Queensland Competition Authority

Draft position paper

Inflation forecasting

July 2021

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SUBMISSIONS

Closing date for submissions: 17 September 2021

Public involvement is an important element of the decision-making processes of the Queensland Competition Authority (QCA). Therefore, submissions are invited from interested parties concerning its draft position on inflation forecasting. The QCA will take account of all submissions received within the stated timeframes.

Submissions, comments or inquiries regarding this paper should be directed to:

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Claims for confidentiality should be clearly noted on the front page of the submission. The relevant sections of the submission should also be marked as confidential, so that the remainder of the document can be made publicly available. It would also be appreciated if two versions of the submission (i.e. a complete version and another excising confidential information) could be provided.

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Public access to submissions

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EXECUTIVE SUMMARY

This draft position paper sets out our preliminary findings and proposed approach to estimating expected inflation and input cost escalation for future regulatory reviews. Our aim is to assist stakeholders in future regulatory submissions by providing them with greater transparency and confidence in our inflation forecasting approach.

Expected inflation and escalation rates are relevant when we calculate revenues and prices for entities that are subject to the various regulatory regimes provided for in the *Queensland Competition Authority Act 1997* (QCA Act).

Guided by underlying economic principles and regulatory best practice, we propose to make the following changes to our existing approach:

- *the term for estimating expected inflation for capital revenue calculations*—our preliminary position is to match the term for estimating expected inflation used for calculating the return on capital with the length of the regulatory period (Chapter 2)
- *our approach to estimating expected inflation*—our preliminary position is that an appropriate estimation approach for expected CPI inflation is to use short-term RBA forecasts for the first two years and then use a linear glide path from the RBA's short-term forecast in year 2 to a rules-based anchor-point forecast (Chapter 3).

This review process is not intended to prescribe a binding inflation forecasting methodology for future regulatory reviews. Should stakeholders wish to submit alternative methods in future regulatory investigations, we shall consider these alternatives on their merits.

Table 1 sets out our preliminary findings. We will consider stakeholder views on these findings before finalising our inflation forecasting approach and publishing our final position paper.

In most cases, our draft positions are similar to those of other Australian regulators. We compare our approaches to those of other regulators throughout the report.

Table 1 Preliminary findings on our inflation forecasting approach

Issue	***Draft position***
Inflation objectives	Maintain our existing inflation objective of targeting a real rate of return on investments in regulated infrastructure assets (section 2.2.1).
Inflation forecasting term for capital revenue purposes	Match the term for estimating expected inflation used for calculating the return on capital with the length of the regulatory period (section 2.2.2).
Different uses of expected inflation	Use a single approach to estimate expected consumer price index (CPI) inflation but base the term over which it is estimated on the relevant purpose of the analysis (section 2.3).
Opex and capex escalation	Use expected CPI inflation to escalate opex and capex categories for which the underlying cost drivers are not materially different from CPI inflation. However, use input-specific or sector-specific cost escalators where underlying cost drivers are materially different from CPI inflation (section 2.3).
Revenue/price smoothing	Use an estimate of expected CPI inflation over the regulatory term to smooth allowable revenue and prices, unless the potential for price shocks over subsequent regulatory periods warrants using different growth rates (section 2.3).
Indexing renewals annuities	Use an estimate of expected CPI inflation over a 10-year term to index renewals annuities (section 2.3).

Issue	*Draft position*
Inflation forecasting approach	Derive CPI forecasts using short-term RBA forecasts for the first two years ahead, and derive forecasts up to the fifth year ahead using a linear glide path from the RBA's short-term forecast in year two to a rules-based anchor-point forecast in the fifth year ahead. Assume the midpoint of the RBA's target range (2.5%) beyond the fifth year ahead for other purposes (section 3.5).
Measure of inflation	Use headline CPI, rather than trimmed mean estimates, as the appropriate measure of general CPI inflation in revenue and price modelling, other than in abnormal and transient economic circumstances—when the appropriate measure will be considered on a case-by-case basis at the time of the review process (section 4.2).
National or Brisbane inflation	Use national CPI for capital revenue purposes (i.e. inflation deduction and RAB indexation), and use location-specific (Brisbane) cost escalators in cases where there are underlying cost drivers that are materially different to the national CPI inflation measure (section 4.3).

Stakeholder consultation

In preparing this draft position paper, we have considered stakeholder submissions on our issues paper (March 2021). The submissions we received are listed in Appendix A and are available on our website.

We would like to thank stakeholders for taking the time to engage in this process so far. Stakeholder engagement is an important part of this process.

