Australian Gas Networks

Final Plan Attachment 9.3

Estimating Expected Inflation Using the Breakeven Method

A Report by PwC

December 2016

Report to Australian Gas Networks Limited

Estimating Expected Inflation using the Breakeven Method – Response to Liquidity Issues raised by the Australian Energy Regulator

Australian Gas Networks Victoria and Albury 2018-2022 Access Arrangements

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Executive summary

The Breakeven method is one way to estimate expected inflation, and is essentially derived as the differential or 'premium' between nominal bond yields and real or inflation-indexed bond yields. Several central banks in western developed economies, such as the Federal Reserve Board in the United States and the Bank of England routinely use breakeven method in their analysis and publications, with both these central banks publishing and regularly updating Breakeven inflation rates[1]. The Reserve Bank of Australia also publishes a 10 year Breakeven rate[2].

The Breakeven method allows for a 'term structure' of expected inflation rates provided there are a series of real and nominal bonds over a maturity spectrum. In Australia, this is possible using Commonwealth Government bonds as there are a significant number of issues by the Commonwealth of Australia of Treasury Indexed Bonds ("Indexed CGS") and Treasury Bonds ("Nominal CGS"), with maturities extending out to 2040 and 2037 respectively. Table 1 shows the current Indexed CGS issues, with seven issues, ranging in maturity from 2018 to 2040.

Table 1 – Indexed CGS Issues as at 23 November 2016

Amount Outstanding ($bn) (rounded)	Maturity	Coupon	ISIN
5.089	21/11/2018	1.00%	AU000XCLWAJ6
5.114	20/08/2020	4.00%	AU0000XCLWE2
5.39	21/02/2022	1.25%	AU0000XCLWE2
6.843	20/09/2025	3.00%	AU0000XCLWP8
3.593	20/09/2030	2.50%	AU0000XCLWV6
3.35	21/08/2035	2.00%	AU000XCLWAF4
1.8	21/08/2040	1.25%	AU000XCLWAO6

Source: AOFM

At present, it is possible to derive an expected inflation rate over a 10 year term, being the allowed rate of return horizon used by the Australian Energy Regulator ("AER"), given there is a 2025 maturity Indexed CGS and a 2027 maturity Nominal CGS. Other bonds, with nearby maturities are available to produce a 'clean' 10 year maturity through interpolation. The Australian Office of Financial Management ("AOFM"), the entity responsible for issuance and management of Nominal CGS and Indexed CGS, is highly likely to continue to issue CGS with 10 year maturity as this is a key "benchmark" for investors. As such, our view is that the AER will have the ongoing ability to use Nominal and Indexed CGS in the Breakeven model to

[1] The Federal Reserve Bank of St Louis publishes the "10 year Breakeven Inflation Rate" at https://fred.stlouisfed.org/series/T10YIE, and the Bank of England updates and publishes its "Implied Inflation (Government liability)" rates at http://www.bankofengland.co.uk/statistics/pages/yieldcurve/default.aspx

[2] The breakeven rate is updated quarterly in column H of the G3 statistics tables (see http://www.rba.gov.au/statistics/tables/). The breakeven rate is updated on a quarterly basis and calculated as the "Average annual inflation rate implied by the difference between 10-year nominal bond yield and 10-year inflation indexed bond yield; End-quarter observation". Rates are sourced from the RBA and YieldBroker. Historical data is provided back to December 1985

estimate a 10 year expected inflation as an input in the Post Tax Revenue Model ("PRTM") used in access determinations.

In its Final Decision for Australian Gas Networks (South Australia) - Access arrangement 2016-21 (May 2016) ("SA Final Decision"), the AER set out several reasons not to use the Breakeven method[3]:

a. Liquidity issues with the Indexed CGS, being the liquidity of Indexed CGS, and also their liquidity relative to Nominal CGS which the AER measures by "*Trading volume of indexed CGS expressed share of total indexed and nominal CGS*[4]". The AER notes that relative liquidity has only seen a minor improvement since early 2008, and is concerned that this lack of relative liquidity introduces a liquidity bias that "*can be material and difficult to identify and remove from the breakeven rate—particularly as evidence indicates that it can vary considerably over time*[5]"

b. The requirement to adjust the Breakeven approach to account for the value of a liquidity premium, which premium had not been defined

c. Other biases introduced through the use of Indexed CGS, being related to convexity, the inflation risk premium and the indexation lag

"Liquidity" is a term used frequently in financial markets to describe the volume of financial instruments bought or sold in a period, as evidenced by trading volumes, and this is the way the AER views "liquidity"[6]. Market participants often refer to trading volumes as "turnover data".

Our view is that besides trading volume data, "liquidity" also must involve metrics related to the dimensions of the particular instrument being considered, as seen in:

- the growth in trading volume/ turnover over time
- the outstandings of a particular instrument[7] as a representation of the volume that can *potentially* be traded
- the size, regularity and way in which issuance occurs in the primary market
- the maturity, participation and sophistication of the market

These qualitative and quantitative aspects of a market are all valuable metrics to understanding and assessing the "liquidity" of a particular instrument.

