), the rules state that the PTRM must specify:[3]

    a methodology that the AER determines is likely to result in the best estimates of expected inflation

17. In relation to step ii), within the structure of the PTRM expected inflation gives rise to the "indexation of the regulatory asset base" building block as set out in 6A.5.4(b)(1) of the National Electricity Rules. The regulatory asset base is calculated in accordance with clause 6A.6.1 and schedule 6A.2. The building block comprises a negative adjustment equal to the amount referred to in clause S6A.2.4(c0(4) for that year (being the amount necessary to maintain the real value of the regulatory asset base as at the beginning of the subsequent year by adjusting that value "for inflation", or, more specifically, for expected inflation).

18. In relation to step iiib) the RAB is indexed for actual inflation between regulatory periods. Specifically, the RAB is rolled forward to the start of the next regulatory

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1 This is compensated primarily in the RAB roll forward used to set the opening RAB at the beginning of the next regulatory period but also (to a small extent) in the form of price escalation for inflation during the regulatory period.

2 NER, R6A.6.2(d)(2).

3 NER, R6A.5.3(b)(1).

period using actual (outturn) inflation in each year of the previous regulatory period (NER 6A.6.1(e)(3)).[4]

19. The National Gas Rules do not contain an equivalent to the above, but the AER's approach and application of its PTRM and RAB RFM is the same.

3.1 Simplified example

20. A simple example illustrates the calculations. Let there be a one-year regulatory period and a perpetual (non-depreciating) asset in the RAB with a value of $100. Let the nominal WACC be 8% and let expected inflation be 2% over the regulatory period and beyond (also let the tax rate be zero). In this stylised example, allowed revenues generated by this asset over the regulatory period will be $6 – comprised of 8% return on $100 less 2% ($2) expected revaluation.

21. If inflation turns out to be 2% then the asset owner will receive an actual $2 revaluation of their asset at the end of the one year regulatory period. Consequently, their total return comprising both revenues within the regulatory period and revaluation at the end of it will be equal to the 8% estimated cost of capital at the beginning of the regulatory period (6% in the form of revenues and 2% in the form of revaluation).

22. However, if actual inflation turns out to be 0% then the asset owner will receive 0% actual revaluation at the beginning of the next regulatory year. Consequently, the asset owner's nominal return will be 6% and not the estimated 8% at the beginning of the previous regulatory year. Similarly, if actual inflation turns out to be 4% then the asset owner will receive nominal compensation of 10% (6% in revenues and 4% in revaluations).

23. It can be seen that the current arrangements deliver a return on capital that is equal to the real cost of capital estimated at the beginning of a regulatory period. This real return is the key cost of capital assumption in the AER's methodology (even if it is derived from two separate assumptions). This is the real return that the regulated entity can expect to earn - with actual inflation added to this return via the operation of the RAB RFM in order to give a nominal return. Of course, the nominal return earned fluctuates with actual inflation – always consistent with the real return that was determined within the PTRM.

4 CEG, Measuring expected inflation for the PTRM, January 2016, paragraph 6.

3.2 Rationale for current approach

24. Broadly speaking the rationale for the current approach is to avoid double counting of inflation. Absent any decrement for expected inflation in the PTRM (step ii), the regime would provide double compensation for inflation:

    a. once through the nominal rate of return allowed (step i at paragraph 15); and

    b. once through the inflation indexation of the RAB across regulatory periods (as per the AER's RAB Roll forward model (RFM)) (step iiib at paragraph 15).

25. The role of the decrement for expected inflation in the PTRM is to cancel out the expected value of one of the above sources of compensation for inflation. This still leaves open the question of which of these two sources of inflation compensation should be cancelled out?

26. This becomes an issue when it is recognised that the two sources of inflation compensation are not necessarily the same. That is, the inflation expectations that are built into the nominal rate of return (which it is the AER's practice to benchmark based on 10 year bond yields) is not necessarily the same as the expectation of inflation over the 5 year period that the RAB RFM will be applied. Therefore, it becomes an open question as to whether expected inflation used in the PTRM should have a 10 year horizon or a 5 year horizon.

27. We have previously proposed the adoption of two different terms for inflation forecasts - a 5 year term to be applied in the PTRM to the debt portion of the RAB and a 10 year term to be applied to the equity portion.[5] Our basis for this proposal was that it targeted a nominal return on debt which, we considered appropriate given that debt is issued in nominal terms and attempting to remove the same inflation compensation expected to be provided in the RAB RFM would target a nominal return.

28. In its final decision for AusNet electricity distribution the AER clearly stated its view that a 10 year term should be used:[6]

> *It is both internally consistent and necessary to use a 10 year inflation expectation to convert a nominal return on debt with a 10 year term to a real return on debt with a 10 year term. Debt contracts are based on prices investors are willing to pay. These prices reflect investor expectations of the risk free rate, debt risk premium and inflation over their investment horizon at the time they raise this debt. Service providers, including AusNet Services agree that this horizon (or term) for the return on debt is 10 years.*

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5 See CEG, Measuring expected inflation for the PTRM, June 2015, CEG, Measuring risk free rates and expected inflation, April 2015. CEG, Measuring expected inflation for the PTRM, January 2016.

7 Sheldon M. Ross, Introduction to Probability Models, Academic Press, 2007, p.39

> *Therefore, while debt contracts may fix the nominal cost of debt, this cost incorporates investor expectations of inflation over the next 10 years*. (Emphasis added.)

29. Here, the AER expresses its view that the objective in setting expected inflation is to cancel out inflation compensation built into the nominal allowed rate of return (step i at paragraph 15) not compensation that will be provided in the RAB RFM (step iiib at paragraph 15).

30. We accept the logic of this view as it applies to the cost of equity but, in our view we consider that the logic is weak when applied to the cost of debt. Nonetheless, for the purpose of this report we proceed on the basis that the objective is to use expected inflation to remove prevailing 10 year, and only 10 year, expectations of inflation from the nominal allowed rate of return in the PTRM. That is, we accept the AER's premise as set out in the above quote. We note that this is conservative and that, instead, giving 60% weight to a 5 year term would lower the expected inflation estimate and raise both expected real and nominal compensation.

4 Expected inflation is a probability weighted average

31. This section establishes that expected inflation, as used in the PTRM, is a probability weighted average of all possible inflation outcomes as perceived by bond investors. This is important for a number of reasons, most notably:

- It explains the distinction between "most likely" inflation outcomes and expected inflation. This becomes critical when attempting to estimate expected inflation in the presence of an asymmetric distribution of perceived outcomes which is currently the case (as discussed in section 5 below).
- It highlights the fact that inflation measures taken from bond markets are measures of expected inflation (while many forecasts cannot be assumed to be) and are the most relevant measures of expected inflation.

4.1 Expected vs most likely inflation

32. The term 'expected inflation' has a precise meaning as a matter of financial economics. This precise meaning is also consistent with the way in which expected inflation is used within the PTRM.

33. As a matter of financial economics (and mathematics more generally), the use of the term 'expected' connotes the mean of the distribution of all possible outcomes.[7]

> *In other words, the expected value of X is a weighted average of the possible values that X can take on, each value being weighted by the probability that X assumes that value.*

34. That this is the same use of the term 'expected' in financial economics is clear from reading any finance text book, including Brealey and Myers.[8] An example of an expected return on a risky asset is the probability weighted average of all outcomes. Consider a $100 bet on the toss of a fair coin. There are two possible outcomes – being the gambler loses $100 (100% loss) or wins $100 (100% gain) each with 50% probability. However, the *expected* outcome is that the gambler earns a zero return on their bet.

7 Sheldon M. Ross, Introduction to Probability Models, Academic Press, 2007, p.39

8 For example, see Brealey and Myers, Principles of Corporate Finance, tenth edition, Mcgraw-Hill/Irwin, p. 578.

35. This example illustrates that the expected return is not, necessarily, the most likely outcome.[9] Rather, it is the weighted average across each possible outcomes, where the weight is given by the probability attached to each outcome. In the context of expected inflation, an investor may believe that inflation could be:

- 1.0% with 30% probability;
- 2.0% with 50% probability; and
- 2.5% with 20% probability.

36. Here the expected inflation outcome is 1.8% - which is the probability weighted average of all inflation outcomes. This is not the most likely (modal) outcome which is 2.0% and nor is it the median outcome (which is also 2.0%). This is because the investors' perception of all possible outcomes is skewed – in that a there is a greater perceived probability of lower than modal/median inflation than higher than modal/median inflation.

37. In this regard it is important to note that 'expected inflation' is not necessarily the same as 'forecast inflation'. A forecast of inflation could, and typically is, a statement of what is the most likely outcome. This need not correspond with the probability weighted expected outcome. In the case of the above example, forecast inflation may be reported as 2.0% - being the most likely outcome. However, the expected inflation estimate is 1.80% - being the probability weighted average of all possible outcomes.

4.2 Bond investors' inflation expectations are the most relevant

38. The reason that an investor's inflation expectations are important is that they determine the nominal return the investor will expect for any given target real return. For example, imagine the same investor in our above example had a required real return on investments in government debt of 1.0%. In which case, that investor would, given inflation expectations of 1.8%, require a promised nominal return of 2.8% (=1.0% + 1.8%).[10] [11]

9 In fact, in this case the expected return cannot actually come to fruition (at least not on a single coin toss).

10 For simplicity of illustration the calculations are performed without using the Fisher equation. The correct calculation of real returns are equal to (n-p)/(1+p), where n=the nominal return and p=inflation.

11 This assumes that the investor does not demand an additional premium in order to compensate for the fact that the investor is still exposed to inflation risk – being the variability in actual (as opposed to expected) real returns given that the actual inflation outcome is not known. This is because the 1.0% expected real return is the probability weighted return across three possible inflation outcomes, namely:

- 1.8% (2.8%-1.0%) with 30% probability;
- 0.8% (2.8% - 2.0%) with 50% probability; and
- 0.3% (2.8% - 2.5%) with 20% probability.

39. The previous section explains that the expected inflation input to the PTRM determines, in combination with the nominal cost of capital inputs to the PTRM, a real rate of return that is delivered to the regulated entity. The AER's current methodology is to estimate the nominal cost of capital inputs based on:

- nominal corporate bond yields for the cost of debt; and
- nominal government bond yields as the risk free rate used to determine the cost of equity.

40. The nominal bond yields determined by supply and demand in financial markets already include bond investors' expectations of inflation. As the AER argues,[12] it follows that it is this expectation of inflation that should be removed from these bond yields.

41. That is, it is the expectation of inflation that is built into nominal bond yields that must be removed from these bond yields to derive an internally consistent estimate of the real return on capital – the return that is going to be delivered to the regulated entity by the operation of the regime. In this context, a measure of expected inflation taken directly from bond market prices, as discussed in section 5 below, is the obvious first place to look for a measure of expected inflation built into nominal bond yields.

12 AER, Final decision, AusNet distribution, May 2016, p. 3-154.

5 Break-even rates best capture bond investors' expectations

42. Break-even inflation is calculated based on the difference in yields between inflation indexed Commonwealth Government Securities (CGS) and nominal CGS. This is termed 'break-even' inflation because that is the inflation expectation at which investors expect the same nominal return from either asset. That is, it is the rate of inflation that, if it actually occurred, would leave investors' indifferent between having purchased a nominal bond versus an inflation indexed bond.

43. By contrast, the AER's method is to assume expected inflation over the next 10 years is equal to the average of:

- The midpoint of the RBA's inflation forecast range which typically only extends out 2 years;
- An assumption that inflation expectations are 2.5% in every year thereafter.

44. Break-even inflation has three critical advantages over the AER's proposed method for estimating expected inflation:

- First, and foremost, break-even inflation is a direct measure of inflation expectations in the same bond market that the AER uses to set the nominal rate of return on equity (i.e., the CGS market).
- Second, break-even inflation already reflects a probability weighted average of all possible inflation outcomes as perceived by bond investors. This cannot be assumed to be the same, and generally is not the same, as published forecasts of the most likely inflation outcome.[13]
- Third, break-even inflation is available at a 10 year horizon when alternative non-market based[14] forecasts of inflation are not typically available for more than one or two years.

45. All of these points suggest advantages in the use of break-even measures of expected inflation estimates. A further important advantage of adopting break-even inflation in the PTRM is that doing so has the effect of setting the real risk free rate equal to

13 It is also possible that expected inflation by bond investors is different to expected inflation of other members of society (e.g., consumers, 'talking head' economic pundits, government agencies etc.).

14 We note that we can also observe fixed rates on CPI indexed swaps. However, as we have stated in our previous reports, and repeat in Appendix B, CPI swaps are in effect equal to break-even inflation plus a margin for bank costs (including regulatory costs in the form of capital requirements). They are therefore an upwardly biased measure of inflation expectations in bond markets. It is also the case that transaction costs associated with entering into CPI swaps are likely to be high.

the observable yield on indexed CGS. This is an advantage because, as explained section 7.1, indexed CGS are a more direct proxy for the real risk free rate than nominal CGS less an estimate of expected inflation (even if that estimate of expected inflation is accurate). Consequently, adopting the yield on indexed CGS as the real risk free rate will substantially improve the accuracy of the PTRM in setting real returns (which, as set out in section 3, is the ultimate output of the PTRM).

46. We consider the AER's estimate of inflation, in particular the assumption that investors expect inflation to average 2.5% beyond 2 years, to be at odds with all of the available evidence. Namely, The 80% weight to an assumption of 2.5% inflation, without any circumstance specific justification, means that AER's estimate of expected inflation cannot, by construction, respond to either falling actual inflation (which has been below target on average over the last three years) or other evidence which strongly suggests falling inflation expectations (including dramatically lower nominal CGS yields in absolute terms and relative to yields on inflation indexed CGS).

47. Evidence in support of break-even inflation providing a better measure of expected inflation includes:

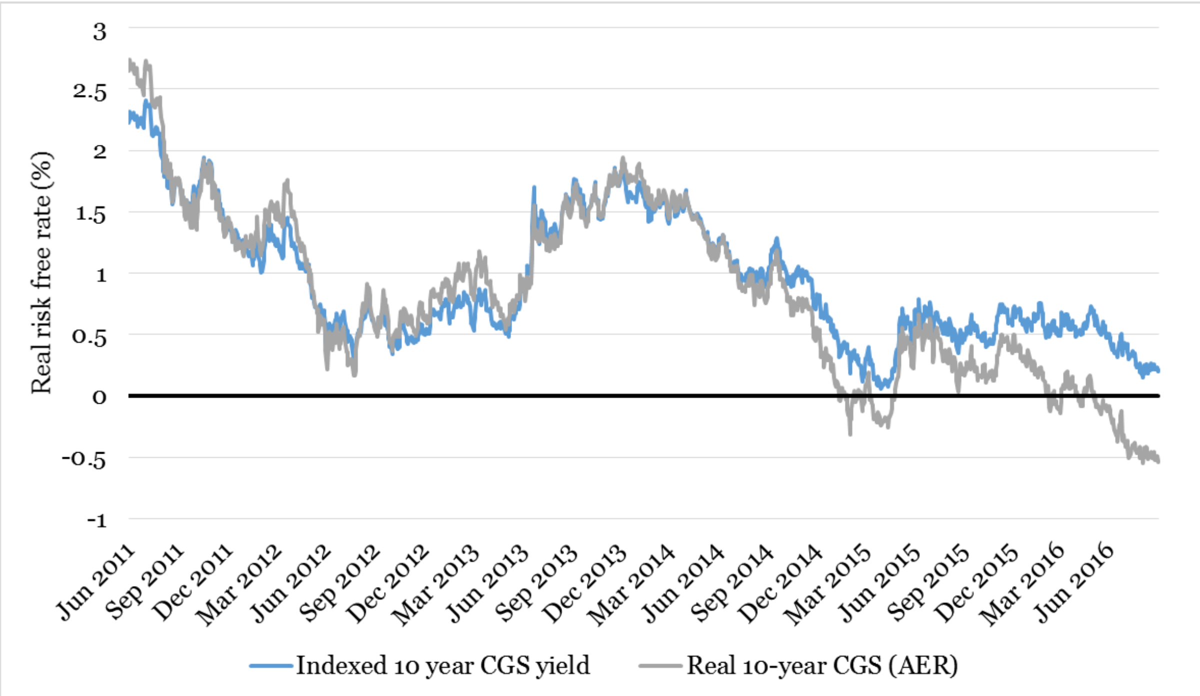
- The AER's estimate of inflation expectations implausibly suggests that investors expect a negative real return on nominal CGS at the same time that they can achieve a positive guaranteed real risk free return simply by buying inflation indexed CGS (see **section 5.1**); and
- Break-even inflation estimates have, unlike AER estimates, responded materially to the sustained low inflation outcomes over the last three years (in a manner consistent with expectations (see **section 5.2** below).
- Break-even inflation accurately predicted the recent fall in inflation below the bottom of the RBA's target range – more accurately than RBA forecasts (see **section 5.3**);
- Break-even rates are the only plausible way in which the uncertainty about the multiple different paths inflation could take can be weighted in a manner consistent with the probabilities that bond investors attach to these outcomes. This is critical in the current environment where such uncertainties are heightened by unusually low recent inflation outcomes and the RBA's target cash-rate approaching the "zero lower bound". See **section 5.1** below;
- Moreover, RBA short term forecasts are "central forecasts" and, therefore, likely to underestimate "expected inflation" where the downside risks exceed the upside risk (see **section 5.5** below);
- An expectation that Australian inflation will jump to 2.5% at the end of the RBA forecast period is inconsistent with the fact that Australian (and global) inflation rates have been persistently below target for many years, with instances of deflation in Australia (March quarter CPI), US, Japan, the UK and the Eurozone (see **section 5.6**).

- Falling 10 year break-even inflation is a statistically significant explanatory variable when regressed against nominal CGS yields – suggesting that most of the recent fall in nominal CGS yields is due to falling inflation expectations (not falling required real returns as implicitly assumed by the AER – see **section 5.7** below).

5.1 The AER's estimate for expected inflation implies negative real returns

48. The yield on 10-year indexed CGS over the last 5 years is provided in Figure 1 below. It is relevant to compare this yield with the estimated real risk free rate applying the AER's current methodology, which is to deduct its estimate of expected inflation from the yield on 10-year nominal CGS.

Figure 1: Competing 10-year real risk free rate estimates (last 5 years)



Source: AER, RBA, CEG analysis

49. It can be seen that until late 2014, the AER's methodology implied a real risk free rate that was similar to the yield on indexed CGS. However, since then the AER's estimate of the real risk free rate has fallen precipitously and is currently negative 0.5. That is, the AER's estimate implies that investors are expecting to lend to the Australian government in return for receiving less in purchasing power after 10 years than they invested originally.