We invite stakeholders to comment on the preliminary approaches put forward in this draft position paper. We will consider all views put forward by stakeholders to inform our final position paper.

Submissions on the draft position paper are due by **17 September 2021**.

Contact us

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1 INTRODUCTION

1.1 Inflation and its uses

Inflation is normally defined as the increase in the aggregate price level in the economy over time. However, in regulatory applications, inflation is also often used to describe the escalation of capital expenditure (capex) and operating expenditure (opex) using several alternative factors.

At present, we effectively convert the nominal return on capital to a real return—using an estimate of expected price level inflation[1]—and provide inflation compensation via indexation of the regulatory asset base (RAB)—using a related measure of actual inflation.[2] This approach seeks to:

- avoid, as far as practical, the double counting of expected inflation when calculating the return on capital
- minimise inflation risk for both the regulated firm and customers.

For the escalation of capex and opex, several factors, including a measure of consumer price-level inflation, are used depending upon the particular investment and operational circumstances of the regulated entity.

1.2 Why are we reviewing our inflation forecasting approach?

In this draft position paper, we establish our preliminary positions on the appropriate estimation and application of inflation in calculating regulatory revenue allowances and associated prices.

Alternative estimates of expected inflation can result in significantly different allowable revenues for regulated entities and the prices paid by their customers.

We currently estimate expected price-level inflation by combining Reserve Bank of Australia (RBA) forecasts, where available in the short term, and the midpoint of the RBA target band (2.5%) thereafter. In recent reviews, we have estimated expected inflation over a 10-year term to apply the adjustment process of deducting expected inflation from the nominal rate of return.[3] Our method of forecasting inflation has been subject to some discussion in our recent reviews.[4]

Following input from stakeholders, our final position paper will set out our preferred approach for estimating expected price-level inflation and input cost escalation in future reviews.

1.3 Review timeframe

We invite submissions on our draft position paper by **17 September 2021**.

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[1] We adjust the return on capital by deducting an amount equivalent to the forecast change in the RAB value from indexation, derived using our estimate of expected price level inflation.

[2] Forecast inflation is given by an estimate of expected inflation. We use these terms interchangeably. Further, they are distinct from realised, or actual, inflation.

[3] QCA, *Queensland Rail 2020 draft access undertaking*, decision, 2020, p. 75; QCA, *GAWB price monitoring 2020–25*, final report, 2020, p. 22.

[4] For example, QCA, *Aurizon Network's 2017 draft access undertaking*, decision, 2018, pp. 56–68; QCA, *Queensland Rail 2020 draft access undertaking*, decision, 2020, pp. 76–77; QCA, *GAWB price monitoring 2020–25*, final report, 2020, pp. 22–23.

Timeframes for this review process, including when we intend to publish our final position paper, are provided below.

1.4 Scope of the review

This review covers appropriate methods for estimating expected inflation and input cost escalation, for all uses in revenue and price modelling.

For this draft position paper, we have assessed our existing approach to estimating expected inflation against alternative methods. We have set out our draft position for estimating expected inflation and on other methodological issues.

1.5 Guiding principles for this review

In estimating expected inflation and input cost escalation for entities that are subject to our regulatory regime, we are required to consider various factors in the *Queensland Competition Authority Act 1997* (QCA Act).

Under Part 5 of the QCA Act, when making an access determination, and in order to approve a draft access undertaking for a regulated entity, we must have regard to the factors in ss. 120(1) and 138(2) of the QCA Act respectively, including the pricing principles mentioned in s. 168A.

These pricing principles (s. 168A) do not explicitly state that we must have regard to the effect of inflation, but instead require that we have regard for prices at least meeting the efficient costs of providing access to the service (s. 168A(a), referenced in ss. 120(1)(l) and 138(2)(g)).

Under Part 3 of the QCA Act, when conducting investigations about pricing practices or price monitoring investigations for monopoly business activities, we must have regard to the effect of inflation (ss. 26(1)(f) and 170ZI(1)(i)).