KEY FINDINGS OF PwC

1. Indexed CGS liquidity

Our view is that Indexed CGS are sufficiently "liquid" for their pricing to be a reliable input to the Breakeven model, for several inter-related reasons:

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3 referred to by the AER in the Final Decision (May 2016) for AGN's South Australia access arrangement Attachment 3 at pages 3-149 to 3-160

4 ibid pp. 157-8

5 ibid

6 ibid

7 "Outstandings" are the volume of securities that have been issued and not yet matured

- Indexed CGS turnover (ca. $50bn in 2014-15), market size (currently ca. $31bn), historic and expected annual issuance (ca. $2-4bn), all of which qualify as 'large' and 'significant' in the Australian context

- Overall "liquidity" of Indexed CGS has increased significantly since 2008. This is reflected in the overall outstandings of Indexed CGS, the turnover, the growth in turnover, and the Liquidity Ratio of Indexed CGS

- The Indexed CGS is mature with longstanding participation[8] by sophisticated entities such as agencies (e.g. AOFM), banks, funds, insurance companies, and other institutions

2. Relative liquidity and 'liquidity bias'

The AER is also concerned that the low relative liquidity as measured by trading volume of Indexed CGS to Nominal CGS introduces a liquidity bias which distorts the use of Indexed CGS pricing in the Breakeven model. The "liquidity bias" is generally interpreted as meaning the dynamic where investors express a preference for a more liquid security over a less liquid security. The AER would consider Nominal CGS to be more "liquid" than Indexed CGS, therefore investors will demand a higher yield on the latter as compensation for the risk of market prices moving against them if they try to sell their position; in other words, a premium due to what can be termed the "liquidity preference".

Our view is that the low relative trading volume of Indexed CGS to Nominal CGS does not introduce a liquidity bias. We therefore do not believe a premium for a liquidity bias needs to be removed from the pricing of Indexed CGS. We hold this view for the reason that Nominal CGS are not a substitute for Indexed CGS. Investors do not hold Nominal CGS because they are the liquid alternative. In fact, the two instruments are completely different in their economic effect and have very different investor motivations. Investors will buy an Indexed CGS to take a view that the inflation rate over time will be *more* than the implied breakeven rate at purchase. On the other hand, investors will buy a Nominal CGS on the basis that future inflation will be *less* than the future inflation rate built into the bond's pricing at the time of purchase. These two views are diametrically opposed and therefore it cannot be said that there is a liquidity-related preference or dynamic between the two instruments that drives relative pricing. Therefore, pricing of Indexed CGS does not incorporate a premium reflective of a "liquidity bias".

3. Price efficacy

The AER discusses "liquidity" in the context of the use of the pricing of Indexed CGS in the Breakeven model to estimate the expected inflation factor within the Post Tax Revenue Model. It is therefore important to link "liquidity" to "price efficacy". Our view is that Indexed CGS have very high "price efficacy" and price reliability, sufficient for the AER's purposes. "Price efficacy" describes the degree to which a security reflects the true market price and is not distorted for reasons such as lack of turnover or some idiosyncratic market factor. In looking at "price efficacy", it is important to look at all the circumstances and factors around the security, including who the issuer is, how the security is issued and traded, the number and type of participants in the market, and the probity around pricing.

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[8] Indexed CGS were first issued in July 1985, a debut auction of $100 million of 10 year and 20 year capital indexed bonds, with indexing to the CPI

There are several inter-related reasons for the price efficacy and reliability of secondary market prices of Indexed CGS:

- The presence of a large number and diverse range of sophisticated investors in the Indexed CGS market[9] ensuring probity, price visibility and market transparency

- The presence of large funds who invest in the Indexed CGS market and are required by law to mark-to-market their portfolios. This ensures strong price responsiveness to yield changes in the secondary market

- Many investors buy Indexed CGS to immunise 'long-tail' inflation risk in their portfolios and hold these securities with a 'long term hold' mindset, but regularly monitor and update the pricing of their Indexed CGS holdings. This creates price discipline and reliability to the market

- Nominal CGS and Indexed CGS are connected in price terms with the price difference being the inflation expectation. In other words, investors derive the real yield being the yield of Indexed CGS by deducting the inflation expectation from Nominal CGS. It means there is a clear inter-connectedness between the pricing of highly liquid Nominal CGS and less liquid Indexed CGS, thereby in turn substantiating the Breakeven model

- The strong observed price correlation between Nominal CGS and Indexed CGS which shows Indexed CGS are highly price responsive to moves in Nominal CGS, highlighting that Indexed CGS do not contain "stale" pricing, again corroborating the pricing efficacy of Indexed CGS

- The probity of Indexed CGS pricing from AOFM's tender process, the issuer being the Commonwealth of Australia being the largest and most important issuer in the Australian market in terms of benchmark securities, and one of only a few sovereigns with a AAA credit rating[10]

- The market's use of conventions published by AFMA that govern the way Indexed CGS are priced in the secondary market using the Indexed CGS pricing formulae published on AOFM's website

- Regularity of Indexed CGS tenders that ensures secondary market pricing for Indexed CGS is constantly being refreshed from the primary market

- The existence in the market of several financial instruments that cross-reference directly or indirectly the pricing of Indexed CGS which serves to reinforce the price reliability and efficacy of Indexed CGS, viz. bond repurchase agreements ("repos"), Exchange-traded Indexed CGS, OTC options on Indexed CGS, and semi-government inflation-indexed bonds.

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[9] The Indexed CGS market is a wholesale market with investors being predominately large, sophisticated fund managers/institutions. Many investors buy and hold the securities to maturity to "immunise" long-tail inflation risk in their liability profile, including insurance companies, and superannuation/pension funds. Using AFMA data[9], and our own experience, investors include superannuation funds, sovereign wealth funds, ADIs/banks, insurance companies, government and semi-government entities, 'real money' and 'hedge' fund/'absolute return' funds

[10] Commonwealth of Australia's current credit ratings are: Standard & Poor's AAA/ A-1+, Moody's Aaa/P-1, Fitch AAA/F1+

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1 Purpose and scope

We have been engaged by Australian Gas Networks Limited ("AGN") to consider certain matters relating to the 'expected inflation' factor which forms part of the AER's determination for the Victorian and Albury 2018-2022 Access Arrangements. In particular, we have been asked to respond to the AER's concerns with the use of the Breakeven method to estimate expected inflation due to what it considers to be liquidity-related issues with Treasury Indexed Bonds ("Indexed CGS").