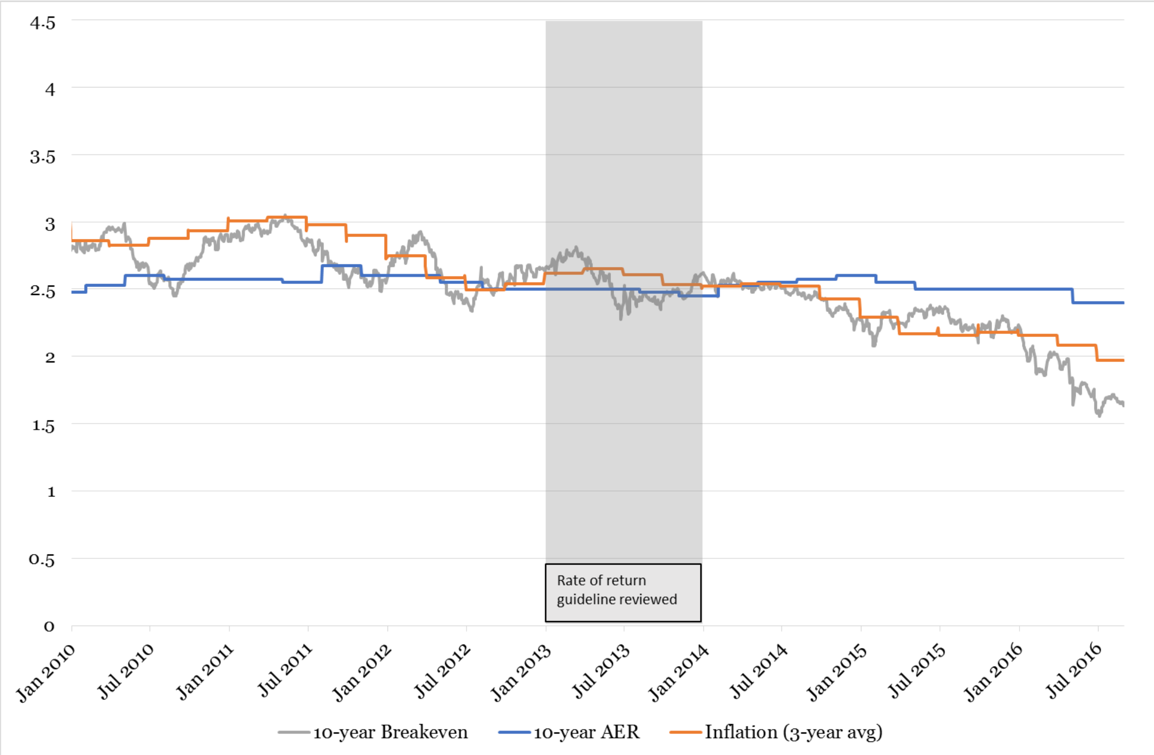
50. The unreasonableness of such an outcome is demonstrated by observing that investors' could buy inflation indexed CGS at a guaranteed positive real return. We believe that the anomaly (negative estimated real returns to risk free saving in nominal assets) is a result of the AER's estimate of the expected inflation rate being inappropriate for the current economic environment rather than a true anomaly in investor required returns.

51. We further note that the late 2014 divergence between the AER's real risk free rate estimate and the yield on indexed CGS has coincided with actual inflation falling well below the RBA's target range. That is, annual inflation fell below the bottom of the RBA range for the year ended December 2014 and has remained below that range since (being just over 1% in the most recent year to June 2016). By contrast, the AER's estimate of expected 10 year inflation has fallen by only 10bp to 2.40%.

5.2 Break-even inflation estimates vs AER estimates

52. Over the month of August, 10-year break-even inflation rates averaged 1.7%. A time series for 10 year break-even inflation and AER 10 year inflation estimates is provided in Figure 2 below. Also shown is the actual inflation averaged over three years (ending on the date shown on the x-axis). Average inflation over three years is provided as a measure of the recent trend in CPI outcomes that would have been apparent to investors in bond markets on the relevant dates.

Figure 2: break-even inflation vs AER inflation (10 years) vs actual inflation (1 year) less 2.5%



Source: AER, RBA, CEG analysis

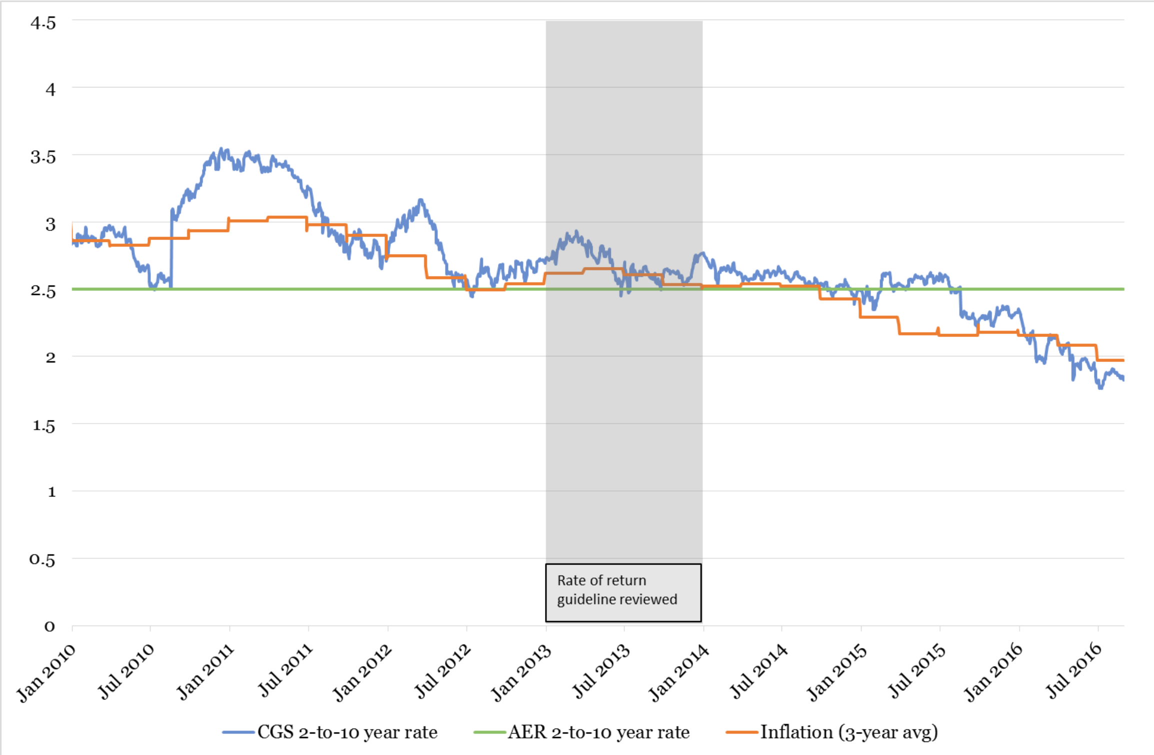
53. It can be seen that break-even inflation responded quickly to actual inflation falling well below RBA target from late 2015. We have highlighted the period in which the rate of return guideline was reviewed. It is relevant to note that this was:

- before the sustained decline in actual inflation outcomes; and
- a period where there was not a material difference between break-even and AER estimates of expected inflation.

This explains why there was not a high degree of stakeholder concern about the AER's forecasting methodology expressed during the Guideline review.

54. Figure 2 follows the same structure as does Figure 1 except instead of showing the 10 year inflation estimate (break-even and AER) it shows the implied 8 year forward inflation rate. The AER's estimate is, by assumption, 2.5% in all future years. The implied 8 year forward break-even inflation rate is back-solved from the 2 year and 10 year break-even inflation rates.

Figure 3: break-even inflation vs AER inflation (10 years) vs actual inflation (1 year) less 2.5%



Source: AER, RBA, CEG analysis

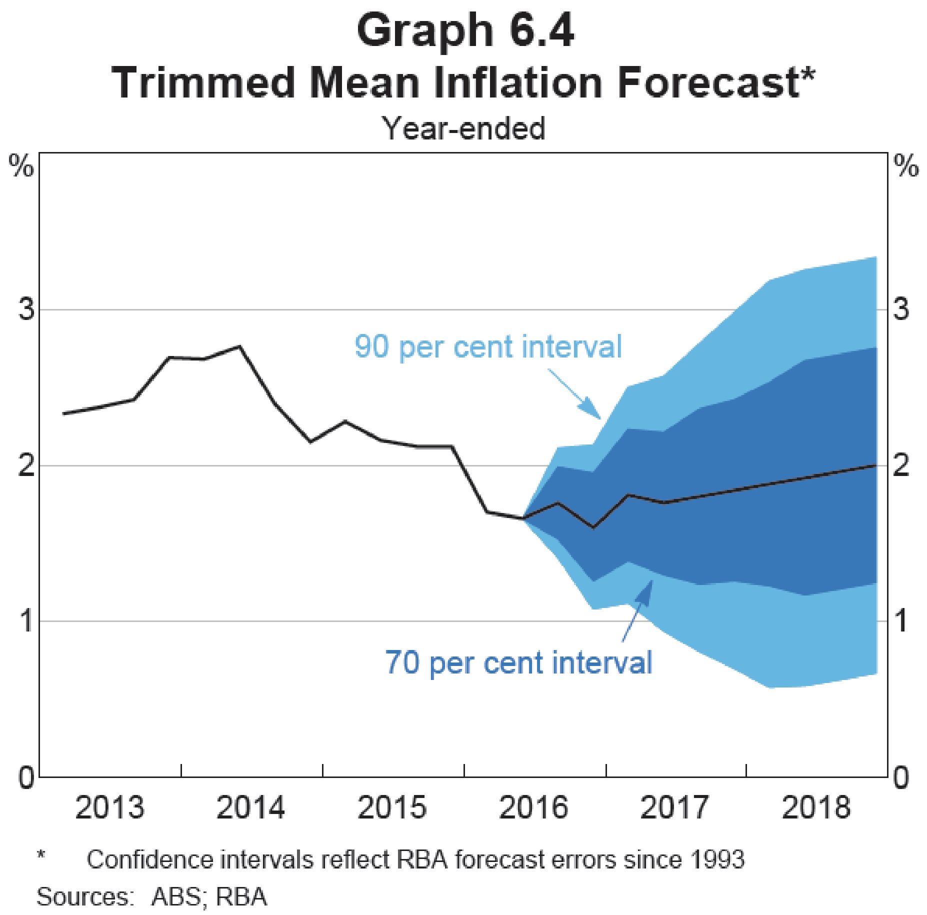
55. This illustrates that the AER's estimate of inflation beyond year 2 is impervious to market developments while the corresponding break-even inflation rate has declined dramatically.

5.2.1 RBA forecasts of underlying inflation are below 2.0% over the maximum forecast period

56. In this context it is relevant to note that the RBA's central forecast of underlying inflation (trimmed mean inflation)[15] increases only gradually over the next two and a half years as evidenced from Graph 6.4 of the August SoMP (reproduced below).

15 The RBA's standard measure of underlying inflation is trimmed mean inflation. See RBA Bulletin, Measures of Underlying Inflation, March Quarter 2010 which states "Given that CPI inflation is quite volatile, most of the models and equations used in the Bank to explain inflation use some measure of underlying inflation (often 15 per cent trimmed-mean inflation) as the dependent variable."

Figure 4: RBA forecast path for underlying inflation



57. It is important to note, as the chart itself does, that the confidence intervals portrayed here are based on the historical average accuracy of RBA forecasts. They do not represent a bespoke estimate of the RBA's estimate of the distribution of possible future outcomes given the specific uncertainties that exist today.

5.3 Break-even inflation has accurately predicted actual inflation

58. This section examines the forecasting accuracy of break-even inflation estimates since 2011. Figure 5 compares actual inflation (orange bar) over the (single) year ending in each of the quarters specified on the horizontal axis to:

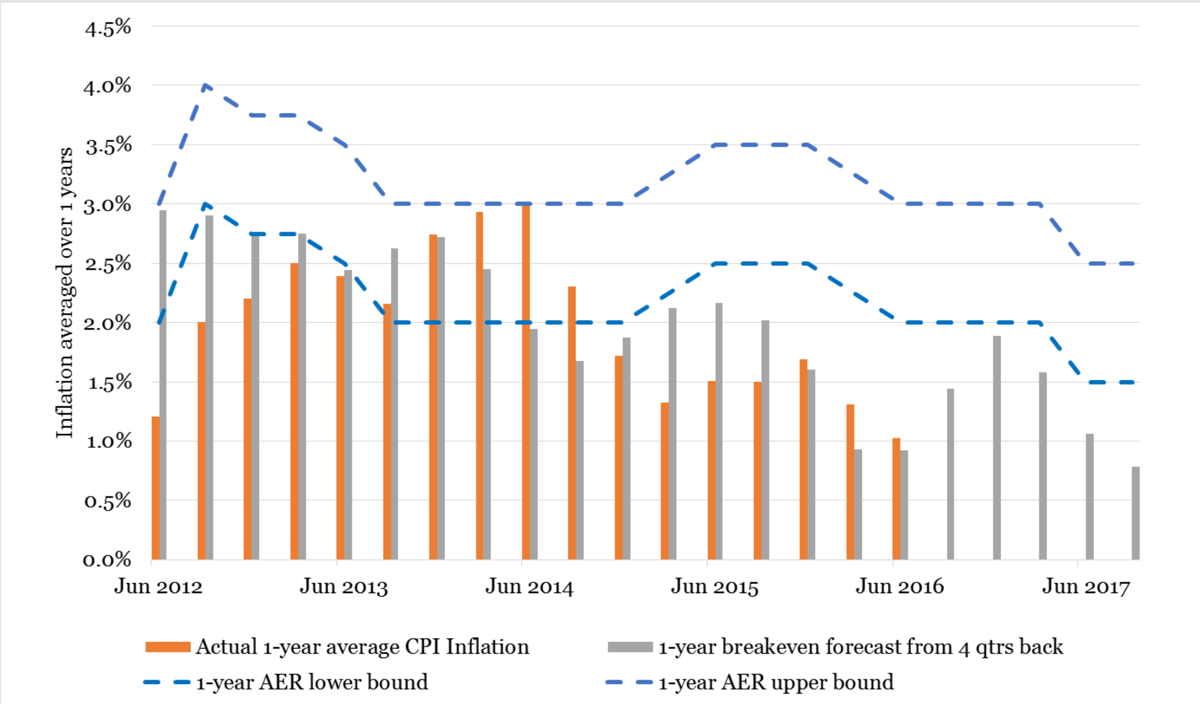
- The RBA forecast range (the midpoint of which is the AER forecast) (blue dotted lines) in that year made one year prior; and
- The 1-year break even inflation rate (grey bar) one year earlier.

59. It can be seen that break even inflation has typically performed best (grey bar is closer to orange bar than is the middle of the RBA forecast range). In fact, break-even

inflation is more accurate in predicting inflation from the December quarter 2014 onwards (which is associated with predictions made in December 2013 onwards).

60. Note also that the chart is extended out to June 2017 where there are no actual CPI figures available. This is done to remind the viewer that the forecasts shown are all made one year prior to the actual inflation figures (i.e., we have some forecasts that are yet to be tested). It also illustrates that the RBA only very recently reduced its midpoint forecast below 2.5% to follow break-even rates down.

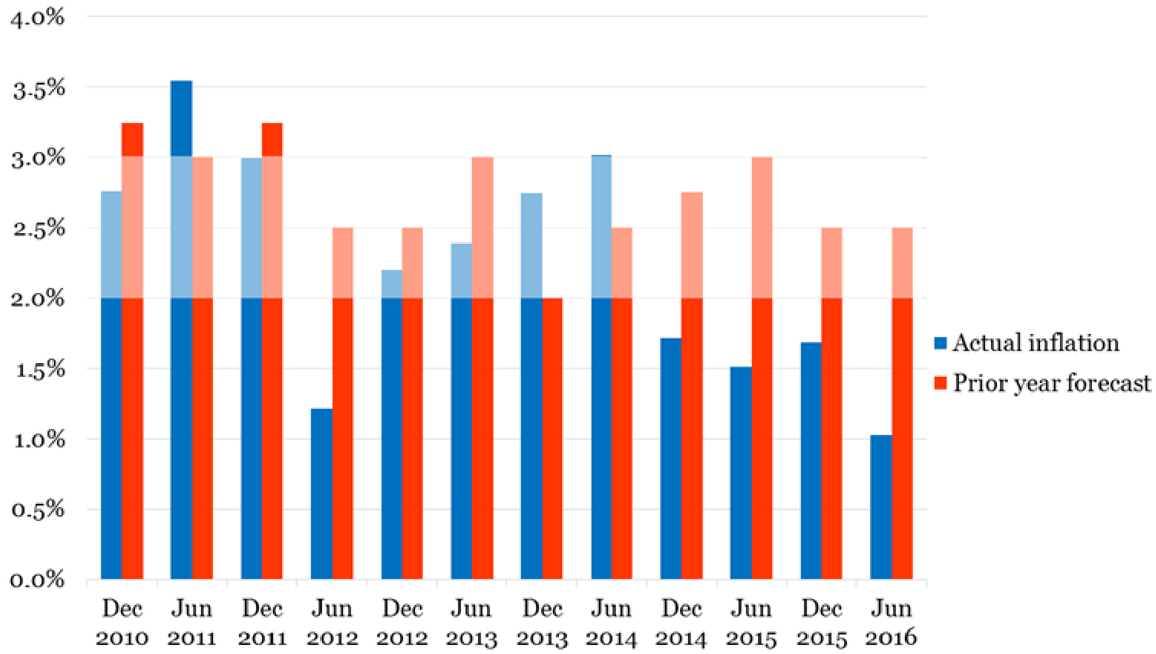
Figure 5: 1 year break-even inflation vs RBA range



Source: AER, RBA, CEG analysis

61. Similar content is presented slightly differently in Figure 6 below which compares, with semi-annual updates, actual inflation to RBA forecast inflation one year prior. Also shown via light shading is the RBA's target range of 2.0% to 3.0% inflation.