When estimating expected inflation, we also consider matters set out in any relevant direction notice from the responsible Minister.[5]

1.6 Structure of the report

Our draft position paper is set out as follows:

- Introduction and context (Chapter 1)
- The regulatory treatment of inflation, including appropriate inflation measures and forecasting terms for different purposes (Chapter 2)

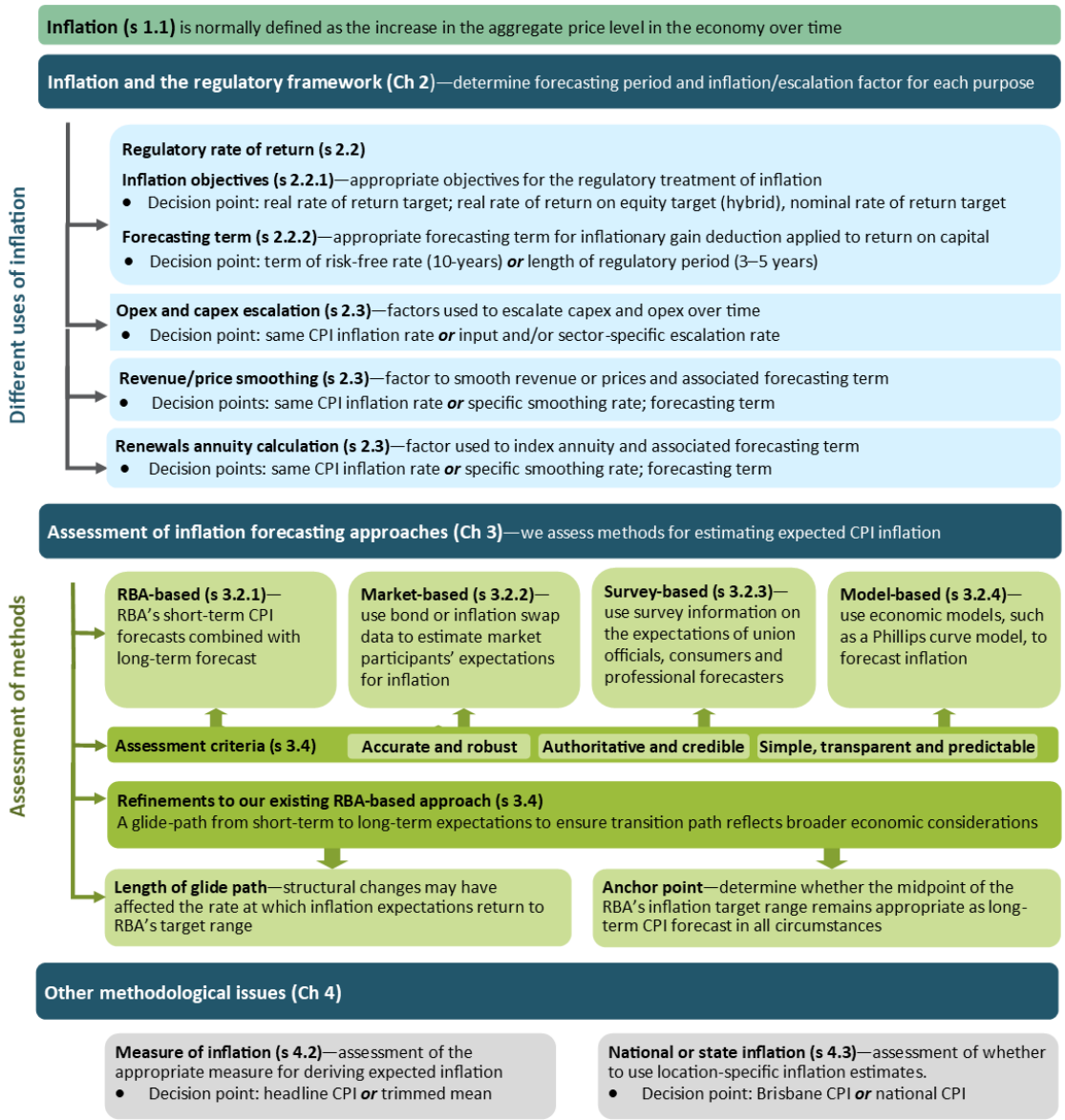
[5] For example, for our 2022–26 Seqwater bulk water price review, the Treasurer directed us, among other stated matters, to consider and recommend prices that are consistent with an inflation forecasting methodology that determines the forecast rate of inflation using inflation swaps data.

- Assessment of alternative methods for estimating expected CPI inflation (Chapter 3)
- Other methodological issues (Chapter 4)
- Appendices A to E that include more detailed information on methodological issues and relevant research studies.

1.7 Inflation at a glance

Figure 1 provides an overview of the relevance and uses of inflation in revenue and price modelling. It also indicates the section in the report where each issue is discussed.

Figure 1 Inflation overview



2 INFLATION AND THE REGULATORY FRAMEWORK

Investment in long-lived assets requires an expectation that the rate of return will keep pace with the rate of inflation in the economy. For this reason, the regulatory framework takes investors' inflationary expectations into account when determining the regulated rate of return.