Our review has primarily focused on analysing the liquidity and pricing efficacy of Indexed CGS in light of comments by the AER in the SA Final Decision which in part led the AER to conclude that the Breakeven method is not the preferred method to estimate expected inflation. The liquidity issues referred to by the AER included the trading volumes of Indexed CGS, and the low trading volume of Indexed CGS relative to Nominal CGS which the AER believes cause a potential 'liquidity bias' leading to a 'liquidity premium' in the pricing of Indexed CGS, which in turn tends to understate the expected inflation rate.

Our understanding is that this report will form part of AGN's submission to the AER with respect to the Victorian and Albury 2018-2022 Access Arrangements proposal.

2 Our approach

We have primarily analysed and reviewed Indexed CGS to determine if these bonds have sufficient liquidity and pricing efficacy to enable AGN to confirm to the AER that expected inflation (forecast of inflation) can be reliably estimated by the "Breakeven" method. The Breakeven method essentially looks at the yield difference between Indexed CGS and the Nominal CGS to determine the market's estimate of expected future inflation.

Our primary focus is on the 10 year maturity being the AER's reference maturity for the rate of return determination and estimate of inflation in the access arrangement. In our review, we have considered other maturities.

In summary, we have reviewed the following:

1. the SA Final Decision
2. the inflation-indexed bond market in Australia, particularly the Indexed CGS market, and other inflation-indexed markets
3. nominal bond markets, particularly the Nominal CGS market
4. the nature and characteristics of the Indexed CGS market, investors in that market and their motivations to buy, hold or sell Indexed CGS
5. the depth, liquidity, turnover and pricing characteristics of the Indexed CGS market, and how well the price/yield of Indexed CGS relative to Nominal CGS reflects the market's expectation of future inflation, with reference to the market now and compared to 2008 (which is our understanding of when the AER last used the breakeven approach)

3 Report preparation

This Report has been prepared by Matthew Lemke, Director, Debt & Capital Markets, PwC. Matthew has 35 years' experience, in both transactional and advisory capacities, in Australian and international debt capital markets, fixed income and derivatives markets, including inflation swap markets. He has provided funding, capital markets and hedging advice (currency, interest rate and inflation related) in a number of regulatory contexts. Matthew is a Subject Matter Expert in the areas covered in this Report. Matthew's background is contained in Appendix B.

4 Liquidity issues raised by AER

In the SA Final Decision, the AER stated that:

"*For instance, despite having improved since 2007, the size and liquidity of the indexed CGS market is still limited. Further, increased absolute liquidity in the indexed CGS market does not necessarily imply that this market has become more liquid relative to the nominal CGS market. This is important because relative liquidity between these two markets determines the liquidity bias in implied breakeven rates. Trading volume of indexed CGS expressed share of total indexed and nominal CGS can be used as a measure of the relative liquidity. According to this metric, there has only been a minor improvement to relative liquidity of the indexed CGS since early 2008. 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*"[11].

The AER has essentially raised three sets of issues, which are discussed in the ensuing sections:

- Liquidity of Indexed CGS (section 5)
- Relative liquidity of Indexed CGS and the "liquidity bias" (section 6)
- Price efficacy of Indexed CGS (section 7)

[11] Final Decision (May 2016) for AGN's South Australia access arrangement, the AER in Attachment 3, pp. 157-8

5 Liquidity of Indexed CGS

Our view is that "liquidity", a commonly used term in financial markets, means the following in combination or in part:

- the rate at which a security or other financial instrument is bought or sold over a period of time, as evidenced by *turnover* data
- the depth of the market as measured by *outstandings* which is the magnitude or dimension of a particular market being considered and a measure of the extent of securities that can *potentially* be traded
- the rate at which outstandings turn over in a period as measured by the "*Liquidity Ratio*" (turnover divided by outstandings of the instrument)
- *annual issuance* being the rate and volume of which new securities are issued into the marketplace (often called the "primary market")
- *qualitative factors* such as the overall rules and procedures governing the market, its longevity (how long it has been operating, the types of entities and participants in the market, and the maturity of the market

The turnover of a security, as used by the AER in the Final Decision, is not the only measure of a security's "liquidity". The other quantitative and qualitative measures mentioned above are equally as important as overfall metrics to understand and measure the "liquidity" of a particular security or market.

5.1 Turnover

Table 2 provides annual turnover data for various instruments in Australia from 2007-2008 to 2014-2015 as provided by AFMA[12]. It shows that Indexed CGS have both higher and lower turnover relative to other Australian financial instruments. This is also seen in the "Liquidity Ratio" (turnover divided by outstandings) in Table 4 below which is a common turnover metric, for example as used by AFMA[13].

Based on the pure turnover data, Indexed CGS have exhibited more "liquidity" than some instruments but less liquidity than other instruments since 2007-08.

The turnover of Indexed CGS is however very substantial at ca. $50 billion per annum, and therefore our view is that the Indexed CGS market is "liquid".

[12] AFMA data for 2015-2016 is not yet available

[13] See further at http://www.afma.com.au/data/afmr/2015%20afmr.pdf

Table 2 – Annual Turnover, $ billion (rounded)

AFMA Survey Year	Nominal CGS	Indexed CGS	State Gov't Bonds	State Gov't Indexed Bonds	Exchange-Traded Interest Rate Futures	Australian Corporate Debt Securities	Interest Rate Caps and Floors
2007-08	273	11	322	1	43,695	105	124
2008-09	288	11	439	3	28,695	94	82
2009-10	417	35	377	18	36,202	123	147
2010-11	657	32	584	13	47,702	177	55
2011.12	935	40	519	9	46,456	80	60
2012-13	1,049	46	445	10	48,257	107	53
2013-14	1,109	55	397	4	45,076	116	62
2014-15	1,094	51	419	2	49,088	116	45

Sources:
AFMA 2015 Australian Financial Markets Report
(*http://www.afma.com.au/data/afmr/2015%20afmr.pdf*)
2012 Australian Financial Markets Report (http://www.afma.com.au/data/afmr/2012%20afmr.pdf)

5.2 Turnover growth

Table 3 shows the growth in the financial instruments year on year since 2007-08. Indexed CGS turnover has grown significantly since the AER last used the Breakeven approach to estimate future inflation. According to the AFMA data, Indexed CGS turnover growth has been the highest of any of the other financial instruments, including Nominal CGS, in the period 2007-2008 to 2014-2015.