Figure 6: 1 year break-even inflation vs RBA range

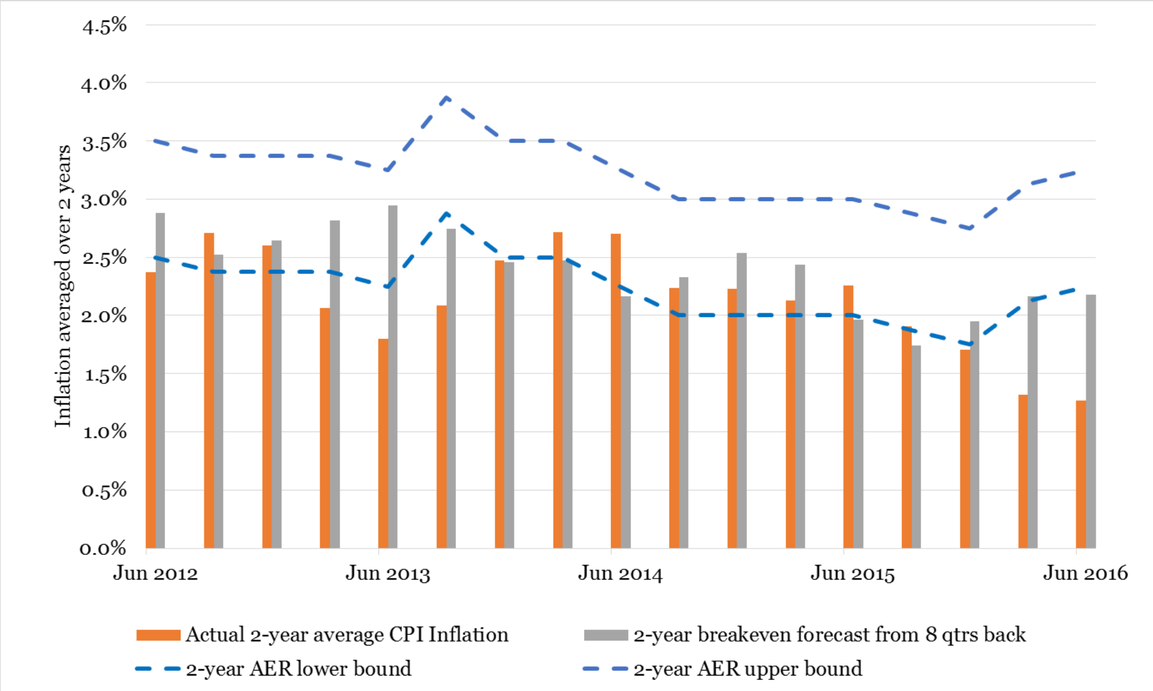


Source: AER, RBA, CEG analysis

62. The next chart is the same as the Figure 5 but uses 2 year inflation forecast horizons. Once more, break even inflation has performed materially better than the midpoint of the RBA range in the most recent years. In interpreting this chart, it must be kept in mind that the forecasts provided are now from one additional year earlier (two year prior to the date marked on the horizontal axis). That is why the RBA forecast range is still centred on 2.5 for June 2017 (because it was made in June 2015).

63. Once more, break-even inflation is almost always a better predictor of actual 2 year inflation than the midpoint of the RBA forecast range.

Figure 7: 2 year break-even inflation vs RBA range



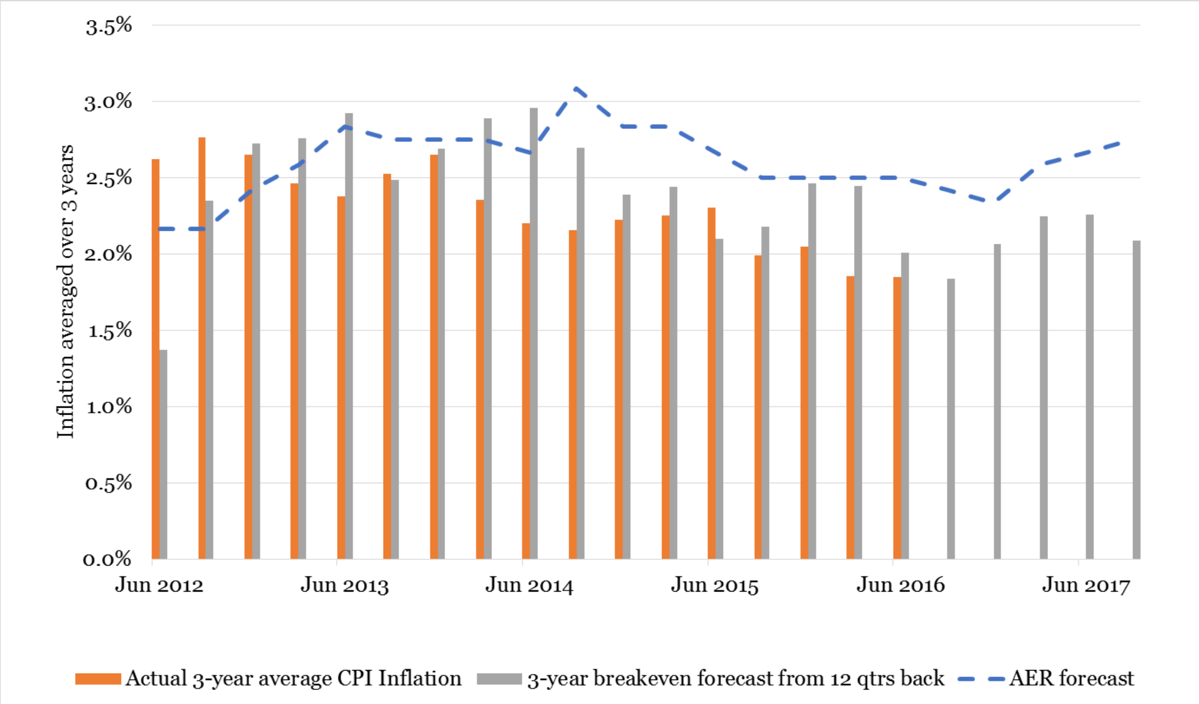
Source: AER, RBA, CEG analysis

64. A similar story exists for 3 year forecast horizons as shown in Figure 8 below. 3 year AER forecasts simply add one year of 2.5% estimated inflation to the midpoint of RBA forecasts. For this reason we dispense with showing a range because this is no longer based purely on an RBA forecast range.

65. Break-even inflation has been more accurate in predicting actual 3 year inflation ending in every quarter since September 2014. However, this is now associated with all predictions made since September 2011.

66. In this chart, the earliest inflation forecasts (left hand side of the chart) are from June 2009, which is affected by the GFC and the abnormally high liquidity premium at that time. This is a reasonable explanation of why break-even inflation underestimated actual inflation over the next three years. However, for forecasts from September 2009 (associated with September 2012 on the x-axis of Figure 8) break even inflation has been almost always the more accurate forecast and especially in more recent periods.

Figure 8: 3 year break-even inflation vs AER forecast



Source: AER, RBA, CEG analysis

5.4 Break-even rates capture and weight highly uncertain and asymmetrically distributed outcomes

67. A critical advantage to the use of break-even inflation as a measure of inflation expectations is that it will incorporate the probability weighted average of all possible inflation outcomes perceived by bond market investors. This is a critical advantage in the current market circumstances in which there is a great deal of uncertainty around these possible outcomes and where there is every reason to believe that the balance of inflation risks are to the downside of the 'most likely' outcome.[16]

68. With the RBA cash rate at record low levels of 1.5%, the policy interest rates are dangerously close to the 'zero lower bound'. Monetary policy's most direct effect on the economy and, therefore, inflation is through lower interest rates. However, the RBA cannot set a cash rate below zero (or at least not materially below zero) because at such levels, businesses and households will prefer to hold cash – which delivers a zero rate of interest. The potential for monetary policy to stimulate economic activity diminishes as policy interest rates approach zero, thereby creating the potential for a

16 In this circumstance, reliance on forecasts of inflation that typically reflect the forecaster's assessment of the most likely outcome (see section 5.5 below) will be biased upwards relative to the true expected inflation (just as was the case in the example in section 4.1).

low inflation trap, for which monetary policy may be ineffective at extracting the economy from.

69. Governor Brainard of the US Federal Reserve released the text of a speech made on 12 September 2016 (i.e., immediately prior to finalisation of this report) which made precisely this point:[17]

> *The four features just discussed that define the new normal make it likely that we will continue to grapple with a fifth new reality for some time: the ability of monetary policy to respond to shocks is* ***asymmetric****. With policy rates near* ***the zero lower bound*** *and likely to return there more frequently even if the economy only experiences shocks similar in magnitude to those experienced pre-crisis, due to the low level of the neutral rate, there is an asymmetry in the policy tools available to respond to adverse developments. Conventional changes in the federal funds rate, our most tested and best understood tool,* ***cannot be used as readily to respond to downside shocks to aggregate demand as it can to upside shocks****.*
>
> …
>
> *Indeed, it is striking that despite active and creative monetary policies in both the euro area and Japan, inflation remains below target levels.* ***The experiences of these economies highlight the risk of becoming trapped in a low-growth, low-inflation, low-inflation-expectations environment*** *and suggest that policy should be oriented toward minimizing the risk of the U.S. economy slipping into such a situation.* [Emphasis added.]

70. This is, obviously, not a concern limited to the circumstances of the United States. Following the RBA's May 2016 rate cut, the financial press reported that: [18]

> *Australians must urgently confront the danger that the Reserve Bank of Australia is nearing the very limits of its powers* ***and risks stumbling***

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17 Governor Lael Brainard, At the Chicago Council on Global Affairs, Chicago, Illinois, September 12, 2016, *The "New Normal" and What It Means for Monetary Policy,* available at http://www.federalreserve.gov/newsevents/speech/brainard20160912a.htm

18 AFR Weekend, RBA joins race to the interest rate bottom, 6 May 2016 at 11.45pm. Available at this link: http://www.afr.com/news/economy/monetary-policy/rba-joins-race-to-the-interest-rate-bottom-20160506-gooblo#ixzz47xFNhJoE . See also Bloomberg, RBA's New Head Seen Facing Risk of Rate Cuts to 1% by JPMorgan May 9, 2016 (Available at http://www.bloomberg.com/news/articles/2016-05-08/rba-s-new-head-seen-facing-risk-of-rate-cuts-to-1-by-jpmorgan.) which reports:

> *The central bank's focus Friday on inflation expectations was notable given the phrase appeared 16 times in a document that rarely mentions it, said Joseph Capurso, a senior currency strategist in Sydney at Commonwealth Bank of Australia. "It is very hard to lift inflation expectations when they are low and Japan is a good example of this," he said*

> ***into the same zero-interest rate trap that has neutered European and Japanese central banks****, say two high-profile economists. …*
>
> *"The evidence is that even aggressive monetary policy action doesn't seem to be driving up inflation, so far," Mr Yetsenga told* AFR Weekend.

71. It is the potential to fall into such a trap is, naturally, an important factor for bond investors when valuing nominal bond yields. Low nominal bond yields may still offer reasonable real returns in the event that an economy falls into such a low inflation 'trap'. This is, of course, not a new insight and Appendix A discusses other evidence that this is a real concern both in Australian and internationally.

72. It is difficult to over-emphasise the importance of these considerations in the context of arriving at an estimate of expected inflation built into nominal bond yields. Even if investors attribute a low probability of Australia falling into a low inflation trap this will have a material impact on their expected inflation and, therefore, the compensation for inflation they require to be priced into nominal bond yields.

73. In order to illustrate this imagine a highly simplistic scenario where investors believe that:

    - there is a one third probability of Australia falling into a low inflation trap, in which case inflation would average around 0.9% pa over the next 10 years;
    - there is a two third probability that it would avoid falling into such a trap, in which case inflation would average 2.4%.

74. In this case the bond investors' expected inflation will be 1.9% notwithstanding that by far the most likely inflation outcome will be 2.4%. Nonetheless, the bond investor will only price in expected inflation of 1.9% into their valuation of nominal bonds.

75. In reality, the real world uncertainties are much greater than in this simplistic scenario. With some non-trivial probabilities almost certainly being attached to extended deflationary outcomes (as experienced in Japan and the Euro zone (and in Australia, albeit so far only in the March quarter 2016)).

76. It is an extremely fraught task for an individual/organisation to accurately model all such possible outcomes and to weight them by the perceived probability of those events occurring. As we discuss in the next section this is not what the RBA does when it arrives at its 2 year ahead forecasts – let alone what the AER does when it arrives at its assumption that beyond 2 years investors expect 2.5% inflation in every year. However, this probabilistic weighting is what occurs in financial markets where interactions between investors result in a market average expectation of future inflation being reflected in traded nominal bond yields.

5.5 RBA central forecasts of inflation are not the RBA's inflation expectation

77. The most recent IMF April 2016 World Economic Outlook provides a cogent summary of the difference between central forecasts and probability weighted forecasts where the distribution of possible outcomes is tilted to the downside. This discussion, while focussed on global forecasts and risks is, as we shall show, effectively mirrored by the RBA in relation to its domestic forecasts. [19]

> *WEO [(World Economic Outlook)] growth forecasts form a* ***central, or modal, scenario****—growth rates that the IMF staff estimates to be the* ***most likely*** *in each year of the forecast horizon. The weakening in global growth in late 2015 and the escalation of threats to global economic activity since the start of this year have led the staff to reduce the projected growth rates under the central scenario.*
>
> *Alongside these reduced central projections, the staff views* ***the likelihood of outcomes worse than those in the central scenario as having increased****. Put differently, not only is the central WEO scenario now less favorable and less likely;* ***in addition, the even weaker downside outcomes have become more likely****.*
>
> *… Over the near term, the main risks to the outlook revolve around (1) the threat of a disorderly pullback of capital flows and growing risks to financial stability in emerging market economies, (2)* ***the international ramifications of the economic transition in China****, …* ***Perceptions of limited policy space to respond to negative shocks, in both advanced and emerging market economies, are exacerbating concerns about these adverse scenarios.*** *In the euro area,* ***the persistence of low inflation*** *and its interaction with the debt overhang is also a growing concern. Beyond the immediate juncture, the danger of secular stagnation* ***and an entrenchment of excessively low inflation in advanced economies,*** *as well as of lower-than-anticipated potential growth worldwide, has become more tangible.*
>
> [Emphasis added.]

78. RBA Assistant Governor Christopher Kent, in a speech made on 6 April 2016, has used precisely the same example to illustrate the difference between central forecasts of what is most likely to occur and probability weighted consideration of all possible outcomes.[20]

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19 IMF, World Economic Outlook (WEO), April 2016, p. 24.

20 Christopher Kent, Assistant Governor (Economic), Address to the Economic Society of Australia (Hobart), University of Tasmania, Hobart – 6 April 2016. See also section 5.3 of RBA Research Discussion Paper,

> *One can also imagine scenarios that are unlikely to occur but may have far more substantial implications for the economic outlook if realised. These scenarios can be difficult to quantify but may be worth discussing nonetheless.* ***An example that we discussed in our most recent*** **Statement** ***which was the potential for financial instability in China to lead to a sharp slowdown in economic activity there and in the Asian region more broadly.***

79. The "Statement" referred to above is the February 2016 SoMP where there is a long discussion of downside risks to the forecasts associated with negative development in China which mirrors the IMF's own discussion.[21] This is repeated in the August SoMP in which the RBA states under the heading of "uncertainties":[22]

> *The forecasts are based on a range of assumptions about the evolution of some variables, such as the exchange rate and population growth, and judgements about how developments in one part of the economy will affect others. One way of demonstrating the uncertainty surrounding* ***the central forecasts*** *is to present confidence intervals based on historical forecast errors (Graph 6.3; Graph 6.4; Graph 6.5).*
>
> *It is also worth considering the consequences that different assumptions and judgements might have on the forecasts and the possibility of events occurring that are not part of the* ***central forecast***. (Emphasis added.*)*

80. Put simply, the midpoint of the RBA's forecast range cannot be assumed to be the probability weighted mean inflation expectation that is perceived by investors (and which will be reflected in nominal CGS yields). The best way to ensure that this is the case is to use inflation forecasts derived from financial market prices which automatically reflect investors' mean actuarial expectations across all possible outcomes.

5.5.1 RBA forecasts are a policy tool as well as an independent estimate

81. It is also relevant to note that the biggest challenge the RBA faces is avoiding a low inflation is the self-fulfilling prophecy of low inflation expectations. In the words of Nobel Prize winning economist Paul Krugman:[23]

Estimates of Uncertainty around the RBA's Forecasts, Peter Tulip and Stephanie Wallace, 2012-07. This article is referenced by Assistant Governor Kent in his 6 April 2016 speech.

21 See RBA, Statement On Monetary Policy, February 2016 pp. 63-64.

22 RBA, Statement On Monetary Policy, May 2016 p. 63.

23 Paul Krugman, Rethinking Japan, 20/10/2015, New York Times, The Opinion Pages (online, available at: http://krugman.blogs.nytimes.com/2015/10/20/rethinking-japan/?_r=0)

"...if nobody believes that inflation will rise, it won't"

82. If the RBA does forecast inflation to continue to be below its target range then this very act may make its task of returning inflation expectations, and ultimately actual inflation, back to within its target range more difficult. That is, RBA forecasts are a policy tool for anchoring inflation expectations as well as an expression of the RBA's view.

83. Consistent with this, break-even inflation forecasts fell materially following the release of the RBA's downgraded inflation forecast in its 5 May 2016 SoMP. In that publication the midpoint of the RBA forecast range for inflation was 2.0%; at the bottom of, but still within, the target range of 2.0% to 3.0%. This would appear to have shifted market expectations of inflation - with the 10 year break-even rate falling from 1.84% on 4 May to 1.64% on 6 May (noting that in the 5 days after the ABS release of the March quarter CPI deflation (i.e., 28 April to 4 May) the 10 year break-even rate had traded at between 1.80% and 1.84%).

84. The influence of RBA forecasts on inflation expectations creates a potential tension for the RBA. If it publishes a forecast well below its target range it risks triggering a reduction in inflation expectations that is self-fulfilling. On the other hand, the RBA must preserve its credibility and it cannot be seen to be publishing forecasts that are inaccurate or overly optimistic.

85. One way the RBA could deal with this issue is to adopt a set of central assumptions that are credible but that limit, to the extent possible, the risks that the forecast will lower expected inflation in the community. At the same time, the RBA could adopt a wide range around that forecast (which it has recently done by widening its forecast interval) and deal with potentially asymmetric risks to the central forecasts in a discursive manner. It is certainly arguable that this is consistent with the RBA's current practice.

5.6 Actual inflation has been persistently low (in Australia and internationally)

86. Figure 8 from the previous section shows that average inflation in Australia has been below 2.0% for more than the last 3 years. As discussed previously, low Australian inflation is entirely consistent with international experience across western developed countries, with inflation persistently at or below the bottom end of central bank targets.[24] RBA Governor Glenn Stevens has made the same point in a 3 May 2016 speech when announcing a further cut in the official cash rate by 25bp to 1.75%.