The framework also allows for other costs of regulated businesses, such as efficient capital expenditure (capex) and operating expenditure (opex), to keep pace with suitable escalation rates, —including the rate of inflation where appropriate.

By taking account of inflation in this way, the framework supports incentives for appropriate investment and operational decisions.

2.1 Key points

Our draft position on the regulatory treatment of inflation is to:

- maintain our existing inflation objective of targeting a real rate of return[6] on investments in regulated infrastructure assets so that, when combined with the indexed RAB, investors can expect the rate of return to keep pace with the rate of inflation (section 2.2.1)
- match the term for estimating expected inflation used for calculating the return on capital with the length of the regulatory period (section 2.2.2)
- use a single approach to estimate expected consumer price index (CPI) inflation but base the term over which it is estimated on the relevant purpose of the analysis (section 2.3)
- use expected CPI inflation to escalate opex and capex categories for which the underlying cost drivers are not materially different from CPI inflation. However, use input-specific or sector-specific cost escalators where underlying cost drivers are materially different from CPI inflation (section 2.3)
- use an estimate of expected CPI inflation over the regulatory term to smooth allowable revenue and prices, unless the potential for price shocks over subsequent regulatory periods warrants using different growth rates (section 2.3)
- use an estimate of expected CPI inflation over a 10-year term to index renewals annuities (section 2.3).

2.2 Inflation and the regulated rate of return

In Australian regulatory practice, investors in regulated firms generally earn a rate of return to compensate them for the opportunity cost of the invested funds. We typically estimate the rate of return as the weighted average cost of capital (WACC), which is a weighted average of the regulated firm's costs of equity and debt.[7]

We use a nominal modelling framework as it is simpler and more transparent, given most costs, taxes, depreciation and interest are expressed in nominal terms. As this modelling framework applies a nominal WACC to calculate the return on capital allowance, we reduce this allowance for expected inflation so that the firm does not receive compensation for inflation twice—once

[6] That is, exclusive of inflationary effects.
[7] We are currently reviewing our approach to determining reasonable rates of return for regulated entities.

in the return on capital allowance and once via indexation of the RAB. Effectively, the firm receives a real return on capital in its allowed cash flows and inflation compensation via RAB indexation.

As expected inflation is not observable, we necessarily use an estimate of expected inflation. Because the estimate of expected inflation can have a material effect on allowable revenues, it is desirable that this estimate is as accurate as possible.

In our recent irrigation water pricing review, we used the alternative renewals annuity approach (rather than a RAB-based approach) to recover renewals capex. Under that approach, we allowed an annuity charge derived as an indexed annuity, with the indexation rate set to equal our estimate of expected CPI inflation.

2.2.1 Inflation objectives

Our draft position is to maintain our existing approach of targeting a real rate of return on investments in regulated infrastructure assets. This approach is consistent with the approaches of other Australian regulators.[8] A modelling framework with a real rate of return target maintains the real purchasing power of the investor and minimises inflation risk for both the regulated firm and customers.[9]

Under this approach, the post-tax nominal income received by investors of the regulated firm[10] comprises a nominal return on and of capital, with the nominal return on capital comprising a cash component (equivalent to a real return on capital) and an asset revaluation component (delivered through indexation of the RAB). We deduct our estimate of expected inflation from the nominal return on capital so that the regulated firm is receiving the approximate real rate of return. The end-of-period indexation preserves investors' purchasing power and minimises inflation risk for both the regulated firm and customers.

This approach assumes that investors make economic decisions based on underlying real returns, rather than nominal returns. Investors assess nominal returns, and therefore expected inflation, because they will receive nominal returns in future years. However, a real return benchmark ultimately determines the opportunity cost of capital. As a result, investment in long-lived infrastructure assets requires an expectation of real returns that are achievable. In this way, a regulatory framework that targets expected real returns is consistent with efficient costs.

Stakeholder comments

Dalrymple Bay Coal Terminal (DBCT) User Group said that using a nominal WACC (and an unindexed RAB) to compensate for inflation would eliminate the need to forecast inflation for the purposes of calculating the allowed return on and of capital. However, it acknowledged that there were good reasons why we might want to target an initial real rate of return and compensate for inflation through RAB indexation including:

- using a nominal WACC would result in front-loading depreciation in real terms

[8] Like the AER, we implement this using a nominal framework, including a post-tax nominal WACC. Other Australian regulators (including the ACCC, ERA, IPART and ESCOSA) implement this using a real framework.