The turnover growth data indicates that the Indexed CGS market is "liquid" and has become far more "liquid" than when last used by the AER in 200=8.

Table 3 – Year on Year % Turnover Growth

AFMA Survey Year	Nominal CGS	Indexed CGS	State Gov't Bonds	State Gov't Indexed Bonds	Interest Rate Futures	Corporate Debt Securities	Interest Rate Caps and Floors
2008-09	5%	0%	36%	200%	-34%	-10%	-34%
2009-10	45%	218%	-14%	500%	26%	31%	79%
2010-11	58%	-9%	55%	-28%	32%	44%	-63%
2011-12	42%	25%	-11%	-31%	-3%	-55%	9%
2012-13	12%	15%	-14%	11%	4%	34%	-12%
2013-14	6%	20%	-11%	-60%	-7%	8%	17%
2014-15	-1%	-7%	6%	-50%	9%	0%	-27%
Overall Growth	301%	364%	30%	100%	12%	10%	-64%

Sources:
AFMA 2015 Australian Financial Markets Report at
http://www.afma.com.au/data/afmr/2015%20afmr.pdf

5.3 Liquidity ratio

Table 4 shows the Liquidity Ratio (turnover divided by outstandings) based on AFMA data. Our view is that, for a traded security, a Liquidity Ratio of less than 1.0 indicates a market with poor liquidity. Whilst Indexed CGS show a lower Liquidity Ratio than Nominal CGS, the Indexed CGS market has had a Liquidity Ratio of greater than 1.0 since 2007-08, and generally in the order of 2.0 times. Hence, we would describe the Indexed CGS as a market that is "liquid".

Table 4 – Liquidity Ratio

AFMA Survey Year	Nominal CGS	Indexed CGS	Treasury Notes	Bank Paper
2007-08	5.2	1.8	-	12.1
2008-09	4.7	1.1	2.3	12.4
2009-10	4.1	2.9	3.3	11.5
2010-11	4.3	2.3	2.8	12.4
2011.12	4.7	2.4	3.2	13.0
2012-13	4.4	2.2	4.9	12.5
2013-14	3.8	2.0	8.1	11.4
2014-15	3.2	1.6	4.1	10.8

Sources:
AFMA 2015 Australian Financial Markets Report at
http://www.afma.com.au/data/afmr/2015%20afmr.pdf
2012 Australian Financial Markets Report at http://www.afma.com.au/data/afmr/2012%20afmr.pdf

5.4 Outstandings

Table 5 below shows the history of outstandings for Indexed CGS and Nominal CGS since 2008 using AOFM data. The Indexed CGS market is clearly smaller than the Nominal CGS market in terms of bonds outstanding (currently ca. $405bn vs. $31bn) and this has been the case historically as well. However, current outstandings for Indexed CGS of $31 billion, and average outstandings of $18 billion since 2008 clearly demonstrates a large, substantial market, and one that we describe as "liquid".

Table 5 – History of Outstandings, $ billion (rounded)

Quarter	Nominal CGS	Indexed CGS
Sep-08	48.0	6.0
Sep-09	86.3	10.0
Sep-10	131.9	12.3
Sep-11	180.4	14.4
Sep-12	217.4	16.7
Sep-13	252.7	21.0
Sep-14	309.5	24.6
Sep-15	3573	28.3
Sep-16	405.3	31.0

Source: AOFM

5.5 Annual issuance

Table 6 shows issuance data for Indexed CGS and Nominal CGS. The annual issuance of Nominal CGS and Indexed CGS is large, regular, organised, with

issuance intentions announced and tender results publicly disclosed. Our view is that the annual issuance data illustrates that Indexed CGS is a "liquid" market, and this is corroborated by evidence of the expected growth in Indexed CGS on issue.

In its Corporate Plan 2016-17, AOFM stated in the section titled "Key Objectives for the Financial Year 2016-17 and three forward years" that one of its key priorities for the reporting periods was "*delivering the Budget financing task through its Treasury Bond and Treasury Indexed Bond issuance programs*[14]".

We therefore anticipate that AOFM will maintain its regular Nominal CGS and Indexed CGS issuance programmes. Growth in Indexed CGS on issue is likely to grow in percentage terms in line with Nominal CGS. The current outstandings of Indexed CGS is ca. $31bn (September 2016), and using the Federal Budget's projected growth factor in CGS from 2016-17 ($497bn) to 2026-27 ($640bn) of 29%, by 2026-27 the Indexed CGS on issue would be approximately $40bn.

Table 6 – Annual Issuance, $ billion (rounded)

Year	Nominal CGS	Indexed CGS
2009	51.0	4.3
2010	54.9	3.9
2011	63.4	1.8
2012	49.9	2.5
2013	68.8	4.6
2014	75.8	6.1
2015	79.5	4.7
2016 YTD	94.4	2.2

Source: AOFM

5.6 Maturity spectrum

As seen in Table 1, the Indexed CGS market has multiple issues extending in maturity out to 2040. The Nominal CGS market extends out to 2037. Hence, price information for both sets of CGS is available out to a long-term horizon.