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24 See IMF, World Economic Outlook (WEO), April 2016. "*Headline inflation in advanced economies in 2015, at 0.3 percent on average, was the lowest since the global financial crisis, mostly reflecting the*

> *Inflation is quite low. Recent information has confirmed that growth in labour costs remains quite subdued. Given this, and with inflation also restrained elsewhere in the world, inflation in Australia* ***is likely to remain low over the next year or two.***[25]

> *Inflation has been quite low for some time and recent data were unexpectedly low. While the quarterly data contain some temporary factors,* ***these results, together with ongoing very subdued growth in labour costs and very low cost pressures elsewhere in the world, point to a lower outlook for inflation than previously forecast****.*[26] [Emphasis added]

87. The most recent statement following the August 2016 RBA rate reduction echoed the same logic.

> *Recent data confirm that inflation remains quite low. Given very subdued growth in labour costs and very low cost pressures elsewhere in the world,* ***this is expected to remain the case for some time****.*

5.7 Falling break-even inflation is a statistically significant explanatory variable for falling nominal CGS yields

88. There has been a material fall in nominal CGS returns in recent years. As seen in Figure 9, the downward trend in 10-year nominal CGS yields has been associated with a similar downward trend in break-even inflation estimates.[27]

89. If one believes, as we do, that break-even inflation estimates are an accurate measure of expected inflation, then this implies that much, indeed most, of the fall in nominal CGS yields has been due to a fall in inflation expectations – rather than falls in real yields.[28]

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sharp decline in commodity prices, with a pickup in the late part of 2015 (Figure 1.2). Core inflation remained broadly stable at 1.6–1.7 percent but was still well below central bank targets."

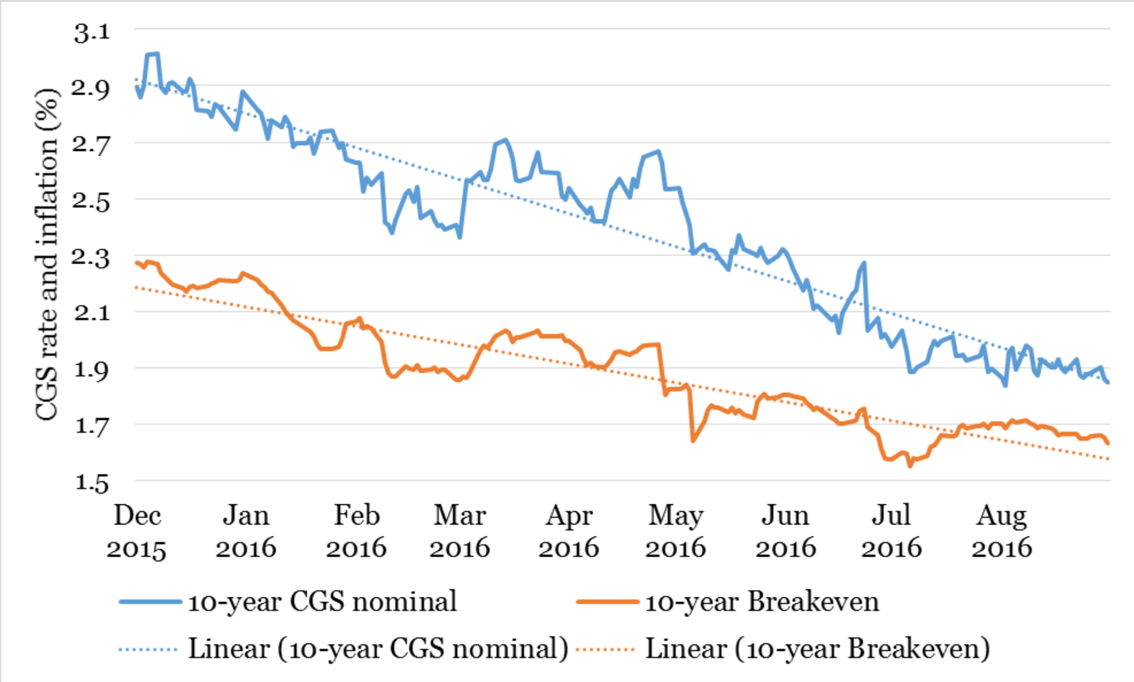
25 RBA, Statement by Glenn Stevens Governor: Monetary Policy Decision, 2016-08, April 2016.

26 RBA, Statement by Glenn Stevens Governor: Monetary Policy Decision, 2016-10, 3 May 2016.

27 Inflation is the link between nominal and real returns on assets. Other things equal, a rise/fall in expected inflation implies a rise/fall in nominal yields as investors demand more/less compensation for the erosion of the purchasing power of money.

28 This does not imply that changes in inflation expectations are the only cause of changes in nominal interest rates or that they are always the dominant cause. It may also be that real interest rates change (as they have dramatically since the GFC). However, over the period from December 2015 it is apparent that changes in inflation expectations have been the dominant driver of changes in nominal yields.

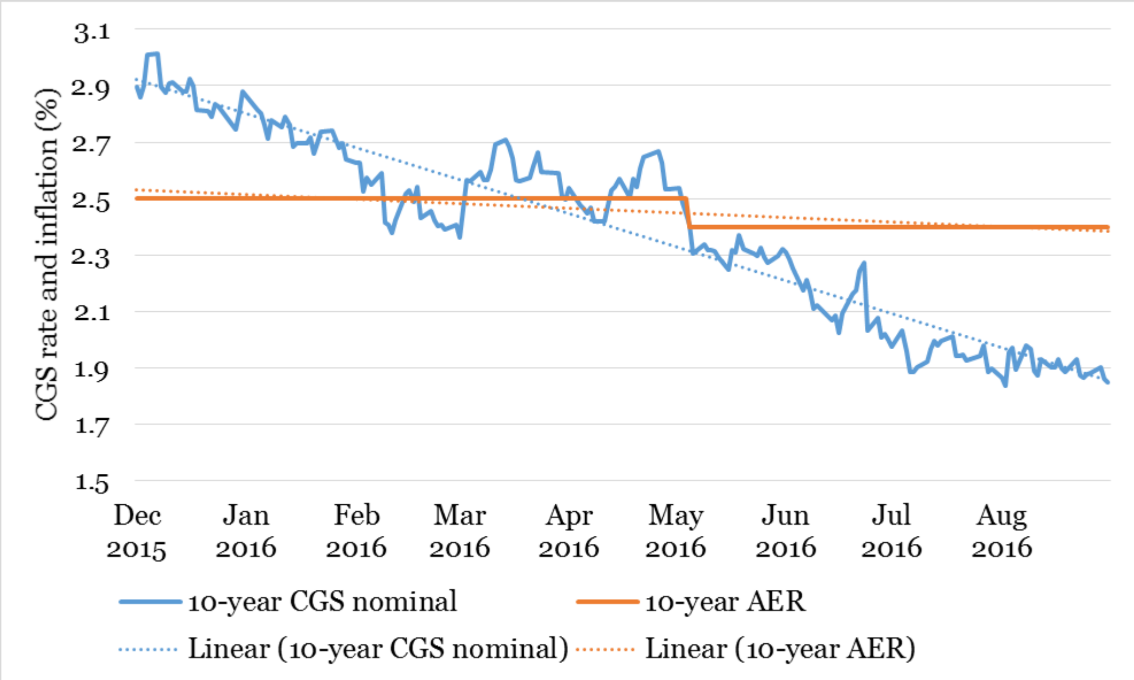
Figure 9: 10-year nominal CGS rates and 10-year breakeven inflation



Source: RBA, CEG analysis

90. By contrast, the AER's estimate of expected inflation has barely changed over this period – see Figure 10. If this was correct then almost all of the fall in nominal CGS yields would be due to falling real required returns.

Figure 10: 10-year nominal CGS rates and 10-year AER inflation



Source: AER, RBA, CEG analysis

91. The failure of the AER's inflation estimate to decline materially over this period is why, given significant declines in nominal yields, the AER's 10 year real risk free rate estimate has fallen to negative levels.

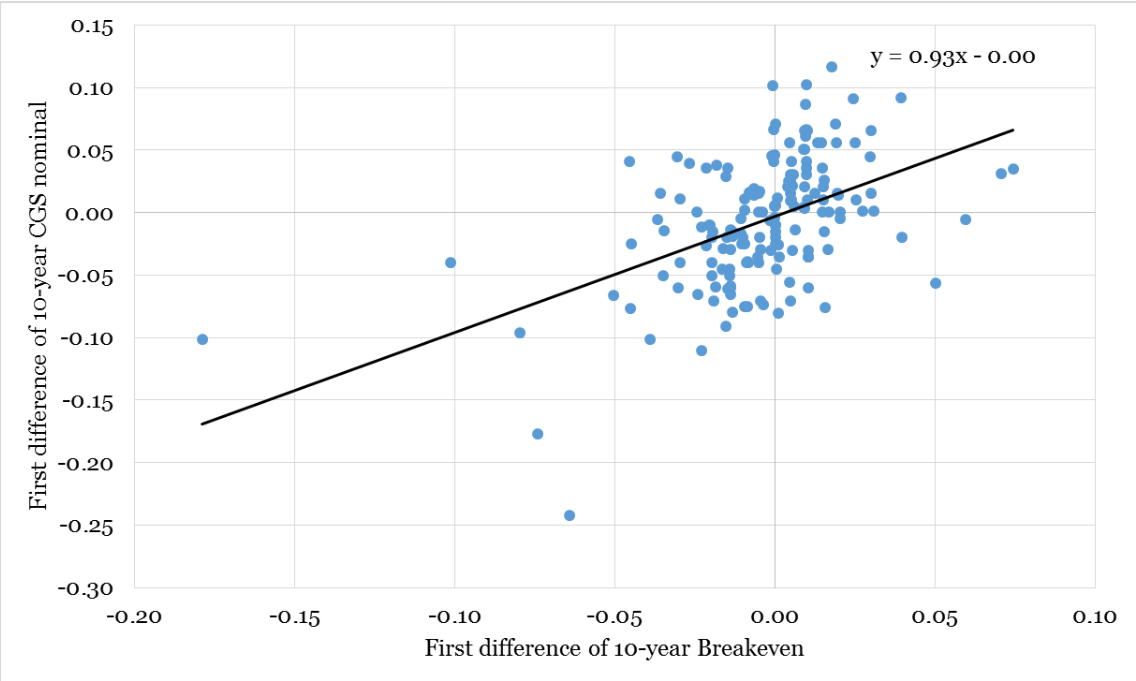
92. Our view that this is inappropriate is supported by noting that, over the course of 2016, daily changes in 10-year break-even inflation have strong explanatory power in explaining daily changes in nominal 10-year CGS yields (as one would expect of an accurate measure of expected inflation). From 31 December 2015 to 31 August 2016, regression of daily changes in CGS yields on daily changes in break-even inflation results in an estimated coefficient of 0.93, suggesting that, on average, one-unit changes in inflation expectations are reflected in changes in nominal yields by 0.93 units, as shown in Table 1 below, with the corresponding scatterplot shown in Figure 11. This coefficient is highly statistically significantly different to zero (significant at the 99% confidence level, with the standard errors of each parameter shown in parentheses).

Table 1: Regression of nominal CGS yields against inflation

	Date range	Frequency	Constant	Slope
Change in 10 year nominal CGS vs change in 10 year breakeven inflation	31/12/15 – 31/8/16	Daily	-0.00 (0.00)	0.93 (0.13)
Change in 10 year nominal CGS vs change in 10 year breakeven inflation	31/12/05 – 30/6/16	Quarterly	-0.05 (0.04)	1.08 (0.15)
Change in 10 year nominal CGS vs change in 10 year AER inflation	31/12/05 – 30/6/16	Quarterly	-0.07 (0.06)	0.06 (1.17)

Source: Bloomberg, RBA, CEG analysis

Figure 11: 10-year nominal CGS and 10-year breakeven inflation (31 Dec 2015 to 31 August 2016, daily)



Source: RBA, CEG analysis

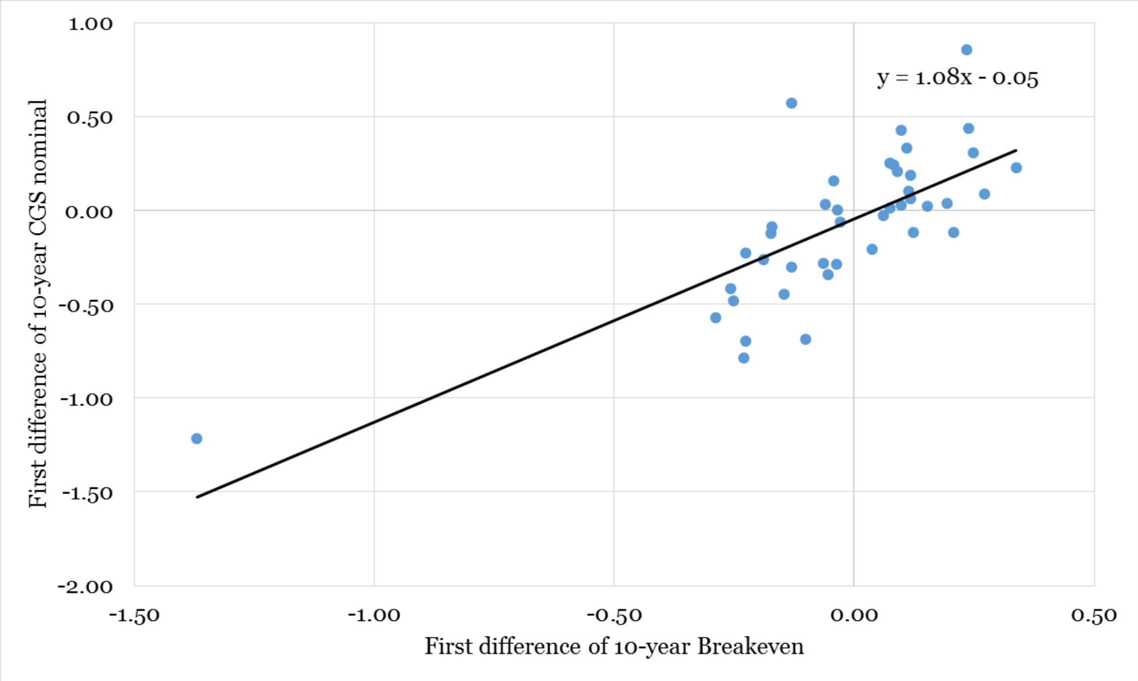
93. Since AER inflation is only updated on a quarterly basis we cannot perform daily analysis to test the AER's inflation estimates' explanatory power. We therefore repeat the regression using quarterly data over a longer timeframe from December 2005 to June 2016.

94. Once again, the slope coefficient of 1.08 for breakeven inflation is close to 1, and is statistically significant, as shown in Table 1 above and Figure 12. On the other hand, the slope coefficient of 0.06 for AER inflation is close to zero and is not statistically significant, as shown in Table 1 above and Figure 13.

95. The AER inflation estimates therefore have little explanatory power over 10-year nominal CGS rates, leading to the counterintuitive implication that the fall in nominal

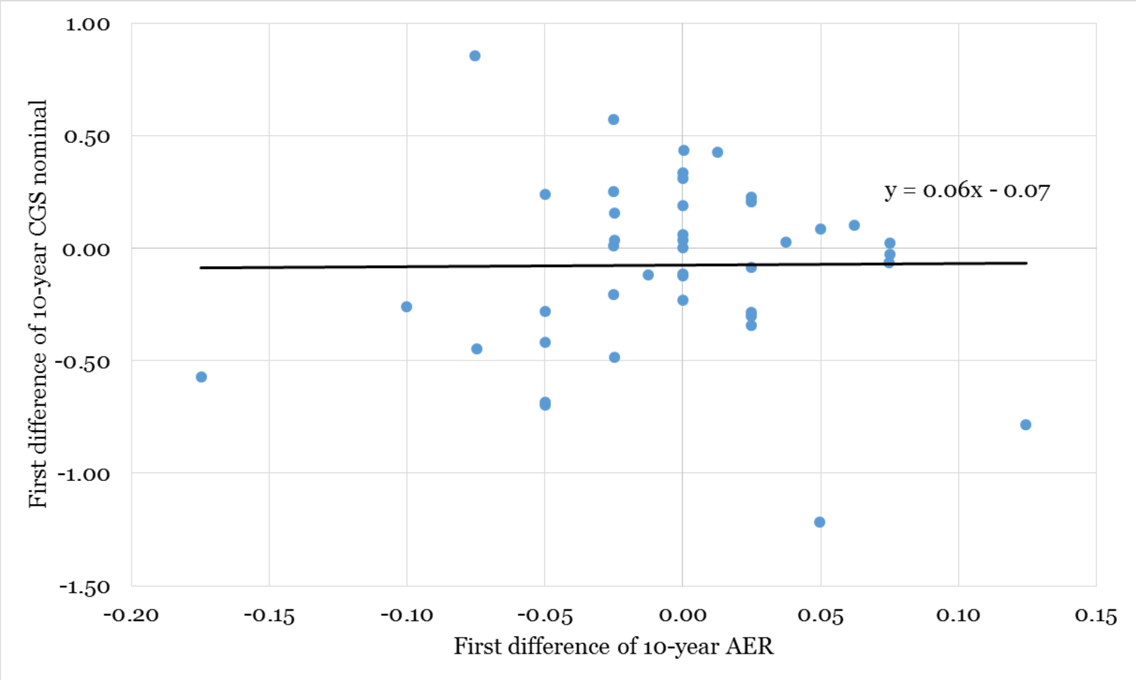
CGS yields over the last 10 years is almost completely attributed to a fall in real yields as opposed to a fall in inflation expectations. Such an implication has been demonstrated to be false, as seen in the discussion above.

Figure 12: 10-year nominal CGS and 10-year breakeven inflation (31 Dec 2005 to 30 June 2016, quarterly)



Source: RBA, CEG analysis

Figure 13: 10-year nominal CGS and 10-year AER inflation (31 Dec 2005 to 30 June 2016, quarterly)



Source: AER, RBA, CEG analysis

5.8 Conclusion

96. Based on the analysis in this section, the AER's estimate of forecast inflation is unrealistically stable (by virtue of AER assumption rather than any external evidence) and has not responded materially to the dramatically changing inflation environment. Moreover, the AER's estimate does not have the desired power to explain movements in nominal CGS yields. The failure of the AER's expected inflation estimate to fall the face of falling actual inflation and falling nominal yields has led to it overestimating any reasonable estimate of the expected inflation that is built into 10 year CGS yields (and, even more so, the inflation over 5 years that is expected to be used to roll forward the RAB). A consequence of this is the AER's implied estimate of required real returns on risk free assets is negative – despite investors having the option to invest in inflation indexed CGS that guarantee positive real returns.

97. By contrast, there are strong theoretical reasons for believing break-even inflation will provide the best measure of expected inflation in the current context (both regulatory and market). The breakeven approach has responded to the dramatically changing inflation environment. Changes in break-even inflation do have the desired power to explain movements in nominal CGS yields. Break-even inflation also has a much better track record in predicting actual inflation outcomes over recent years. In light of these considerations break-even inflation provides a materially better

estimate of the inflation expectations built into prevailing 10 year CGS yields (and, even more so, the inflation over 5 years that is expected to be used to roll forward the RAB).