[9] Under this approach, the RAB evolves over time using actual inflation. If inflation is higher than expected, then future nominal revenues (and future customer expenditures) will be higher than expected due to higher-than-expected indexation of the RAB. However, real revenues and expenditures will be maintained.

[10] Post-tax income, in this context, refers to revenue net of tax and operating expenses.

- not indexing the RAB would open a gap between the regulatory accounts and the statutory accounts.[11]

DBCT User Group considered that, in practice, an adjustment of the RAB for inflation is likely to be at best an approximation of fair value and would simply ensure that the regulatory accounts and statutory accounts do not deviate too far. For this reason, DBCT User Group said that the inflation adjustment should primarily be seen as an issue of setting a tilt factor into the profile of recovering the return of capital consistent with the underlying economic benefits available to different cohorts of users. It said that, in this context, the key issue was ensuring consistency between the amount deducted from the nominal WACC to reflect potential inflation and the amount by which the RAB is adjusted.[12]

DBCT User Group submitted that the best way to balance the considerations of eliminating windfall gains and losses and of maintaining a broad alignment of the RAB with replacement cost would be to use actual inflation from the previous period both to calculate the real WACC and to adjust the asset base for the current period.[13]

Both Queensland Treasury Corporation (QTC) and Seqwater proposed 'hybrid' approaches, where inflation compensation was targeted at the providers of debt and equity capital rather than at the firm level.[14]

QTC proposed that we target a 10-year real return on equity but considered that our existing approach to accounting for inflation resulted in an implied inflation risk premium being reflected in the real risk-free rate.[15] QTC said that this resulted in a biased estimate of the real risk-free rate, as a true real rate would not include compensation for inflation.[16]

QTC considered that this could be resolved by using a 10-year market estimate of inflation expectations. QTC reasoned that since a market estimate of inflation expectations was also likely to include an inflation risk premium, this would remove the (inflation risk) bias that QTC considered to be inherent in our estimate of the real risk-free rate.

QTC accepted that the market estimate of inflation expectations was also likely to be affected by a liquidity risk premium. It proposed that we derive the market estimate as the difference between the 10-year nominal Commonwealth Government security (CGS) yield and the midpoint between the 10-year indexed CGS yield (which would be likely to include a liquidity risk premium) and a 'lower bound' indexed CGS yield (determined so as to exclude an 'upper bound' estimate of the liquidity premium).[17]

In relation to the return on debt, QTC proposed that we target a nominal return[18], as it was efficient practice for the benchmark entity to issue nominal debt rather than inflation-indexed debt.[19] However, were we to continue to target a real return on debt, QTC submitted that we

[11] DBCT User Group, sub. 2, pp. 4–5.
[12] DBCT User Group, sub. 2, pp. 4–5.
[13] DBCT User Group, sub. 2, p. 5.
[14] So-called 'hybrid' approaches have different inflation objectives for equity compared to debt investors.
[15] This is because we deduct our estimate of inflation expectations (that excludes an inflation risk premium) from a nominal WACC (with a risk-free rate component that incorporates an inflation risk premium).
[16] QTC, sub. 5, p. 1.
[17] QTC, sub. 5, pp. 2–5.
[18] Whereby we use the same estimate of expected inflation (for the term of the regulatory period) to determine the real return on debt as we use to index the debt-funded portion of the RAB.
[19] QTC, sub. 5, pp. 5–7.

match our estimate of expected inflation to the term of the regulatory period to limit any mismatch between our nominal cost of debt allowance and the delivered nominal cost of debt.

Seqwater also considered that we should target a nominal return on debt. Seqwater said that under the existing regulatory arrangements, it effectively received a real cash return on debt allowance in each regulatory period even though it had prudently and efficiently raised nominal debt and was therefore contractually required to pay a full nominal return on debt in each regulatory year.[20] Seqwater said that the shortfall between the real allowed return on debt and Seqwater's actual debt service costs must be made up by the equity holder.[21] On that basis, Seqwater proposed either of the following changes to achieve a nominal return on debt target:

- Set a nominal return on debt allowance so that the annual allowable revenue is sufficient to pay actual contractually required nominal return on debt each year.
- Use the same estimate of expected inflation to apply the inflation deduction and for the ex post indexation of the debt portion of the RAB.