The AER's main focus in its access arrangement determinations is the 10 year maturity being the term for the rate of return determination. This maturity is a key point on the yield curve for investors and participants in the Indexed CGS and Nominal CGS markets, and indeed is a maturity "benchmark". The 10 year point therefore has a very high degree of market focus and visibility. Hence, the probity of pricing information from CGS circa the 10 year maturity band is very high.

5.7 Sophistication

Indexed CGS were first issued in Australia just over 31 years ago, so there is a very long history and experience with these instruments in Australia.

Furthermore, as indicators of the Indexed CGS market's standing in the financial community, the following attributes are relevant:

[14] see http://aofm.gov.au/publications/corporate-plan/

- issued by the Commonwealth of Australia, the largest and most significant issuer in the Australian market in terms of benchmark issuance used by the market in price references for all other securities issued in the market

- regularly tendered by the AOFM through a large group (10) of large well-rated and longstanding banks[15] in the Australian marketplace, pursuant to a publicly-disclosed Information Memorandum[16]

- bought and sold by sophisticated institutional investors both Australian-based and international investors

- quotes for Indexed CGS are accessible via a range of parties including the RBA, Bloomberg, Thomson Reuters, as well as YieldBroker, banks, financial intermediaries and institutions, and a diverse range of fixed interest brokers

- priced in terms of the coupon and indexation component by a well-documented process and formulae with conventions provided by AFMA and included on the AOFM website

These factors support our conclusion that the pricing of Indexed CGS is highly credible, robust, reliable and efficacious.

[15] The current tender panel for Indexed CGS comprises: Australia and New Zealand Banking Group Ltd, Bank of America Merrill Lynch, Citi, Commonwealth Bank of Australia, Deutsche Bank AG, JPMorgan Chase Bank NA, National Australia Bank Ltd, Nomura, UBS AG, and Westpac Banking Corp (source: AOFM website op cit)

[16] An Information Memorandum governs the issue of Indexed CGS (see *http://cdn.aofm.gov.au/uploads/sites/31/2016/07/Treasury-Indexed-Bond-Information-Memo-July-2016.pdf)*. The Issuer is the Commonwealth of Australia. The Registrar is Computershare Investor Services Pty Limited. The Australian Office of Financial Management ("AOFM") is the manager of the Indexed CGS programme. Indexed CGS are exempt from non-resident interest withholding tax

6 *Relative liquidity*

The quote from the AER's Final SA Decision (p.10 above) highlights that the AER is also concerned that the low liquidity as measured by trading volume of Indexed CGS *relative* to Nominal CGS introduces a liquidity bias which distorts the use of Indexed CGS pricing in the Breakeven model.

It is true that Nominal CGS have historically exhibited far more trading volume/turnover than Indexed CGS. This can be expected to persist into the future. The volume relativity of Indexed CGS to Nominal CGS is mirrored in the Australian states that issue both types of instrument and also in other countries where the central financing authority issues both instruments.

The "liquidity bias" is generally interpreted as meaning the dynamic where investors will have a preference for a more liquid security over a less liquid security, and this becomes reflected in a higher yield for the less liquid security. The AER would consider the Nominal CGS to be more "liquid" than the Indexed CGS, therefore investors will demand a higher yield on the latter as compensation for the risk of market prices moving against them if they try to sell their position; in other words, a premium exists in the yield of the Indexed CGS due to what can be termed the "liquidity preference".

The AER's view would be true if the two instruments were substitutes or near substitutes for each other. We would then expect there to be exhibited a "liquidity preference" for the more liquid security.

Whilst Nominal CGS and Indexed CGS are issued by the Commonwealth of Australia and have a similar maturity spectrum, they are not substitutes or near substitutes for each other. The two instruments are completely different in their economic effect which in turn drives investor motivation for buying and holding either instrument:

- Investors will buy an Indexed CGS on the view that the inflation rate over time will be more than the breakeven inflation rate at purchase

- Investors will buy a Nominal CGS on the view that future inflation will be less than the breakeven inflation rate at the time the bond was purchased

The two views are diametrically opposed and therefore it cannot be logically inferred that there is a liquidity-related preference or dynamic between the two instruments that drives relative pricing.

Our view is that the low relative trading volume of Indexed to Nominal CGS does not introduce a liquidity bias. We therefore do not believe a liquidity bias needs to be removed from the pricing of Indexed CGS.

7 Price efficacy of Indexed CGS

The AER discusses "liquidity" in the context of the use of the pricing of Indexed CGS in the Breakeven model. It is therefore important to link "liquidity" to "price efficacy" which describes the degree to which the security reflects the true market price or is distorted for any reason, for example by lack of turnover or other market considerations. Pricing efficacy is key to usingf Indexed CGS in the Breakeven model to ensure the results are true and fair. Price efficacy can be present even though "liquidity" may be considered low especially if pricing for a security truly reflects its fair value, and this can be both validated and corroborated. Below we review several ways to gauge the price efficacy of Indexed CGS.

Our view, from the analysis below, is that the nature of the Indexed CGS market, its pricing correlation and co-dependence with Nominal CGS, and the myriad of pricing associations between Indexed CGS and other traded financial instruments, supports our view that the Indexed CGS has a very high overall pricing efficacy and one that supports its use as a pricing input in the Breakeven model.

7.1 Cross over pricing between Indexed CGS and Nominal CGS

There are significant pricing associations between Indexed CGS and Nominal CGS such that the pricing efficacy of the Nominal CGS directly supports the pricing efficacy of Indexed CGS due to the interchangeability and affinity between the two CGS and the high co-dependence of their pricing.