6 Quantification of potential sources of bias in break-even inflation

98. This section provides a review of literature on issues related to RBA forecasts and break-even inflation as raised in the AER's draft decision[29]. It is broken into two parts consisting of a review and discussion of the results in papers:

- cited by the AER; and
- other papers not cited by the AER.

99. The overwhelming conclusion of this literature survey is that the potential sources of bias alluded to by the AER are small and just as likely to result in an over-estimate of expected inflation as an underestimate. Certainly, it is not plausible that these account for the current 70bp difference between break-even inflation and the AER's estimate of expected inflation.

[29] AER, AusNet Services transmission determination 2017-28 to 2021-22, Draft Decision, Attachment 3 – Rate of return, July 2016.

Table 2: Summary of literature on bias in break-even inflation

Paper	AER criticism	Actual findings	CEG Comments
		Research cited by AER	
Tulip and Wallace (2012)	RBA forecasts are historically more accurate than private sector forecasts	No significant difference between RBA and private sector forecasts	RBA only provides forecast intervals up to 2 years ahead. Our main criticism pertains to the AER's use of the midpoint of the fixed interval*, as well as its 2.5% assumption for the remaining 8 years.
D'Amico, Kim and Wei (2010)	Breakeven estimates are biased and require adjustment	Excluding the GFC, break-even inflation has mostly been similar to, or above, inflation expectations	The paper's conclusion suggests that if any adjustment is needed, it would be a downward adjustment. Given that break-even inflation is already lower than the AER's forecasts, this suggests that the former is a more accurate estimate.
Scholtes (2002)	Bond convexity could bias long-term inflation rates below expectations	The possibility of convexity bias was stated but not estimated.	Ang, Bekaert and Wei (2008) find that convexity bias amounts to less than 1 bp, even at longer maturities
Grishchenko and Huang (2012)	Inflation risk premium bias ranges from -0.16 to 0.10	Over 2000-2008, inflation risk premium ranges from -16 to 10. Over 2004-2008, the range is 14 to 19.	The risk premium in the longer sample has a range with a midpoint close to zero, while the shorter more recent sample has a range that suggests break-even inflation substantially overestimates expected inflation. The earlier period in the longer sample reflects a period when TIPS was still new, and may not reflect current conditions. The authors also explicitly state that they consider the second set of estimates (14-19) as more reasonable.
Shen and Corning (2001)	Liquidity premium is: (1) likely to be greater during periods of uncertainty; and (2) is difficult to identify and remove	No support for (1) in the paper. (2): Breakeven inflation calculated from TIPS is lower than estimates from surveys, but study was conducted while TIPS was new. The liquidity premium is likely to decline, allowing closer approximations of market inflation expectations.	With regard to (1), note that a high liquidity premium during the GFC cannot be generalised as applying broadly to "periods of uncertainty". Shen and Corning (2001) were careful to note that TIPS was still new when their study was done, and also stated that experience from UK suggests that the liquidity premium would decline.

Paper	AER criticism	Actual findings	CEG Comments
Literature not cited by AER			
Ang, Bekaert and Wei (2008)	-	Convexity bias amount to less than one basis point, even for longer maturities. Inflation risk premium is 114 bp on average over the period studied.	Our own simulation modelling also finds the convexity bias to be trivial, and is insufficient to explain the gap between break-even inflation and the AER's estimate. Inflation risk premium has historically been positive.
Pflueger and Viceira (2015)	-	TIPS liquidity premiums fell below 50 bp from 2012 onwards. Liquidity premium is lower in the UK than the US.	The study was carried out by regressing breakeven inflation on variables related to liquidity. However, the sample includes periods when TIPS was first introduced, which is likely to bias the results. Their results also suggest that there may be instability in their estimates.
Lehman Brothers (2006)	-	For the 3-year forward rate, convexity bias is 4 bp, inflation risk premium is 35 bp, liquidity premium is 15 bp.	The net bias is an underestimation of expected inflation by 16 bp, even after including liquidity premium in indexed bonds.
Banco Central do Brasil (2014)	-	Liquidity premium for Brazilian indexed bonds is not statistically different from zero. Inflation risk premium is positive for all bonds majority of the time.	The net effect of liquidity premium and inflation risk premium is that break-even inflation is more likely to over-estimate expected inflation.
Coroneo (2016)	-	Using a dynamic factor model, the liquidity premium has been close to zero since 2005, aside from the GFC. During the quantitative easing period, liquidity premium was negative.	-

*Source: Articles and CEG analysis; *The RBA's does not derive its forecast interval in a manner that sets its point estimate as the midpoint of the interval. Instead, the interval is obtained by taking the closest 25 bp unit and then placing the interval at ±50 bp around it.*

6.1 Liquidity premium

100. Before proceeding with a discussion of teach individual paper it is useful to make a few observations about the existence or otherwise of a 'liquidity premium'. The first point to note is that in much of the literature the reported 'liquidity premium' is, in

reality, an error term in the analysis. It is the term given to the amount of the difference between nominal and indexed government bonds that is not explained by the other factors in the researchers' models. For example, D'Amico, Kim and Wei (2016) estimate a TIPS[30] liquidity premium that has historically been negative (i.e., associated with breakeven inflation underestimating expected inflation) but has recently been positive (i.e., associated with breakeven inflation overestimating expected inflation). This is despite the fact that TIPS are generally acknowledged to have been less liquid than nominal US Treasuries over the entire period.

101. However, there is a specific theoretical reason for the existence of a liquidity premium. Investors will have a preference for assets that are more liquid because those assets allow them to optimise their portfolios at lowest cost. Specifically, a 'liquid' market is one where an individual investor can expect to be able to buy or sell into the market without their personal transaction having a significant impact on the price paid/received in the transaction.

102. In reality, both indexed and nominal CGS are highly liquid. This means that the value investors place on any differential in liquidity is likely to be trivial. Both the nominal and indexed CGS markets are highly liquid with turnover of around $1,000bn and $50bn respectively. While the turnover in nominal bonds is around 20 times larger both are very large in absolute magnitude.

103. Moreover, liquidity is a function of the ability of an investor to divest their holding without moving the market and, given that investors' holdings on nominal CGS tend to be larger, the absolute turnover must be adjusted for the average holding of these bonds in an investor's portfolio. The standard way to do so is to divide turnover rates by total outstanding stock in order to provide the 'turnover ratio'. The Australian Financial Markets Association produces this metric for nominal CGS and it has fallen from 5.2 in 2007/08 to 3.2 in 2014/15.[31] A similar metric for indexed CGS was around 1.2 in 2007/08 and 2.0 in 2014/15.[32] On this metric, liquidity in nominal CGS is only modestly higher than for indexed CGS.

104. Moreover, it is important to note that investors valuation of additional liquidity falls to zero as soon as they are confident that their own trading will not move the market against themselves. That is, if I am already confident that I will not move the CGS market against myself when trading, then I receive no advantage, and will not value CGS any higher, if the turnover in the market doubles/quadruples. Both nominal and indexed CGS are a homogenous product that are very easy to value (i.e., there are not

30 US Treasury Inflation Protected Securities.

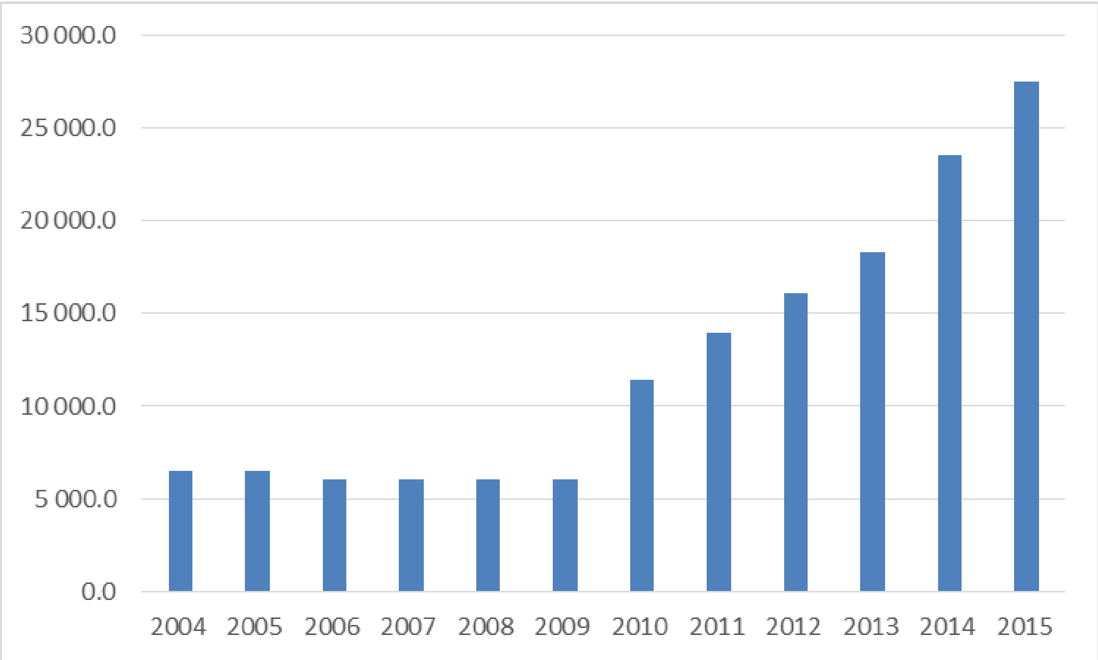
31 AFMA, 2008 and 2015 Australian Financial Markets Report.

32 AFMA does not explicitly present this ratio but it can be calculated as total turnover in index linked CGS (e.g., $51bn in 2014-15) divided by total bonds outstanding available from AOFM ($25.5bn average of beginning and end of year outstanding in 2014-15).

the same 'inside information issues' that arise with trading corporate equity and debt) and are very large in size (and turnover relative to size). It is therefore reasonable to assume that the potential value of incremental increases in turnover/liquidity ratio when moving from indexed CGS to nominal CGS are very small. That is not to say that there might be a more material liquidity premium when moving from CGS to less liquid assets (such as corporate debt/equity or real-estate). However, there is no reason to believe that a material liquidity premium exists when moving from indexed to nominal CGS – at least not in normal market circumstances (see discussion of GFC in section 7.2.3 below).

105. In this regard we note that in 2007/08 when the Government had ceased issuing indexed CGS and the liquidity ratios for nominal CGS were much higher (around 5 times) those of indexed CGS it is accepted by the AER that, if anything, breakeven inflation was overestimating expected inflation. (This was around the time that the AER ceased relying on break-even inflation on the basis that it was over-estimating expected inflation.) It is generally accepted that this reflected a lack of supply of indexed CGS at that time – a lack of supply that has been reversed with fivefold increase in indexed CGS on issue.

Figure 14: Indexed CGS on issue



Source: AOFM

106. The relevant point here is that when indexed CGS were relatively much less liquid than they are today there was no evidence that a differential liquidity premium was causing break-even inflation to under-estimate expected inflation – in fact the opposite was accepted as being the case.

6.2 Research Cited by AER

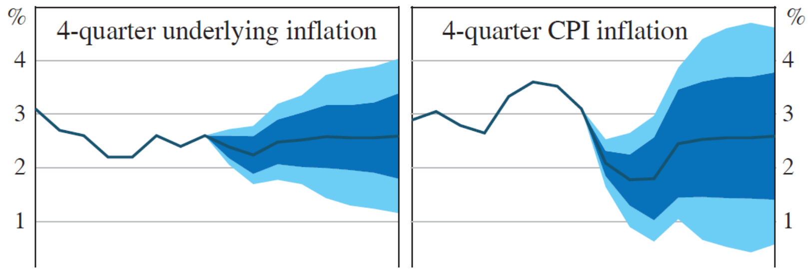
6.2.1 Tulip and Wallace (2012)[33]

107. Regarding the quality of RBA forecasts, the AER cites from Tulip and Wallace (2012), to state that the RBA's *"1 year forecasts of inflation have substantial explanatory power and in the past RBA forecasts have been marginally more accurate than private sector forecasts."*

108. First, we note that our main concern with the AER's forecast methodology is not with the use of RBA forecasts for the first two years but with the assumption of 2.5% inflation in all subsequent years. Relatedly, we note that the point of interest to us is the relative accuracy of break-even inflation expectations versus AER year estimates of inflation – an issue not addressed by Tulip and Wallace (at the 10 year horizon or any other horizon). We have addressed this issue in section 5 of this report and find break-even inflation is superior.

109. In any event, Tulip and Wallace (2012) report wide confidence intervals for the RBA forecasts as illustrated in Figure 15. For underlying inflation, actual inflation lies outside a 100bp range 30% of the time. For CPI inflation the actual inflation will lie outside a 200bp range 30% of the time.

Figure 15: 70% and 90% Confidence Interval for RBA forecasts



Source: Tulip and Wallace (2012)

110. Furthermore, comparing the accuracy of RBA forecasts relative to forecasts by the private sector, Tulip and Wallace (2012) states *"the differences are small and not statistically significant"*. That is, the RBA is forecasts are not found to be statistically significantly different to other forecasts.

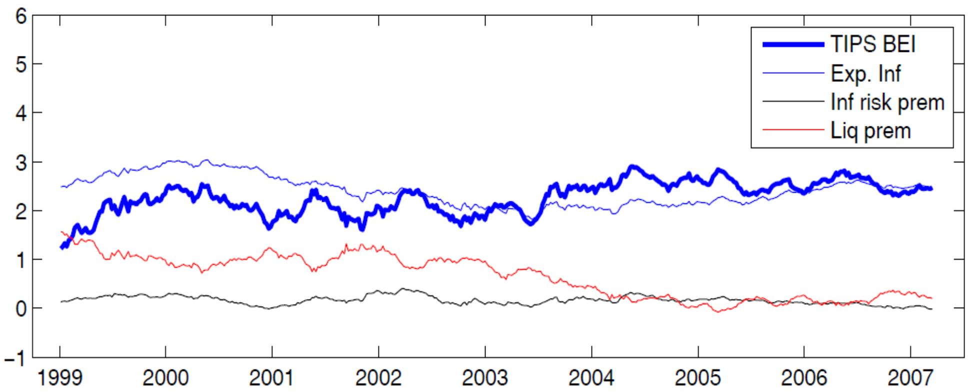
33 Tulip, P., Wallace, S., (2012) "Estimates of uncertainty around the RBA's forecasts", RBA Research Discussion Paper – November 2012, RDP2012-07.

6.2.2 D'Amico, Kim and Wei (2010)[34]

111. The AER references D'Amico, Kim and Wei (2010) and says, "*breakeven estimates require adjustment to account for several different types of bias*." The AER mentioned this paper in passing, claiming that it supports the view that some adjustments are required for expected inflation. However, the AER fails to mention the methodology to breakdown the components proposed by D'Amico, Kim and Wei (2010) and the findings on the net effect of the bias.

112. The result of D'Amico, Kim and Wei (2010) is summarised in Figure 16. This clearly shows break-even inflation at*, or above*, expected inflation from around 2002.

Figure 16: Decomposing 10-year TIPS Breakeven Inflation D'Amico, Kim and Wei (2010)

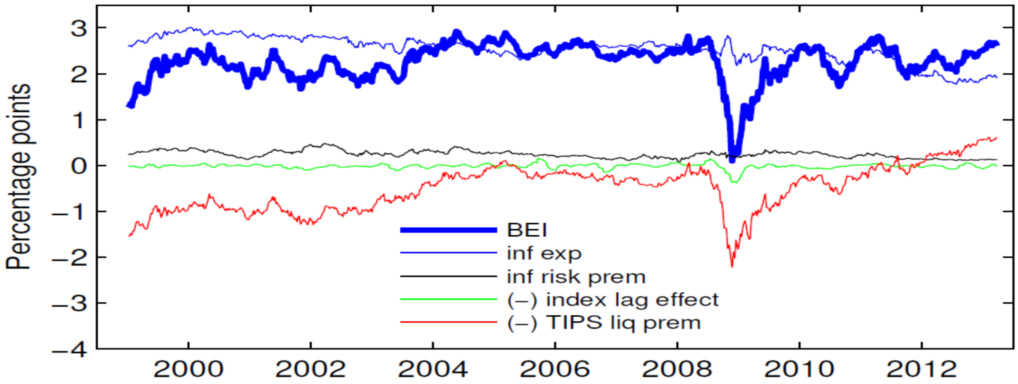


Source: D'Amico, Kim and Wei (2010)

113. Figure 17 and Figure 24 show an update of the same estimates in a subsequent 2014 paper by the same authors (this time including the index lag effect). The thick blue line is breakeven inflation, the thin blue line is the expected inflation, the black line is the inflation risk premium, the green line is the index lag effect and the red line is the liquidity premium. Once more, since the early 2000s, but with the exception of the GFC, break-even inflation has been very similar to inflation expectations and, most recently, above. The authors estimate that in 2013, there is a negative liquidity premium, indicating a preference for indexed bonds compared to nominal bonds.

34 D'Amico, S., Kim, D.H., Wei, M., (2010) 'Tips from TIPS: the informational content of Treasury inflation-protected security prices', Federal Reserve Board, 2010-19 (Draft Version December 29, 2009)

Figure 17: Decomposing 10-year TIPS Breakeven Inflation D'Amico, Kim and Wei (2016)



Source: D'Amico, Kim and Wei (2014) [35]

6.2.3 Scholtes (2002)[36]

114. The AER cites Scholtes (2002) when it describes "the differences in bond convexity bias could bias long-term breakeven inflation rates below inflation expectations." While Scholtes (2002) does not attempt to estimate the impact of the convexity bias, Ang, Bekaert and Wei (2008)[37] has found that the "*convexity bias amount to less than one basis point, even for longer maturities*".[38]

6.2.4 Grishchenko and Huang (2012)[39]

115. We also note that the AER cites Grishchenko and Huang (2012), which finds that the "the inflation risk premium to range from -0.16 to 0.10." However, the -0.16 to 0.10 range is not the inflation risk premium in its strictest definition, rather it is the bias after taking into account the liquidity premium, and it can therefore be considered as the net bias. Grishchenko and Huang (2012) states: "*…if we add a monthly average*

35 D'Amico, S., Kim, D. H., and Wei, M., (2014) "Tips from TIPS: the Informational Content of Treasury Inflation-Protected Security Prices," FEDS Working Paper 2014-24 (Draft Version February 19, 2016)

36 Scholtes, C., (2002) "On market-based measures of inflation expectations", Bank of England Quarterly Bulletin, Spring 2002

37 Ang, A., Bekaert, G., Wei, M., (2008) "The Term Structure of Real Rates and Expected Inflation," Journal of Finance, Volume 63, No 2, pg 797-849

38 Further discussion of Ang Bekaert and Wei (2008) is in Section 6.3.1 Ang, Bekaert and Wei (2008)

39 Grishchenko, O., Huang, J.Z. (2012), "Inflation Risk Premium: Evidence from the TIPS market", Finance and Economics Discussion Series Divisions of Research and Statistics and Monetary Affairs, Federal Reserve Board, Washington, D.C. 2012-06

liquidity adjustment to it,…, we obtain the estimates that vary from -16 to 10 basis points."[40] That is, an average very close to zero.