Analysis

Our inflation objective is to target an initial real WACC and then compensate investors for actual inflation. We consider that this is best achieved by providing investors with an initial real return through revenues and then compensating them for inflation by indexing the RAB with actual inflation. While compensation is achieved through RAB indexation, the primary aim is to maintain the value of funds invested. The aim is not about aligning the regulatory accounts with the statutory accounts. Moreover, as recognised by DBCT User Group, this approach avoids front-loading the return of capital in real terms.[22]

In relation to the hybrid approach, we consider that it is more appropriate to target the overall rate of return so as to allocate the risk of financing decisions to the regulated entity, as the regulated entity is best placed to manage this risk.[23] It is up to the firm to manage its debt profile (and be incentivised to outperform the cost of debt allowance). Recovery of actual debt costs is not consistent with a benchmark approach. We also believe that any potential benefits from the hybrid approach would likely be outweighed by the increased complexity of such a framework. Moreover, we consider that a hybrid approach is inconsistent with the assumptions of the capital asset pricing model (CAPM)/WACC framework which underlies our valuation analyses.

We have considered QTC's proposal for estimating inflation expectations. However, as further discussed in Chapter 3, we believe the inherent and unquantifiable biases associated with market-based measures of inflation are not understood well enough to provide confidence that this type of approach is appropriate, irrespective of the extent of any inflation risk premium built into the nominal bond rate. As a result, we consider that this approach would result in biased estimates of inflation expectations and real returns.

We consider that the risk parameters estimated in determining the nominal WACC should provide compensation for the extent to which inflation represents a systematic risk to the regulated

[20] Seqwater, sub. 6, pp. 4, 6–7.
[21] Seqwater, sub. 6, p. 7.
[22] In terms of DBCT User Group's proposal to use actual inflation from the prior period to calculate the real WACC, we note that we generally require an inflation forecast over a longer term of at least 3–5 years (see section 2.2.2). For this length of forecasting period, we do not consider it reasonable to use prior period's actual inflation.
[23] On this, we agree with the AER's position as set out in its position paper on the regulatory treatment of inflation—AER, *Regulatory treatment of inflation*, final position, December 2017, pp. 88–89.

entity. To the extent that there are unexpected inflation shocks, we consider that the regulated firm should be compensated by indexing the RAB with actual inflation.

We note Seqwater's concern that the shortfall between the real allowed return on debt and Seqwater's actual debt service costs must be made up by the equity holder. However, our building blocks model assumes that the firm maintains constant gearing rather than a constant level of debt. The benchmark debt balance therefore is assumed to increase by inflation as we apply indexation to the opening RAB each year. This implies that the benchmark firm borrows against the indexation of the debt-funded portion of the RAB using nominal bonds to raise cash to service part of its nominal cost of debt.[24]

Draft position

Our draft position is to maintain our existing approach of targeting a real rate of return on investments in regulated infrastructure assets.

2.2.2 Term for forecasting inflation

Our draft position is to match the forecasting term with the length of the regulatory period when estimating expected inflation for the purpose of deriving capital-related revenues.[25] This approach targets expected real returns[26], so that inflation risk is minimised for investors and customers, and it ensures that the allowed nominal return is achieved in expectation (i.e. the allowed nominal return is achieved if actual inflation outcomes over the regulatory period are equal to those expected or, in other words, in the absence of unexpected inflation outcomes).

In previous reviews, we have generally estimated expected inflation over a term consistent with the term of the risk-free rate incorporated in the nominal rate of return. Historically[27], we have estimated the risk-free rate using a bond term that matched the term of the regulatory period (a regulatory term-matched bond term). However, in more recent reviews, we have used a 10-year term for the risk-free rate and expected inflation.[28]

Historically, other Australian regulators have also estimated expected inflation over a horizon consistent with the term of the risk-free rate incorporated in the nominal rate of return. However, the Australian Energy Regulator (AER), the Independent Pricing and Regulatory Tribunal (IPART) and the Independent Competition and Regulatory Commission (ICRC) have recently modified their approaches to adopt a regulatory term-matching approach for estimating expected inflation. Table 2 summarises recent approaches.

Table 2 Inflation forecasting term used for calculating capital revenues by selected regulators

Regulator	*Term*	*Source*
ACCC	10-years	ACCC, *Australian Rail Track Corporation's 2017 Hunter Valley Access Undertaking*, draft decision, April 2017, pp. 169–170.

[24] Or the benchmark firm could have issued inflation-linked bonds for part of its debt funding of prior investments, as this would also be consistent with RAB indexation and real returns through annual cash flows.
[25] We consider the appropriate forecasting term for estimating expected inflation for other purposes in section 2.3.
[26] By deducting an amount equivalent to the forecast change in the RAB value from indexation, derived using our estimate of expected price level inflation.
[27] For reviews completed by the QCA from 2010 up to 2020.
[28] See, QCA, *GAWB price monitoring 2020–25*, final report, 2020; QCA, *Queensland Rail 2020 draft access undertaking*, decision, 2020; QCA, *Rural irrigation price review 2020–24*, final report, 2020. Our recent draft report from our rate of return review also adopts this position – see, QCA, *Rate of return review*, draft report, 2021.