We have reviewed Indexed CGS and Nominal CGS in terms of their correlation of their pricing in the secondary market. That the analysis shows that, even though the turnover of Indexed CGS is less than Nominal CGS, the pricing of Indexed CGS is highly correlated with the pricing of Nominal CGS of similar maturity. This correlation extends not just to the long-term correlations, but also to daily price movements.

Table 7 shows a comparison of the daily yield changes for five pairings of Indexed CGS and Nominal CGS of similar maturity. The date ranges differ for each pair depending on when the bonds were issued. It is noteworthy that for the 2022 pairing and the 2027 Nominal CGS/ 2025 Indexed CGS pairings, there is a full 10 years of data available (our analysis only went back 10 years).

The relative daily yield movements in Table 7 show the percentage of occasions in the series that the daily yield changes of the two bonds in the pair are respectively within +/- 5, 10 and 15 basis points of each other.

Table 7 – Price relationship of Indexed CGS to Nominal CGS of similar maturity

Nominal CGS	1.75% 21-Nov-2020	5.75% 15-Jul-2022	4.75% 21-Apr-2027	2.75% 21-Jun-2035	3.75% 21-Apr-2037
Indexed CGS	4.00% 20-Aug-2020	1.25% 21-Feb-2022	3.00% 20-Sep-2025	2.00% 21-Aug-2035	1.25% 21-Aug-2040
Date range	25/06/10-22/11/16	23/11/06-23/11/16	23/11/06-23/11/16	26/03/15 - 23/11/16	18/08/15 - 23/11/16
Data years (rounded)	6.5y	10y	10y	1.5y	1.25y
R^2 of yield series	92.6%	85.6%	87.0%	73.4%	86.7%
% that relative daily yield movement < +/- 15bp	94.1%	91.7%	94.8%	91.9%	92.8%
% that relative daily yield movement < +/- 10bp	82.9%	80.0%	89.1%	72.1%	77.9%
% that relative daily yield movement < +/- 5bp	53.6%	49.5%	69.2%	42.9%	41.1%

The results of our analysis above are summarised as follows:

a. the yield series of the five pairings have an R-squared correlation above 90% which is very high, indicating the yields of Nominal CGS and Indexed CGS move closely together over time

b. the vast majority of daily yield movements of the bonds in each pairing are within a yield variation of 10-15bp

The analysis above shows that Indexed CGS and Nominal CGS have a very close pricing affinity. There are several reasons for this affinity:

1. **Indexed CGS investor requirement to mark-to-market**: the vast majority of holders of Indexed CGS are large, sophisticated funds and required by legislation to mark-to-market their portfolios daily (i.e. adjust their book prices to market rates), so yield changes in Nominal CGS quickly translate to yield changes in Indexed CGS due to their yield association

2. **Probity and attention**: Indexed CGS have significant probity, attention and focus in the market being issued by the Commonwealth of Australia, the largest and most important issuer in the Australian market, through its agency the AOFM, a very well-organised tender process through a panel of 10 major licensed

banks to sophisticated wholesale investors both onshore and offshore, with detailed information on the securities, tenders and issuance appearing on the AOFM and RBA websites

3. **Tender process constantly conforms secondary market yields to primary market yields**: Tenders are held regularly (twice a month in most months), with total amount allotted each month through tenders averaging $255 million since July 2013. The pricing for Indexed CGS in the primary market is therefore consistently being updated through these "live" auctions. This dynamic occurs due to two factors: first, the regularity of the tenders which acts as a major pricing reference for investors and market-makers in Indexed CGS in the secondary market, and secondly, because most tenders are for existing Indexed CGS lines and fungible with these lines. Hence, there is a direct and highly liquid reference point for secondary Indexed CGS stock with the result that pricing changes in Indexed CGS occur quickly and efficiently

4. **Coverage ratio (ratio of bids received to bonds allocated) high for Indexed CGS tenders:** as Appendix A shows, the Coverage Ratio for Indexed CGS tenders has typically averaged 4.12 times since July 2013, meaning there are generally far more bids received from the market than Indexed CGS issued. This shows high investor participation/interest in Indexed CGS (significantly above volumes actually issued), and corroborates our conclusion that Indexed CGS have a high degree of pricing efficacy

5. **Maturity profile**: both instruments have closely corresponding maturity profiles facilitating direct price comparisons

6. **Instrument connectivity**: investors will typically buy Nominal CGS to express their view on nominal interest rates. Investors will on the other hand buy Indexed CGS to explicitly express an inflation view (or hedge an inflation risk) with the pricing of the Indexed CGS derived by subtracting their expected inflation rate from the Nominal CGS. Hence, there is a direct pricing connection between the two instruments

   The pricing of the two instruments is inextricably linked via by the inflation expectation and it is this variable that determines the pricing for Indexed CGS. This provides certainty that the Breakeven inflation rate is robust to capture the market's future inflation view and expectation.

7.2 Pricing relationships with other financial instruments

Pricing of Indexed CGS is a key component of the pricing of the financial instruments described below. This price association supports our view that pricing for Indexed CGS has high visibility, efficacy and reliability. The instruments that cross-reference pricing of Indexed CGS are as follows:

a. Repurchase agreements ("repos")

Indexed CGS are 'repo eligible' meaning that market participants can borrow/ lend them, assisting in their portfolio management, and increasing their market usefulness and pricing visibility.

b. *Exchange-traded Indexed CGS*

Exchange-traded Treasury Indexed Bonds[17] were listed on the Australian Securities Exchange ("ASX") in May 2013. ASX listing means another set of investors can access Indexed CGS, deepening the market and thereby improving the overall price efficacy of these instruments.

c. *Indexed CGS Options*

There is an OTC market in options on Indexed CGS with these options that have exercise references to the underlying Indexed CGS. These instruments provide further indirect investor participation in Indexed CGS enhancing price efficacy.

d. *Semi-government indexed bonds*

As shown in Table 3, there is a significant volume of inflation-indexed bonds issued by semi-government authorities in Australia. These bonds tend to trade at spreads to Indexed CGS.