116. Furthermore, the analysis is done for the whole sample from 2000 to 2008. If the result is restricted to the sample period from 2004 to 2008, Grishchenko and Huang (2012) finds "*that 10-year inflation risk premium is between 14 and 19 basis points*," after taking into account the liquidity adjustment. That is, when the sample is limited to after 2004, after the TIPS market has matured, Grishchenko and Huang (2012) finds that breakeven inflation lies within the range of 19 basis points above to 14 basis points above expected inflation on average. That is, break even inflation *overestimates* expected inflation by around 14-19 bp.

117. When comparing the two sets of estimates (-16 to 10 bp versus 14 to 19 bp), the authors explicitly noted that they favoured the second set of estimates [emphasis added]:[41]

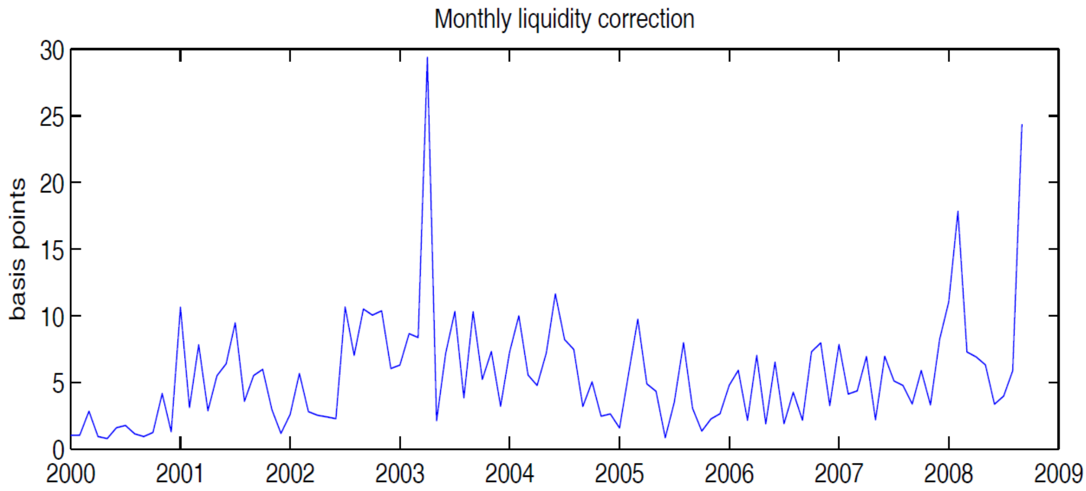
> *As a result of the above discussion of causes of negative inflation risk premia,* ***we consider the estimates of inflation risk premium obtained over the second half of the sample period to be more reasonable****. Furthermore, we focus on estimates relative to CPI but not core CPI as TIPS are indexed to the former.* ***As such, we conclude that the 10-year inflation risk premium ranges between 14 and 19 b.p.****, depending on the proxy used for expected inflation, based on our empirical analysis and when we correct for liquidity using a liquidity adjustment (28).*

118. Figure 18 reports the monthly average liquidity premium reported by Grishchenko and Huang (2012). It shows that, with the exception of a month in 2003 and the period of the 2008/09 GFC, the liquidity premium is generally around 10 basis points or less.

40 In Section 5.4 Liquidity correction of Grishchenko and Huang (2012).

41 Grishchenko, O., Huang, J.Z. (2012), "Inflation Risk Premium: Evidence from the TIPS market", Finance and Economics Discussion Series Divisions of Research and Statistics and Monetary Affairs, Federal Reserve Board, Washington, D.C. 2012-06, p. 30.

Figure 18: Liquidity Premium in Grishchenko and Huang (2012)



Source: Grishchenko and Huang (2012)

6.2.5 Shen and Corning (2001)[42]

119. Shen and Corning (2001), published only a few years after the introduction of TIPS, is also cited by the AER. The AER cites this paper in support of its two statements that:[43]

> *This premium is likely to be greater during periods of uncertainty when there is a 'flight' to more liquid nominal bond markets*

> *Liquidity bias can be material and difficult to identify and remove from the breakeven rate—particularly as evidence indicates that it can vary considerably over time.*

6.2.5.1 Liquidity premium and the GFC

120. We do not find support for the first statement in Shen and Corning. However, we do agree with the AER's statement and, as is explained in section 7.2.3, consider that in times of very high liquidity premium (as observed during the GFC) it is nominal government bond yields that are depressed by a "liquidity premium" making them an inappropriate foundation from which to build up a real rate of return for illiquid corporate financing instruments.

42 Shen, P., Corning, J., "Can TIPS Help Identify Long-Term Inflation Expectations?', Federal Reserve Bank of Kansas City, Economic Review, Fourth Quarter 2001, pp. 61–87.

43 AER, AusNet Transmission Draft Decision, p. 3-134 and p. 3-136.

121. In relation to the experience during the GFC, D'Amico, Kim and Wei (2014)[44] does show that the liquidity premium for TIPS rose up dramatically as seen in Figure 17 above. However, this experience is specific to the most significant financial crisis since the great depression. It is unreasonable to proceed 'as if' such volatility is a random and difficult-to-discern event that could be materially depressing break-even inflation now.

122. Relevantly, D'Amico, Kim and Wei (2014) argue that part of the reason for the high liquidity premium in the GFC is because of the liquidation of TIPS holdings following the Lehman collapse. The reason, as explained by Haubrich, Pennacchi, Ritchken (2012)[45], is due to:

> *Lehman's use of substantial amounts of TIPS to collateralize its repo borrowings and derivative positions. Lehman's bankruptcy led to creditors releasing a flood of TIPS into the market at a time when there were few willing buyers. Many hedge funds that had bought TIPS also were forced to sell to meet withdrawals by clients.*

6.2.5.2 Liquidity premium can be "material and difficult to identify"

123. Shen and Corning's (2001) support for the AER's second statement must be tempered somewhat by the fact that Shen and Corning (2001), published in 2001, claim difficulty in assessing the use of TIPS as a forecast for inflation due to the "*short history of TIPS*". Moreover, the method used by Shen and Corning (2001) to arrive at an estimate of the liquidity premium is, in retrospect, highly problematic. Shen and Corning compare the breakeven spread against:

- historical 10-year average consumer price index inflation from 1960 to 2000; and
- survey forecasts of economists.

124. Shen and Corning (2001) find the breakeven inflation to be 87 basis points lower than the (latter) survey on average. Assuming the survey of forecasts by economists is the same as the inflation expectation of investors, Shen and Corning (2001) attributes the difference to liquidity premium. This is a very strong assumption (i.e., unlikely to be true).

125. In any event, Shen and Corning (2001) note that, given the relative newness of TIPS and its uniqueness, its low trade volumes were likely causing liquidity premiums in the yields of TIPS. The high liquidity premium in the first few years after the introduction of TIPS is corroborated in more recent research which is illustrated in

44 D'Amico, S., Kim, D. H., and Wei, M., (2016) "Tips from TIPS: the Informational Content of Treasury Inflation-Protected Security Prices," FEDS Working Paper 2014-24 (Draft Version 2016)

45 Haubrich, J., Pennacchi, G., and Ritchken, P., (2012) "Inflation Expectations, Real Rates, and Risk Premia: Evidence from Inflation Swaps," Review of Financial Studies, Volume 25, No 5, pg 1588-1629

Figure 24. Research by D'Amico, Kim and Wei (2016) shows that breakeven inflation is persistently lower than the expected inflation prior to 2004.

126. Shen and Corning (2001) remark that in the UK, where inflation indexed bonds had a longer history and were traded at a higher rate compared to the U.S., "*the liquidity difference there is much smaller*", and "*the liquidity premium on indexed debt is smaller than the inflation risk premium on conventional debt.*" Shen and Corning (2001) also state that "*if the current trends continue, indexed Treasuries should become liquid and the liquidity premium should gradually decline, allowing the yield spread to more closely approximate market inflation expectations*." In fact this can be seen in Figure 17, where the breakeven inflation has either hovered around or lie above the expected inflation.

6.3 Other Literature not cited by AER

6.3.1 Ang, Bekaert and Wei (2008)[46]

127. Ang, Bekaert and Wei (2008) analyse the breakeven spread between nominal bonds and indexed bonds by breaking it down into two components: expected inflation; and inflation risk premium. Regarding convexity, the paper concludes that the "*convexity bias amount to less than one basis point, even for longer maturities.*"

128. This is a consistent finding across other papers and our own simulation modelling[47] of this potential source of bias (including surveyed below). That is, it is trivial in magnitude and cannot be expected to make any contribution to explaining the gap between break-even inflation and the AER estimates.

129. However, the paper does find a material source of bias in the form of the inflation risk premium. Figure 19 shows its estimated inflation risk premium for a 5 year bond. The grey lines are two standard deviation intervals and the grey bars are periods of recession. The average inflation risk premium calculated is approximately 1.14 percentage points.

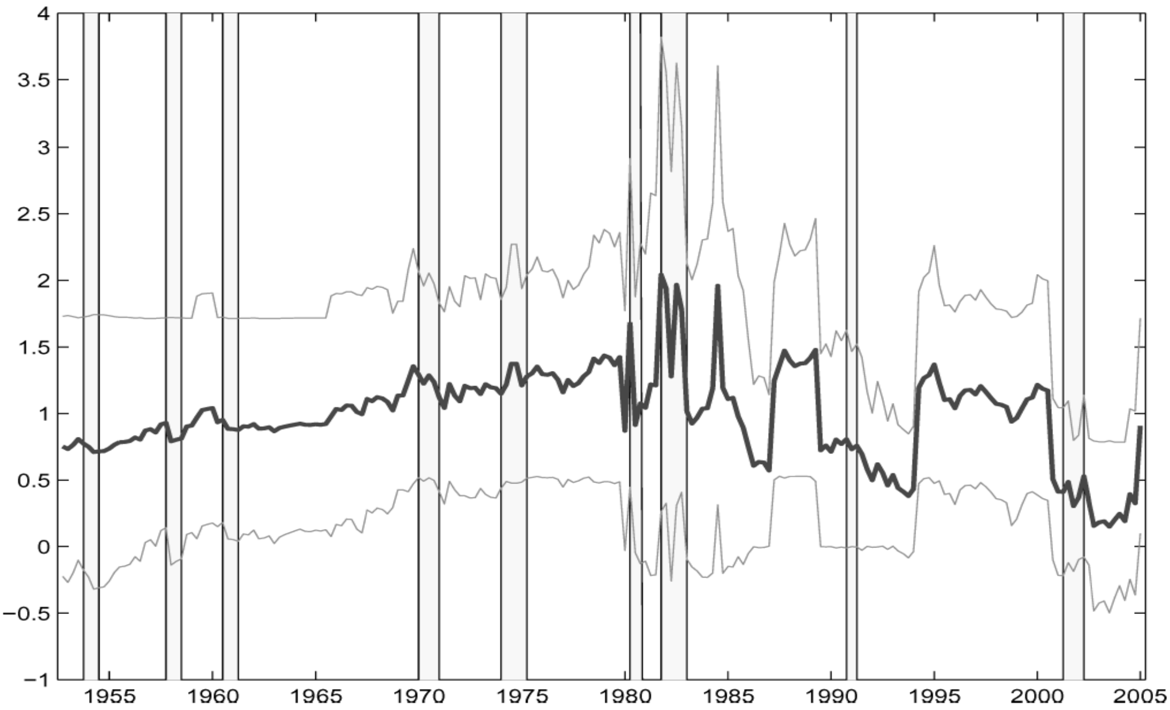
130. That is, based on this element of 'bias' identified by the AER break-even inflation would tend to *overestimate* expected inflation by around 1.14% over the period studied. This is the average of the dark line in the below chart. This shows the value is never negative but has been lower since the 1980s (consistent with more stable inflation outcomes in that period). However, even in that period it has averaged around 50bp.

46 Ang, A., Bekaert, G., Wei, M., (2008) "The Term Structure of Real Rates and Expected Inflation," Journal of Finance, Volume 63, No 2, pg 797-849

47 See 7.2.3Appendix C Convexity Bias.

131. This means that any other bias (namely liquidity/index lag effect) would have to make up approximately 50bp in order to make the total bias negative (i.e., lead to an understatement of expected inflation).

Figure 19: Inflation Risk Premium



Source: Ang, Bekaert and Wei (2008)

6.3.2 Pflueger and Viceira (2015)[48]

132. Pflueger and Viceira (2015) calculates the highest liquidity premium for the U.S. TIPS. It adopts a different approach for determining the liquidity premium. Pflueger and Viceira (2015) regresses the breakeven inflation on variables that may indicate liquidity issues[49] and published expected inflation. The component of the regression with variables related to liquidity issues is considered as the liquidity premium. The result is illustrated in Figure 20, it finds the liquidity premium for the U.S. TIPS to be approximately 50 basis points or more up to 2010. After 2012, TIPS liquidity

48 Pflueger, C. E. and Viceira, L. M., (2015) "Return Predictability in the Treasury Market: Real Rates, Inflation, and Liquidity", Working Paper, (Draft Version February 2015)

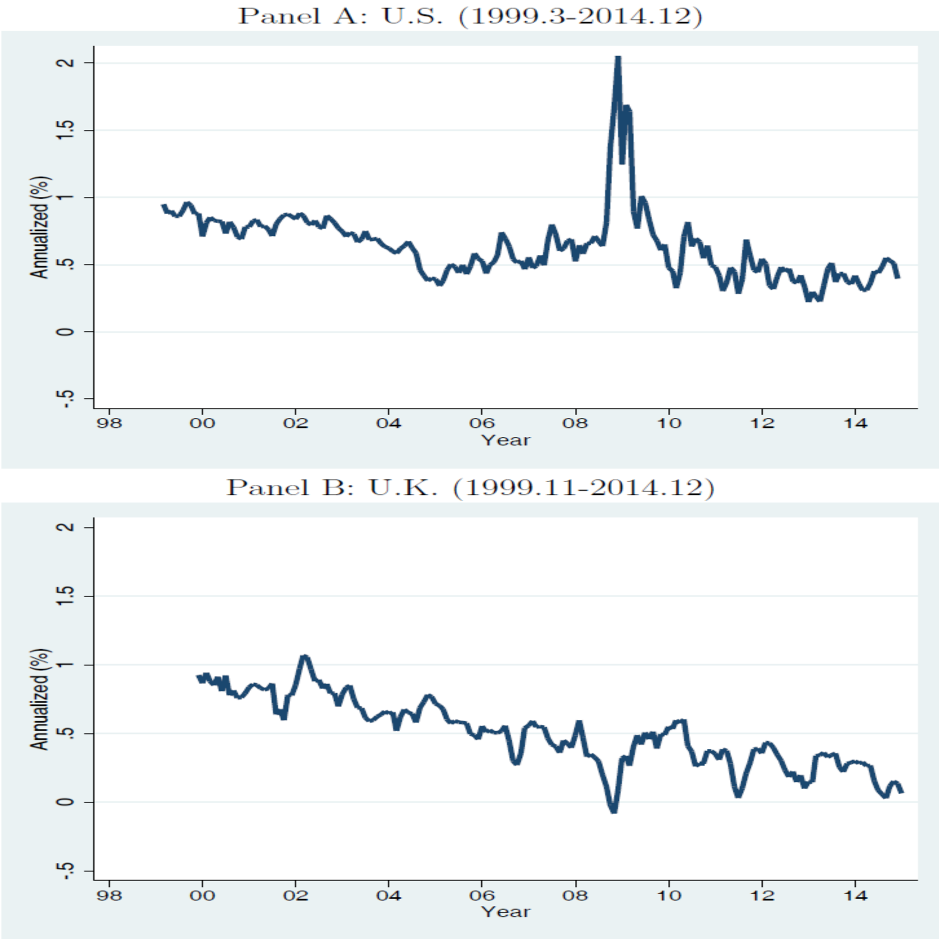
49 The variables are the spread between on-the-run nominal bonds and off-the-run nominal bonds; synthetic and cash breakeven inflation differential; and transaction volume ratio between nominal bonds and TIPS.

premiums have fallen to below 50 basis points. However, it finds much lower liquidity premium in the U.K. TIPS where it has fallen below 50 basis points since 2006.

133. Since the coefficients on the variables related to liquidity do not change over time, the model utilised by Pflueger and Viceira (2015) assumes a constant relationship between liquidity premium and the explanatory variables. If these variables do not explain all the movements of liquidity premium across time, the liquidity premium will be over-estimated for some time periods and under-estimated for other time periods. This is because the coefficient is trying to capture the average relationship between the liquidity premium and the explanatory variables. Since Pflueger and Viceira's (2015) sample includes the periods when TIPS are first introduced and the global financial crisis, which exhibits high liquidity premium, the estimation will overestimate the relationship between the liquidity premium and the explanatory variables in other periods.

134. Pflueger and Viceira (2015) do not test the stability of the estimated coefficient or allow for the removal of the impact of the global financial crisis and introductory period of TIPS. Pflueger and Viceira (2015) do run a separate regression for the period prior to the global financial crisis and finds that the estimated coefficient for two of the liquidity indicators is no longer statistically significant, which may indicate instability in the coefficient.

Figure 20: Liquidity premium in Pflueger and Viceira (2015)



Source: Pflueger and Viceira (2015)

6.3.3 Lehman Brothers (2006)[50]

135. Lehman Brothers (2006) discusses how it managed convexity, inflation risk premium and liquidity in its valuation framework. Lehman Brothers (2006) does not report the size of the premiums for a 5 year bond, however it reports the premiums for a 3 year forward rate, two years forward which approximate a 5 year bond. The use of forward rates (rather than spot rates) will exaggerate the impact of convexity. For the 3 year forward rate, two years forward, the convexity bias is 4 basis points, the inflation risk premium is 35 basis points, and the liquidity premium is 15 basis points. Therefore the net bias is an *underestimation* of the expected inflation by 16 basis points – even including any liquidity premium in indexed bonds.