Regulator	*Term*	*Source*
AER	Regulatory period	AER, *Regulatory treatment of inflation*, final position paper, 2020, p. 6.
ESC	10-years	ESC, *Melbourne Water Final Decision—2021 water price review*, 2021, pp. 47–49.
IPART	Regulatory period	IPART, *Review of prices for Sydney Water from 1 July 2020*, final report, 2020, pp. 65–72.
ESCOSA	10-years	ESCOSA, *SA Water Regulatory Determination 2020*, final determination: statement of reasons, 2020, p. 225.
ERA (electricity)	Regulatory period	ERA, *Final Decision on Proposed Revisions to the Access Arrangement for the Western Power Network—Appendix 5: Return on Regulated Capital Base*, final decision, September 2018, pp. 92–93.
ERA (rail)	10-years	ERA, *2018 and 2019 Weighted Average Cost of Capital, For the Freight and Urban Networks, and the Pilbara Railways*, final determination, 2019, pp. 79–80.
ICRC	Regulatory period	ICRC, *Review of Methodologies for the Weighted Average Cost of Capital*, Report 8 of 2021, final report, 2021, pp. 35–43.

In its 2020 inflation review, the AER considered that moving to a regulatory term-matching approach for expected inflation would improve alignment between expected revenues and nominal debt costs, thereby lowering the financeability risks for service providers. The AER also said that allowing regulatory returns to be achieved in expectation would lead to sufficient incentives for efficient investment.[29] In its 2018 WACC review, IPART also moved to a regulatory term-matched expected inflation measure to deflate the nominal WACC.[30]

Regulators that use a 10-year term typically also adopt a 10-year term for the risk-free rate and seek to align the inflation term with the inflation expectations embedded in the risk-free rate.[31]

Stakeholder comments

Responses from regulated firms to our issues paper generally supported estimating expected inflation over a term matching the length of the regulatory period.

Aurizon Network said that consistent with the AER's conclusions, under a post-tax nominal modelling framework, inflation should be forecast over the term of the regulatory period, so that the expected inflationary gain on the RAB matched the amount deducted from annual revenues. Aurizon Network said that matching the term of the inflation forecast to the length of the regulatory period resulted in a forecast more responsive to changes in market circumstances.[32]

Dalrymple Bay Infrastructure (DBI) said a regulatory term-matching approach for expected inflation was necessary to meet the objective of pricing principle (a) of s. 168A of the QCA Act. DBI noted that any mismatch between the allowed nominal rate of return and the expected rate of return (arising from revenue and indexation adjustments) would be borne by equity investors, because Australian firms almost exclusively issued debt that paid a nominal return.[33]

[29] AER, *Regulatory treatment of inflation*, final position paper, 2020, pp. 40–41.
[30] IPART, *Review of our WACC method*, final report, 2018, pp. 76–77.
[31] See for example, ESCOSA, *SA Water Regulatory Determination 2020*, final determination: statement of reasons, 2020, pp. 225–226.
[32] Aurizon Network, sub. 1, p. 4.
[33] DBI, sub. 3, pp. 3–5.

GAWB said the use of an inflation term matching the length of the regulatory period would mean the regulated firm could expect to receive the allowed nominal rate of return and would be more responsive to current market conditions.[34]

Seqwater said that the 'take out what we expect to put back in' approach required expected inflation to be estimated over the life of the regulatory period to be consistent with the NPV=0 principle. Seqwater said that the use of a forecast term that differed from the length of the regulatory period would mean that if the expected inflation over these two terms differed, the regulated firm would not be expected to receive its allowed nominal rate of return even if actual inflation turned out to be exactly in line with the QCA's forecast each year.[35]

Sunwater said this change would remove the current mismatch between the inflation term used in the return on capital and RAB roll-forward, reducing uncertainty and placing greater weight on current conditions.[36]

QTC said that we should use a 10-year market estimate of inflation expectations (adjusted to exclude liquidity effects but with no adjustment to remove the inflation risk premium) for the inflation deduction for the equity-funded portion of the RAB, while the deduction for the debt-funded portion should be matched to the regulatory term.[37]