7.3 Investor participation

Investor participation in the Indexed CGS and Nominal CGS is extremely strong, comprising both domestic and offshore sophisticated institutional funds, insurance companies, banks and governments. Ongoing issuance of Indexed CGS and Nominal CGS in the primary market by AOFM through a tender panel of large banks, and strong investor participation ensures that the pricing for these securities is highly credible, robust and efficacious.

Indexed CGS have a lower turnover in compared to Nominal CGS, however because many investors in Indexed CGS are required to mark-to-market their portfolios on a daily basis, the pricing for the securities quickly reflects market changes.

Investors in Indexed CGS are generally buying them with the intention to hold them for a very long term commensurate with their long-tail liability risks, and do not set out to trade them. Hence, the turnover in these securities will necessarily be reduced. However this does not in any way mean that the pricing does not quickly and efficiently reflect the market and any changes in the market.

[17] A list of the *Exchange-traded Treasury Indexed Bonds* currently available to investors can be viewed on the Australian Government Bonds Website at www.australiangovernmentbonds.gov.au

8 Conclusion

In this Review, we have focused on the AER's comments in the SA Final Decision regarding the liquidity of the Indexed CGS market as quoted below:

"*For instance, despite having improved since 2007, the size and liquidity of the indexed CGS market is still limited. Further, increased absolute liquidity in the indexed CGS market does not necessarily imply that this market has become more liquid relative to the nominal CGS market. This is important because relative liquidity between these two markets determines the liquidity bias in implied breakeven rates. Trading volume of indexed CGS expressed share of total indexed and nominal CGS can be used as a measure of the relative liquidity. According to this metric, there has only been a minor improvement to relative liquidity of the indexed CGS since early 2008. 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*"[18].

Our review shows that Indexed CGS exhibit sufficient liquidity and pricing efficacy to serve as a reliable input in the Breakeven model to estimate the expected inflation rate over a 10 year horizon as required for gas access arrangements.

In particular, our conclusions are that:

- Turnover/ trading volumes of Indexed CGS has grown significantly since 2008, and we would assess the Indexed CGS market nowadays to be "liquid" on this metric alone

- Looking at "liquidity" with a wider lens to not just turnover/ trading volumes, but also other *quantitative* metrics such as growth in trading volumes, outstandings, the Liquidity Ratio, primary market issuance, and *qualitative* factors such as the market's maturity and sophistication, lead us to the same view, that the Indexed CGS market is "liquid"

- The lower trading volume of Indexed CGS *relative* to Nominal CGS does not introduce a 'liquidity bias' rendering the price information of Indexed CGS unreliable for the purposes of the Breakeven model. We therefore do not believe a liquidity bias needs to be removed from the pricing. The factors suggesting there is no 'liquidity bias' relate to the non-substitutability of Nominal CGS for Indexed CGS given their diametrically opposed future inflation view

- Indexed CGS have extremely high price reliability and efficacy due to the pricing association/co-dependence and observed correlation between Indexed CGS and Nominal CGS, the use of Indexed CGS pricing, either directly or indirectly, in the pricing references of a number of other market instruments, and the probity around the Indexed CGS market which relates to such factors as the Commonwealth of Australia being the issuer, how primary issue tenders are conducted, the sorts of participants involved in the Indexed CGS market, and the regularity of Indexed CGS issuance by AOFM which means secondary market pricing is constantly being updated by pricing information from the primary market

[18] Op cit. Attachment 3, pp. 157-8

Appendix A

Indexed CGS: Tender results since July 2013

Source: Reserve Bank of Australia

Date held	Maturity	Coupon %	Amount offered ($m)	Amount allotted to public $m	Total amount allotted ($m)	Amount of bids received ($m)	Coverage ratio
16-Jul-13	Feb-22	1.25	200	200	200	1,795	8.98
20-Aug-13	Sep-30	2.50	200	200	200	615	3.08
10-Sep-13	Feb-22	1.25	200	200	200	743	3.72
26-Sep-13	Aug-35	2.00	na	2,100	2,100	na	na
29-Oct-13	Feb-22	1.25	200	200	200	676	3.38
12-Nov-13	Sep-30	2.50	150	150	150	527	3.51
26-Nov-13	Feb-22	1.25	200	200	200	1,044	5.22
10-Dec-13	Sep-30	2.50	100	100	100	492	4.92
11-Feb-14	Aug-35	2.00	200	200	200	748	3.74
25-Feb-14	Feb-22	1.25	200	200	200	1,071	5.36
11-Mar-14	Aug-20	4.00	200	200	200	902	4.51
25-Mar-14	Feb-22	1.25	200	200	200	689	3.45
8-Apr-14	Aug-35	2.00	100	100	100	369	3.69
29-Apr-14	Nov-18	1.00	500	500	500	1,982	3.96
2-May-14	Nov-18	1.00	na	2,039	2,039	na	na
20-May-14	Feb-22	1.25	200	200	200	872	4.36
10-Jun-14	Nov-18	1.00	200	200	200	1,068	5.34
24-Jun-14	Aug-35	2.00	100	100	100	577	5.77
8-Jul-14	Nov-18	1.00	300	300	300	920	3.07
29-Jul-14	Feb-22	1.25	100	100	100	662	6.62
12-Aug-14	Sep-25	3.00	100	100	100	547	5.47
26-Aug-14	Nov-18	1.00	200	200	200	1,440	7.20
9-Sep-14	Feb-22	1.25	200	200	200	873	4.37
23-Sep-14	Sep-30	2.50	150	150	150	642	4.28
14-Oct-14	Nov-18	1.00	300	300	300	1,104	3.68
28-Oct-14	Feb-22	1.25	200	200	200	745	3.73
11-Nov-14	Aug-35	2.00	150	150	150	666	4.44
25-Nov-14	Feb-22	1.25	200	200	200	1,020	5.10
9-Dec-14	Nov-18	1.00	300	300	300	1,516	5.05
10-Feb-15	Sep-25	3.00	150	150	150	837	5.58
24-Feb-15	Nov-18	1.00	200	200	200	1,006	5.03
10-Mar-15	Sep-25	3.00	150	150	150	673	4.49
24-Mar-15	Feb-22	1.25	200	200	200	872	4.36
14-Apr-15	Nov-18	1.00	200	200	200	925	4.63
28-Apr-15	Aug-35	2.00	200	200	200	576	2.88
26-May-15	Nov-18	1.00	200	200	200	1,010	5.05