50 Lehman Brothers, (2006) "A TIPS Valuation Framework," U.S. Interest Rate Strategy, Fixed Income Research,

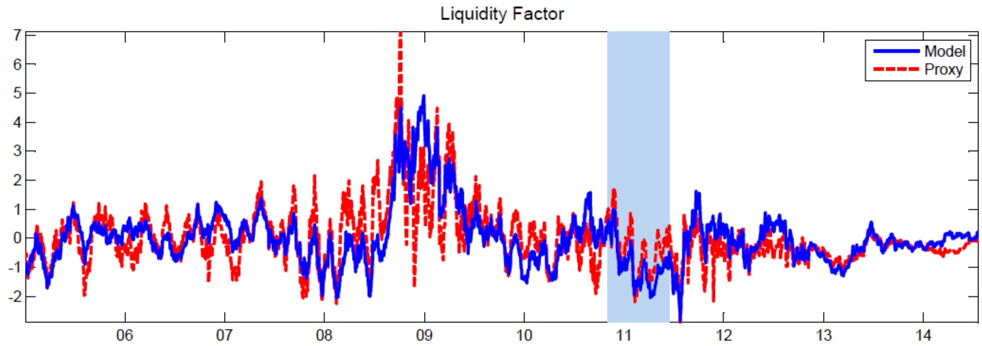
6.3.4 Banco Central do Brasil (2014)[51]

136. Banco Central do Brasil (2014) analyses breakeven inflation for Brazilian indexed bonds with horizon between 1 to 4 years. It concludes that its convexity bias is close to 1 basis points for these bonds (once more, trivial). It finds that the "*liquidity premium is not statistically different from zero.*"

6.3.5 Coroneo (2016)[52]

137. Coroneo (2016) attempts to measure the size of the TIPS liquidity premium using a dynamic factor model. The model separates the TIPS yield into two components, the real interest rate component that causes movements in both the nominal yield and TIPS yield, and the liquidity component that causes movements only in the TIPS. Corneo (2016) also checks the robustness of its result by extrapolating the liquidity premium via inflation swaps. The model obtains the real interest rate via the difference in the nominal yield and inflation swaps, which is then used to generate a proxy for liquidity. The result is presented in Figure 21. It shows that other than the period during the global financial crisis, the liquidity factor calculated based on the dynamic factors model and robustness proxy hovers around zero since 2005. Furthermore during the quantitative easing period, marked by the blue vertical region, the period just prior to the global financial crisis in early 2008 and early 2010, the liquidity factor is below zero. This implies a negative liquidity premium for TIPS bonds.

Figure 21: Liquidity Factor in Coroneo (2016)



Source: Coroneo (2016)

51 Banco Central do Brazil, (2014), "Breaking the Break-even Inflation Rate," Inflation Report, 2016 December

52 Coroneo, L, (2016) "TIPS Liquidity Premium and Quantitative Easing", Working paper (draft version April 2nd 2016)

7 Estimating the real cost of capital directly

138. The sources of potential bias in break-even inflation identified by the AER (and addressed in section 6) actually imply that the nominal CGS yield is a biased proxy for the risk free rate. If these sources of bias did exist then the appropriate course of action would be to adopt the indexed CGS yield as the real risk free rate proxy.

139. In this section we explain how this can be done by estimating a real cost of capital directly (although we note that, notwithstanding our view that breakeven inflation provides superior estimates to the AER's estimates, our approach for estimating the real cost of capital can also be used to deliver the appropriate real cost of capital in the PTRM even if the AER's method for estimating expected inflation in the PTRM must be applied).

140. The nominal cost of capital inputs to the PTRM can be estimated by adding expected inflation to the real cost of equity and debt. Under this approach, the nominal cost of debt and equity used as inputs into the PTRM are set equal to the estimated real of debt and equity plus expected inflation. This approach has, in our view, the material advantage that it renders the estimate of expected inflation used in the PTRM relatively unimportant to the compensation that will be provided to the regulated entity.

7.1 Practical method for building a nominal cost of debt/equity from the real risk free rate

141. Once a real risk free rate has been determined, it is necessary to transform this into a real cost of debt and equity by adding a risk premium to each. However, the PTRM requires nominal (not real) inputs for the cost of debt, the cost of equity and expected inflation. In order to arrive at estimates of the nominal cost of debt and equity that are internally consistent, the expected inflation input into the PTRM the latter must be added to the estimates of the real cost of debt and equity.

142. We set out mechanically how this would be done for equity and debt in the following sections – assuming that, in all other respects, the AER's methodology is followed.

7.1.1 Equity

143. The AER's methodology is for estimating the cost of equity is to add a risk premium of 4.5500%[53] to the risk free rate. The AER's practice has been to add this to nominal

53 This is estimated as the product of an equity beta of 0.7 and an MRP of 6.5%.

risk free rate (of, say, 2.0000%) to arrive at a nominal cost of equity of 6.5500% from which, within the PTRM, expected inflation is removed in order to deliver a real rate of return.

144. In the same circumstances our proposal is that the AER deflate this 4.5500% risk premium by expected inflation in order to turn it into a real risk premium.[54] Let expected inflation be 0.9901% in which case the real risk premium is given by:

Real risk premium = 4.5500%/(1+0.9901%)= 4.5054%

145. This real risk premium is then added to the best estimate of the real risk free rate which, for the purpose of this example, we let be 1.0000%. This gives a real cost of equity of:

Real cost of equity = 5.5054%.

146. This estimate of the real cost of equity is then transformed into a nominal return using the Fisher equation and expected inflation (assumed above to be 0.9901%).

Nominal cost of equity (PTRM input) = 5.5054%+0.9901% +5.5054×0.9901%

= 6.5500%

147. It is useful to note that, in this illustration the nominal risk free rate is 2.0%, the real risk free rate is 1.0% and the estimate of expected inflation is the difference between these values (using the Fisher equation).[55] In this situation we get the same answer whether we start with a nominal or a real risk free rate. This is because our estimate of expected inflation is consistently determined as the difference between these real and nominal rates.

148. By contrast, if the estimate of expected inflation was higher than implied by the Fisher equation (say, 2.00%) then our nominal cost of equity would be higher (7.62)%. Of course, the real return delivered by the PTRM would be unaffected at 5.5054 because the higher expected inflation used to derive the nominal cost of equity would also be removed from revenues within the PTRM – leaving the real return unchanged.

54 This risk premium is largely, but not wholly, net of inflation in the form the AER uses it. Because the risk premium is expressed as a return in excess of the risk free rate it is already in excess of inflation (in the Fisher equation (n=r+p +r*p) it is in excess of "p". However, it still has r*p embedded in it (i.e., it is the real risk premium plus the real risk premium multiplied by inflation). Therefore, it must be divided by (1+p) in order to remove this element of inflation compensation to transform it into a pure real risk premium.

55 That is, 0.9901% expected inflation is the inflation implied by a 2.0000%/1.0000% nominal/real risk free rate (0.9901%=(2%-1%)/(1+1%))

7.1.2 Debt

149. The AER's methodology for estimating the cost of debt is to simply take the average nominal cost of debt from various published data sources. Imagine for the purpose of this example that this average was 5.5000%.

150. In the same circumstances, our proposal is that the AER would calculated a debt risk premium by deducting its estimate of the nominal risk free rate. Consistent with the previous example, imagine that this is 2.0000% implying a DRP of 3.5000%. Once more, this 3.5000% risk premium would be deflated by expected inflation in order to turn it into a real risk premium. Let expected inflation, once more, be 0.9901% in which case the real risk premium is given by:

Real risk premium = 2.5000% / (1+0.9901%) = 2.4755%

151. This real risk premium is then added to the best estimate of the real risk free rate which, for the purpose of this example, we let be 1.0000%. This gives a real cost of debt of:

Real cost of debt = 2.4755% + 1.0000% = 3.4755%.

152. This estimate of the real cost of debt is then transformed into a nominal return using the Fisher equation and expected inflation (assumed above to be 0.9901%):

Nominal cost of debt (PTRM input) = 3.4755%+0.9901% +3.4755%×0.9901%

= 4.5000%

153. Once more, in this illustration the nominal risk free rate is 2.0%, the real risk free rate is 1.0% and the estimate of expected inflation is the difference between these values (using the Fisher equation). Consequently, we get the same answer whether we start with a nominal or a real risk free rate. This is because our estimate of expected inflation is consistently determined as the difference between these real and nominal rates.

154. By contrast, if the estimate of expected inflation was higher than implied by the Fisher equation (say, 2.00%) then our nominal cost of debt would be higher (5.51)%. Of course, the real return delivered by the PTRM would be unaffected at 3.4755% because the higher expected inflation used to derive the nominal cost of equity would also be removed from revenues within the PTRM – leaving the real return unchanged.

7.2 Why indexed CGS are the best proxy for the real risk free rate

155. The AER has rejected using break-even inflation as the best estimate of expected inflation on the basis that it may be biased. However, even if the AER were correct and break-even inflation were a biased measure of expected inflation (a proposition

we do not accept and one that the AER has not demonstrated – see section 6) then the same logic should lead the AER to adopt indexed CGS as the best estimate of the real risk free rate.

156. The AER has expressed the view that break-even inflation may be biased as a measure of expected inflation based on a number of factors unrelated to inflation expectations. These are:

- Inflation risk premium, whereby investors demand a higher expected real yield from nominal CGS due to the fact that they are exposed to inflation risk when investing in nominal CGS;
- Liquidity premium, whereby investors demand a lower expected real yield from nominal CGS because they place value on the higher liquidity of these instruments;
- Convexity premium, whereby investors demand a lower expected real yield from nominal CGS in order to compensate for the greater sensitivity of nominal yields to changes in inflation expectations;
- Indexed lag bias whereby the reported yield on indexed CGS may be influenced by one quarter of known inflation that is yet to be included in the indexed capital value of the bond.

157. To the extent that such sources of bias in break-even inflation existed they would imply that the nominal CGS yield requires adjustment to be an idealised risk free rate (not the indexed CGS yield). This is because a conclusion that the difference between indexed and nominal CGS is not the best estimate of expected inflation must be because:

a. Nominal CGS yields are an imperfect proxy for the real risk free rate plus expected inflation;

b. Indexed CGS are an imperfect proxy for the real risk free rate; or

c. Both of the above are true.

158. That is, even if the potential sources of bias in break-even inflation raised by the AER were considered to be material (and negative), that would not justify rejecting indexed CGS as the best proxy for the real risk free rate. In order to arrive at that conclusion, the AER would also need to believe that the 'bias' manifested in indexed CGS yields being 'too high' rather than nominal CGS yields being 'too low'.

159. The remainder of this section sets out what relevance, if any, the sources of potential bias in break-even inflation (as raised by the AER) have for any attempt to make adjustments to the indexed CGS yield as the best proxy for the real risk free rate.

7.2.1 Convexity and indexed lag bias

160. Nominal CGS prices are sensitive to both changes in real risk free rates and expected inflation. Indexed CGS prices are only sensitive to changes in real yields. Therefore, convexity risk is greater for nominal CGS (their value is more sensitive to potential changes in discount rates). This implies that nominal CGS are more risky than indexed CGS and are a worse starting point for a calculation of the real risk free rate (even if expected inflation was known with certainty).

161. Indexed lag bias is something that, if it exists at all, can be calculated directly and removed. This leaves us with inflation risk and liquidity risk bias as potential reasons why a) and/or b) may be true.

7.2.2 Inflation risk premium

162. The inclusion of an inflation risk premium in nominal CGS yields is clearly a reason to prefer indexed CGS yields as the best proxy of the real risk fee rate. The logic of an inflation risk premium bias in break-even inflation is that investors will demand an additional risk premium from nominal CGS due to the fact that these bonds do not deliver a guaranteed real risk free return but, instead, will deliver volatile real returns depending on the actual inflation outcome over the investment horizon (in this case 10 years). Clearly, as this is a risk premium built into nominal yields, it is inappropriate for inclusion in real yields.

163. It is worth noting that, in the current environment, inflation risk very likely has a strong systematic element such that if inflation is:

- lower than expected this will tend to be associated with 'bad' economic events (slow growth or recession); or
- higher than expected this will tend to be associated with 'good' economic events (stronger growth and the breaking out from a 'low inflation trap').

164. This means that the inflation risk premium built into nominal CGS at the moment is likely to be negative (have negative beta risk). That is, rather than being 'risk free', nominal CGS are providing an insurance premium to investors against bad economic news such that they will benefit (in the form of higher real returns) if the economy performs poorly and inflation is lower than expected.

165. The IMF considers that the reduction in the asset beta of nominal government bonds to negative levels has been an important contributor to the fall in nominal government bond yields. That is, government bonds now exhibit not just low or zero risk, but have become negative risk in the CAPM sense.

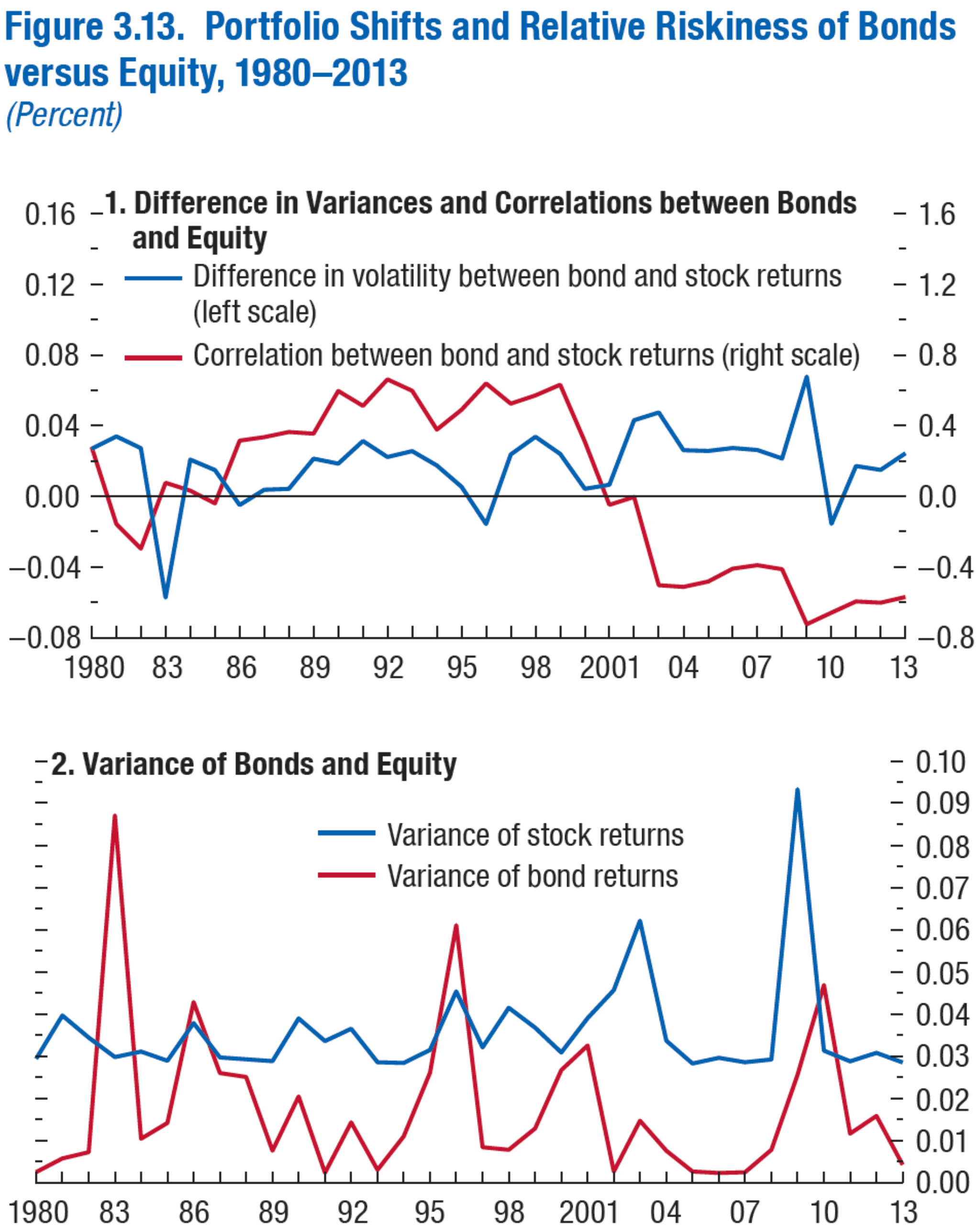
> *"… a change in the relative riskiness of bonds and equities has made bonds relatively more attractive. In particular, the evidence summarized in Figure 3.13 (panel 1) shows that the correlation between bond and equity returns*

has steadily declined (similar results have been found in Campbell, Sunderam, and Viceira, 2013)…"[56]

166. The evidence summarised in panel 1 of Figure 3.13 from the IMF (2014) report is reproduced below.

56 International Monetary Fund World Economic Outlook: April 2014, Chapter 3, Perspectives On Global Real Interest Rates p.13.

Figure 22: IMF estimates of correlation between bond and stock returns



Source: IMF

167. The beta on nominal government bonds implied by the above analysis is around negative 0.25.[57] If one believes that the MRP is 6.5% this would imply that whatever

57 While the IMF does not specifically report the beta for government bonds, the data in the above two panels covers the constituent elements of beta. Specifically, the asset beta is equal to the correlation between stock and government bond returns (shown in the top panel) multiplied by the square root of the ratio of the variance of bond returns to the variance of stock returns (with the variances shown in the bottom

risk exposure is causing negative beta for nominal government bonds is around negative -1.25%.

168. The IMF's estimates are global but are similar to our own for Australian CGS. An examination of the beta for Australian CGS clearly shows the same trend as reported by the IMF. Nominal and indexed 5 and 10 year CGS have had materially negative betas since around 2000. This is apparent in Figure 23 below, which shows weekly asset betas measured over 5 years to the date on the horizontal axis (such that the point at which the time series crosses zero in early 2003 is using data from early 1998 to early 2003). Similarly, the first observations in 1997 use data from 1992 to 1997.

Figure 23: Weekly rolling 5-year betas for 10-year maturity – nominal and indexed CGS

Source: RBA, Bloomberg, CEG analysis

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panel). The ratio of variances will always be positive (as will its square root) and consequently the sign of the beta is determined by the sign of the correlation.

The IMF panel shows, based on a global analysis, that there existed positive betas for government bonds prior to 2000 and strongly negative betas for government bonds since then. Reading off the first panel of the IMF figure the correlation has been at, or below, -0.4 since around 2003. Let us conservatively say that this has been -0.5 on average. Reading off the second panel, the average variance for bonds/stocks appears to be around 0.01/0.04=0.25; such that the square root of this ratio is around 0.5 (√0.25=0.5). This implies an asset beta of around -0.25 (=correlation×√ratio of variances= -0.5×0.5=-0.25).

169. Notably, nominal CGS have, since the early 2000s) had materially more negative (further from zero) betas than indexed CGS. This is consistent with nominal CGS being exposed to greater (negative beta) inflation risk than indexed CGS.[58]

170. The above result suggests that both indexed and nominal CGS yields may be depressed by virtue of having negative betas. However, indexed CGS yields are likely less depressed and, therefore, are a better proxy of the real risk free rate (as one would expect given zero inflation risk exists for indexed CGS).

7.2.3 Liquidity premium

171. The fact that indexed CGS also have a negative measured beta suggests that there may be other risk factors influencing the riskiness of both real and nominal CGS yields. An obvious explanation is liquidity risk.

172. In the Sharpe-Lintner CAPM, used by the AER as its foundation model, relative liquidity plays no role in determining the required return on an asset. The CAPM is a one-period model in which investors invest once, hold the asset for a single period and then divest and consume the entirety of their wealth. In this model there is no role for 'liquidity' to play a role in determining required returns. Consequently, at least in terms of the mathematics of the derivation of the Sharpe Lintner CAPM, it is not obvious how one should deal with the existence of liquidity risk in the real, multi-period, world.

173. A role for liquidity does exist in a multi-period asset pricing model (such as the inter-temporal CAPM). In multi-period models investors are optimising and altering their investment portfolios in response to unexpected news/shocks. In such models investors will have a preference for assets that are more liquid because those assets allow such optimisation to occur at lowest cost. Specifically, a 'liquid' market is one where an individual investor can expect to be able to buy or sell into the market without their personal transaction having a significant impact on the price paid/received in the transaction.

174. It may, or may not, be the case that nominal CGS are materially more liquid than indexed CGS. However, based on the theory of the Sharpe-Lintner CAPM there is simply no way of inferring whether the existence of a difference in liquidity makes indexed CGS a better or worse proxy for the real risk free rate.

175. In order to reach any conclusion along these lines one must step out of the Sharpe Lintner CAPM and ask, in a world where relative liquidity plays a role in investors' required returns, what is the optimal liquidity of the proxy for the real risk free rate?

[58] However, the fact that both have negative betas suggests that there is some risk factor other than inflation risk affecting both forms of CGS (noting that inflation indexed CGS have no inflation risk). This may have a relationship with interest rate risk (valu with the 'liquidity premium' as discussed in section 7.2.3.

The answer to this is that the real risk free rate should have the same liquidity as the assets being valued (the assets whose required return is being estimated).

176. In which case, both the nominal and indexed CGS are imperfect proxies for the nominal/real risk free rate because both are much more liquid than any other asset in the Australian economy. This means that both nominal and indexed CGS will have negative liquidity premiums relative to other less liquid assets; assets such as equity in an energy infrastructure company.

177. This need not be problematic for the application of the Sharpe-Lintner model if the liquidity premium is constant (i.e., if the higher required return on corporate equity/debt is due to lower liquidity is constant over time). In this case, the liquidity premium will simply be built into the estimate of the historical average market risk premium (MRP) and, at least for assets with betas of around 1.0, will not affect the estimated required return (i.e., depressed risk free rates will be offset by higher MRP estimates of the same magnitude).

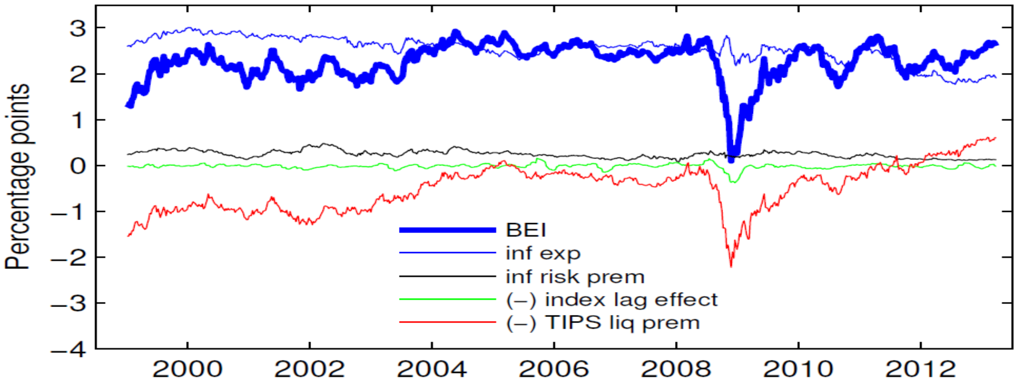
178. However, if there are some periods where investors place an unusually high value on liquidity, such as was the case in the GFC of 2008/09, using either nominal or indexed CGS as risk free rate proxies within the Sharpe-Lintner CAPM will result in:

- estimated risk free rates that are unusually low (unusually depressed by high value placed on liquid assets); and
- market risk premium estimates that are too low (unless they are increased to reflect an unusually high premium (relative to liquid CGS) required for investment in illiquid assets, do not offset the depressed CGS yields). (For low beta stocks (beta less than 1.0), this is true even if the AER increases the MRP to incorporate the heightened liquidity risk premium).

179. The behaviour of CGS yields in the GFC provides a perfect illustration of this point. During the GFC it is generally accepted that the liquidity premium was exceptionally high. This led to significant falls in both indexed and nominal government bonds – but greater falls for the latter than the former.[59] This event is picked up in the academic literature which suggests that during this period break-even inflation was biased downward as an estimate of expected inflation due to nominal government bond yields being depressed by more than indexed government bond yields. This is illustrated in 2008/09 in the below figure – with the thick blue line falling well below the thick blue line.

59 Note that the events of September 2008 can be seen to have measurable differential impact on betas of nominal and indexed CGS – with the latter spiking up towards zero and the former spiking down further away from zero – see Figure 23 above.

Figure 24: Decomposing 10-year TIPS Breakeven Inflation D'Amico, Kim and Wei (2016)



Source: D'Amico, Kim and Wei (2014) [60]

180. However, the critical point to understand is that in the same period the required return on less liquid assets was increasing dramatically – consistent with the massive sell-off on global stock markets and the unprecedented spike in risk premiums on corporate debt.

181. This, at least in part, reflects the fact that the forces driving down yields on liquid government bonds were the *exact same* forces driving up required returns on less liquid corporate assets. If one applied an assumption, as the AER indeed does and did during the GFC, that the market risk premium is very stable and centred on historical average excess returns, then using a very liquid proxy for the risk free rate in a period of unusually high liquidity premium will tend to result in an underestimate of the true cost of capital. Such a conclusion was ultimately arrived at by the Australian Competition Tribunal in assessing the reasonableness of the AER's use of a risk free rate measured in the midst of the GFC.[61]

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60 D'Amico, S., Kim, D. H., and Wei, M., (2014) "Tips from TIPS: the Informational Content of Treasury Inflation-Protected Security Prices," FEDS Working Paper 2014-24 (Draft Version February 19, 2016)

61 *Application by EnergyAustralia and Others (includes corrigendum dated 1 December 2009)* [2009] ACompT 8 (12 November 2009), paras. 112-114.

> *The Applicants submitted that these facts demonstrated that basing a risk free rate on the AER's specified averaging periods would not achieve the objective of an unbiased rate of return consistent with market conditions at the date of the final decision. They appealed to expert opinion that the market risk premium was far higher than its deemed value while the risk free rate was abnormally low, so that the return required by investors was much higher than the AER's specified averaging period would generate.*
>
> …
>
> *The Tribunal considers that an averaging period during which interest rates were at historically low levels is unlikely to produce a rate of return appropriate for the regulatory period.*

182. On this basis, if there was a materially higher liquidity premium built into nominal CGS yields compared to indexed CGS yields, this would make indexed CGS yields a superior proxy for the risk free rate used to determine the required (real) rate of return on relatively illiquid corporate assets.

Of course, the indexed CGS yield would not be a perfect proxy for the risk free rate when valuing illiquid corporate equity. This is because both indexed and nominal CGS are highly liquid.[62] In circumstances where the liquidity premium is so high that it is differentially effecting nominal and indexed CGS yields, the liquidity premium difference between either form of CGS and illiquid corporate equity would dwarf the liquidity premium differential between nominal and indexed CGS.[63] That is, while both nominal and CGS yields will be depressed relative to required returns on risky assets, the indexed CGS yield will be less depressed.

62 Both the nominal and indexed CGS markets are highly liquid with turnover of around $1,000bn and $50bn respectively. While the turnover in nominal bonds is around 20 times larger both are very large in absolute magnitude. Moreover, liquidity is a function of the ability of an investor to divest their holding without moving the market and, given that investors' holdings on nominal CGS tend to be larger, the absolute turnover must be adjusted for the average holding of these bonds in an investor's portfolio. The standard way to do so is to divide turnover rates by total outstanding stock in order to provide the 'turnover ratio'. The Australian Financial Markets Association produces this metric for nominal CGS and it has fallen from 5.2 in 2007/08 to 4.7 in 3.2 in 2014/15. A similar metric for indexed CGS was around 1.2 in 2007/08 and 1.9 in 2014/15. On this metric, liquidity in nominal CGS is only modestly higher than for indexed CGS.

63 Noting that nominal and indexed CGS are likely the most liquid asset classes in Australia with many billions of dollars of turnover each year for a relatively homogenous assets.

Appendix A Low inflation concerns domestically and internationally

183. At the time of writing, the United States, Great Britain, the Eurozone and Japan have all had policy interest rates at or near the zero (below 0.5%) for extended periods and have all suffered from below target inflation (and deflation in much of the Eurozone and in Japan). The US, after five years at the with rates below 0.5% has recently raised policy interest rates to 0.5% but this, as noted by Governor Brainard, does not imply that the zero lower bound no longer affects the potential future path of monetary policy.

184. Moreover, as noted by the IMF in 2015:

> *"… with the United States expecting to exit the zero lower bound this year, but with no such prospects for the euro area or Japan."*[64]

185. In the same document, the IMF pointedly refers to the risk that a number of other countries, including Australia, will fall into the same low inflation trap.[65]

> *However, in economies in which output gaps are currently negative (Australia, Japan, Korea, Thailand), policymakers may need to act to prevent a persistent decline in inflation expectations.*

186. Since then, inflation outcomes have continued to come in below the RBA target range and the RBA policy interest rate has declined even closer to the zero lower bound.

187. In a low interest rate environment, as explained by Governor Brainard, the risks associated with inflation outcomes in the current environment are asymmetric – with greater risk of below target inflation than above target inflation. The essential point is that monetary policy is constrained in how low interest rates can go in order to raise inflation (the 'zero lower bound') with no similar constraint on raising interest rates in order to reduce inflation. This creates the potential for a 'low inflation/interest rate trap' that has no symmetrical opposite. Following the RBA's May 2016 rate cut, the financial press reported that:

> *Australians must urgently confront the danger that the Reserve Bank of Australia is nearing the very limits of its powers and risks stumbling into the same zero-interest rate trap that has neutered European and Japanese central banks, say two high-profile economists. …*

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64 International Monetary Fund, "World Economic Outlook", April 2015, p. xiii.

65 Ibid, p. 56.

> *"The evidence is that even aggressive monetary policy action doesn't seem to be driving up inflation, so far," Mr Yetsenga told* AFR Weekend.[66]

188. Bloomberg also reported that the May SoMP inflation forecasts are built on an assumption that the RBA will reduce interest rates in line with market expectations.[67] This implies that the RBA's then inflation forecasts were based on the RBA reducing interest rates to 1.5% (which, indeed, did occur).[68]

> *"If after cutting once and factoring in another rate cut, as per market pricing, you are still only getting to the bottom half of your target band by the end of the forecast horizon, that's giving a clear signal you feel quite concerned about underlying inflation pressures and the outlook," said James McIntyre, head of economic research at Macquarie Group Ltd.*

189. Similar sentiments were expressed following the August 2016 RBA rate cut:

> *"With 50 basis points of easing since May 2016, we now believe the RBA has delivered the first increment of its likely policy response to lower than expected inflation outcomes," JPMorgan chief economist Sally Auld said.*
>
> ***"Our bias is to think that Australia risks a more protracted - period of low inflation****, and as such, we continue to forecast a further 50 basis points of easing from the RBA in the first half of 2017."*
>
> ...
>
> *ANZ senior economist Kieran Davies agreed that the path of the currency and the extent of the pass-through of the cash rate to lending rates would affect the RBA's thinking on interest rates from here, although he expected rates to bottom at 1.5 per cent.*

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66 AFR Weekend, RBA joins race to the interest rate bottom, 6 May 2016 at 11.45pm. Available at this link: http://www.afr.com/news/economy/monetary-policy/rba-joins-race-to-the-interest-rate-bottom-20160506-gooblo#ixzz47xFNhJoE . See also Bloomberg, RBA's New Head Seen Facing Risk of Rate Cuts to 1% by JPMorgan May 9, 2016 (Available at http://www.bloomberg.com/news/articles/2016-05-08/rba-s-new-head-seen-facing-risk-of-rate-cuts-to-1-by-jpmorgan.) which reports:

> *The central bank's focus Friday on inflation expectations was notable given the phrase appeared 16 times in a document that rarely mentions it, said Joseph Capurso, a senior currency strategist in Sydney at Commonwealth Bank of Australia. "It is very hard to lift inflation expectations when they are low and Japan is a good example of this," he said*

67 RBA, May 2016 SoMP, p. 60. "*In preparing the domestic forecasts, a number of technical assumptions have been employed. The forecasts are conditioned on the assumption that the cash rate moves broadly in line with market pricing as at the time of writing.*"

68 Bloomberg, *Reserve Bank of Australia Cuts Core Inflation Forecast to 1-2%,* May 6, 2016. (Available at http://www.bloomberg.com/news/articles/2016-05-06/rba-cuts-core-inflation-forecast-unlikely-to-hit-target-in-16.)

> *"Our central case is unchanged and we see rates on hold at this point, albeit with a clear risk of further easing given we think that* ***the RBA's forecast outlook of persistently low inflation*** *is consistent with an easing bias," he said.*

190. In its October 2015 World Economic Outlook publications, the IMF projected inflation to continue to be generally below central bank targets.[69]

> *In advanced economies, inflation is projected to rise in 2016 and thereafter, but to remain generally below central bank targets.*

191. This projection was revised down by the IMF in the April 2016 World Economic Outlook with the IMF now stating: [70]

> *With the December 2015 declines in oil prices mostly expected to persist this year, consumer price inflation has been revised downward across almost all advanced economies and is projected to remain below central bank targets in 2016.*

69 IMF, World Economic Outlook, October 2015, p. 16

70 IMF, World Economic Outlook, April 2016, p. 21

Appendix B CPI Swaps are a biased estimate of expected inflation

192. Implied inflation measured from inflation swap markets is also a market measure of inflation expectations. However, this measure will tend to be biased upwards to account for risk premiums and capital costs for the banks providing these products. This is because the inflation swap market is one-sided in the sense that there is more demand for the fixed leg of an inflation swap than the floating leg. That is, there are more investors wanting to hedge long-term inflation than who want to be exposed to long term inflation (by taking on floating rate exposure).

193. This means that the sellers of inflation protection in the swap market (who promise to pay the floating leg of the swap) and buy indexed bonds in order to receive a floating CPI payment which is a hedge to its floating exposure. (If the swap market was evenly balanced the dealer would just take the floating side of another swap rather than buy indexed bonds.) Therefore, it is to be expected that inflation swap data will be above breakeven inflation because breakeven inflation defines the base rate of inflation that the seller can use to hedge its exposure. Thus, the fixed rates offered by dealers must be above breakeven inflation if the dealer is to cover their costs and risks. This issue is also discussed by Campbell, Shiller, and Viceira (2009):

> *The figure shows that the two breakeven rates track each other very closely up to mid-September 2008, with the synthetic inflation breakeven rate being about 35-40 basis points larger than the cash breakeven inflation rate on average.*
>
> *This difference in breakeven rates is typical under normal market conditions. According to analysts, it reflects among other things the cost of manufacturing pure inflation protection in the US. Most market participants supplying inflation protection in the US inflation swap market are levered investors such as hedge funds and banks proprietary trading desks. These investors typically hedge their inflation swap positions by simultaneously taking long positions in TIPS and short positions in nominal Treasuries in the asset swap market. A buying position in an asset swap is functionally similar to a levered position in a bond. In an asset swap, one party pays the cash flows on a specific bond, and receives in exchange LIBOR plus a spread known as the asset swap spread. Typically this spread is negative and its absolute magnitude is larger for nominal Treasuries than for TIPS. Thus a levered investor paying inflation - i.e. selling inflation*

protection - in an inflation swap faces a positive financing cost derived from his long-short TIPS-nominal Treasury position.[71]

194. Consistent with this, inflation swap rates remain well above breakeven inflation – in June 2016 the average 4-year inflation swap was 1.81% vs break-even inflation of 1.22%. It is notable that the period in early 2009 and late 2008 has the greatest difference between breakeven and inflation swap rates. This is an exceptional period where the opportunity cost of capital was very high for financial firms, suggesting that the costs of providing inflation swaps would be high.[72]

195. This conclusion is borne out by noting that the implied CPI swap 10 year forward rate for inflation has typically been well above 2.5% at a 10 year horizon – on average 3.0% since 1 January 2012. That is, the implied expected inflation rate in 10 years' time is typically 0.5% above the middle of the RBA target forecast – and this in a context of low Australian and global inflation. This provides an indication of the magnitude of the bias in inflation swaps.

71 Campbell, Shiller, and Viceira, Understanding Inflation-Indexed Bond Markets, NBER Working Paper No. 15014, (2009), p. 21.

72 However, it is also the case that this was a period of extremely high liquidity premiums which likely depressed breakeven inflation rates (noting that nominal CGS tend to be more liquid than indexed CGS). In such exceptional circumstances it is difficult to be sure what the best estimate of expected inflation was. However, in more normal periods outside of financial crisis circumstances the best estimate will be break-even inflation given that the no-arbitrage condition means that the CPI swap market tends to reflect breakeven inflation rate plus a premium for the hedging costs of swap dealers.

Appendix C Convexity Bias

196. The convexity bias is caused by the curvature of the yield to price function and the dispersion of inflation expectation. It can be approximated using the yield to price function of a zero coupon bond based on the present value formula.

197. The model assumes the nominal yield contains two components, the expected real interest rate and the expected inflation.[73] The expected inflation is assumed to follow a log-normal distribution and the period of the bonds is assumed to be 5 years. We find the convexity bias is increasing on the dispersion of the belief on forecast inflation.

198. Table 3 shows the underestimation of expected inflation caused by the convexity bias. It shows than when the range of the 90% confidence interval is 200 basis, (this implies when the annual expected inflation is 2%, the range of the 90% confidence interval for annual inflation is from 1.1% to 3.1%) the impact of the convexity bias is only 2.2 basis points.

Table 3: Simulated Underestimation of Expected Inflation (basis points)

Expected inflation	Range of 90% Confidence Interval Around Mean (bppa)		
	100	150	200
1.5%	-0.5	-1.2	-2.2
2.0%	-0.5	-1.1	-2.0

73 The convexity bias does not depend on the expected real interest rate and its dispersion. Its impact on the price of nominal bond is offset by its impact on the price of the indexed bond. Therefore its effect disappears when the convexity bias is calculated.