Date held	Maturity	Coupon %	Amount offered ($m)	Amount allotted to public $m	Total amount allotted ($m)	Amount of bids received ($m)	Coverage ratio
9-Jun-15	Sep-25	3.00	200	200	200	723	3.62
23-Jun-15	Nov-18	1.00	300	300	300	1,065	3.55
14-Jul-15	Feb-22	1.25	200	200	200	910	4.55
28-Jul-15	Sep-25	3.00	150	150	150	506	3.37
11-Aug-15	Aug-40	1.25	na	1,250	1,250	na	na
8-Sep-15	Nov-18	1.00	150	150	150	598	3.99
22-Sep-15	Sep-30	2.50	150	150	150	300	2.00
13-Oct-15	Aug-20	4.00	150	150	150	460	3.07
10-Nov-15	Aug-40	1.25	150	150	150	585	3.90
24-Nov-15	Aug-35	2.00	200	200	200	713	3.57
8-Dec-15	Sep-25	3.00	200	200	200	480	2.40
9-Feb-16	Aug-40	1.25	150	150	150	391	2.61
23-Feb-16	Feb-22	1.25	100	100	100	421	4.21
8-Mar-16	Nov-18	1.00	100	100	100	596	5.96
22-Mar-16	Feb-22	1.25	150	150	150	565	3.77
12-Apr-16	Nov-18	1.00	100	100	100	541	5.41
10-May-16	Aug-40	1.25	150	150	150	538	3.59
24-May-16	Sep-25	3.00	150	150	150	830	5.53
14-Jun-16	Aug-35	2.00	150	150	150	456	3.04
28-Jun-16	Feb-22	1.25	150	150	150	260	1.73
12-Jul-16	Aug-35	2.00	150	150	150	543	3.62
9-Aug-16	Sep-30	2.50	150	150	150	395	2.63
23-Aug-16	Feb-22	1.25	150	150	150	390	2.60
13-Sep-16	Sep-25	3.00	150	150	150	350	2.33
27-Sep-16	Feb-22	1.25	150	150	150	341	2.27
18-Oct-16	Aug-40	1.25	100	100	100	291	2.91
08-Nov-16	Sep-25	3.00	150	150	150	405	2.70

Appendix B

Matthew Lemke, Director, Debt & Capital Markets, PwC

Matthew has over 30 years of global markets experience working in advisory and transaction execution roles in debt capital markets and a dealer in the fixed income, interest rate, foreign exchange, commodity, credit and inflation markets. Matthew has worked in New York, London, Singapore, Hong Kong, Melbourne and Sydney. He is very familiar with international best practice across a range of markets. Matthew has dealt specifically in interest rate swaps and inflation swaps.

Matthew has been involved in financial markets since 1982, and has worked in Melbourne, Sydney, New York, London, Singapore and Hong Kong in various roles, including:

- National Companies & Securities Commission (1982-84) in the Prospectuses area (Project Officer)_
- JP Morgan (1984-1995) in its Global Markets division (Vice President)
- Deutsche Bank (1995-2006) in its Global Markets division (Director)
- Powercor/CitiPower (2007-2014) in the treasury/ finance area where he was involved in advising the CFO and Treasurer on large, strategic hedging transactions related to the AER's WACC parameters for several of Powercor/ CitiPower's regulatory rate resets including the Advanced Metering Infrastructure (AMI) 2008 regulatory rate reset (primarily the WACC derivation) and the Electricity Distribution Price Review (EDPR) for Powercor/ CitiPower's 2010-15 regulatory period

Matthew joined PwC in 2014. At PwC, Matthew has been involved in advising on a large number, and diverse range, of finance and hedging transactions. This work has included advising companies on interest rate hedging programmes for the return on debt (Kd) and return on equity (Ke) factors within the WACC used within regulatory determinations by the AER and other regulators. This work has included hedging advice for several electricity and gas distribution businesses in order to meet the AER's Transitional Guidelines for Kd. Matthew has assisted in the implementation of multi-billion interest rate hedging transactions for several AER- regulated entities and entities that are regulated in jurisdictions that have adopted the AER's transitional guidelines for the WACC. His work has also extended to reviewing the inflation risk in regulated businesses, and the use of inflation-linked swaps in this context. Matthew has advised a national regulator on the use of cross currency swaps, and provided a desktop standalone pricing swap model, to evaluate non-A$ issued bonds in the context of a WACC review. Matthew has also recently advised a state government on its multi-billion dollar debt programme and ways to improve it. This work mainly focused on the nominal bonds outstanding, but also touched on inflation-indexed bonds as well.

Professional qualifications and memberships

Bachelor of Laws (with Honours), University of Melbourne
Bachelor of Commerce, University of Melbourne
MBA short course Harvard University
Certified Fellow, FINSIA (Australia)
Certified Fellow, Finance & Treasury Professional (Australia)
Past Chairman, Technical Committee, Australian Finance & Treasury Association