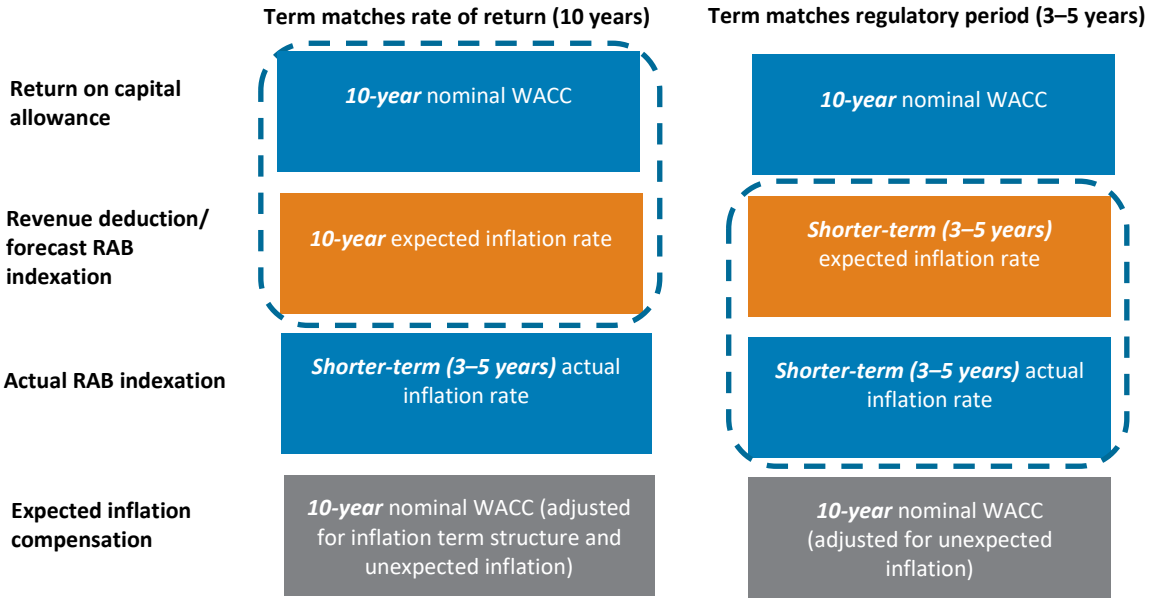
Analysis

We have assessed below the following two options for the term of expected inflation:

- 10-years—matching the term of expected inflation to the 10-year expected inflation embodied in the 10-year nominal risk-free rate incorporated in the nominal rate of return.
- Length of the regulatory period (3–5 years)—matching the term of expected inflation to the term over which the RAB is indexed by actual inflation (i.e. the regulatory period).

Figure 2 compares the inflation term options for calculating capital-related revenues.

Figure 2 Inflation compensation in the capital-related revenues



[34] GAWB, sub. 4, p. 2.
[35] Seqwater, sub. 6, pp. 10–11.
[36] Sunwater, sub. 7, pp. 1–2.
[37] QTC, sub. 5, pp. 2, 5.

In recent reviews, we have sought to match the term of the expected inflation estimate with the 10-year term of the nominal risk-free rate incorporated in the nominal WACC. In those reviews, we used a regulatory on-the-day approach to estimating the cost of debt, which used the same forward-looking nominal risk-free rate as in the estimate of the cost of equity. Under this approach, the inflation gain deducted from revenues at the start of each regulatory period sought to match the best estimate of inflation expectations embodied in the nominal WACC.

Both approaches target expected real returns by adjusting for unexpected inflation over the regulatory period. However, they use different expected inflation measures to remove the inflationary effects from the nominal rate of return. As shown in Figure 2, the first approach also implicitly adjusts for the difference between expected inflation embodied in the nominal WACC and shorter-term expected inflation (which is the reference point in quantifying the difference between expected and actual inflation over the regulatory period). As noted below, this implicit adjustment may result in the nominal return not being achieved in expectation.[38]

The key benefit of the regulatory term-matching approach is that it also ensures that the allowed nominal return is achieved in expectation. Under this approach, the inflation gain deducted from revenues at the start of each regulatory period will, in expectation, more closely match the amount of actual inflation by which the RAB will be indexed over the regulatory period.

As concluded by the AER, under the rate of return term-matching approach, the inflation gain deducted from revenues determined at the start of each regulatory period may not, in expectation, match the amount of annual actual inflation by which the RAB will be indexed over the regulatory period.[39] The nominal rate of return expected to be received by the regulated firm may therefore differ from the allowed nominal WACC. The extent of this difference will depend on the term structure of inflation expectations.[40]

We note that QTC has proposed using a 10-year estimate of inflation expectations for adjustments to the equity-funded component of the RAB. However, if QTC's intention is for us to use actual inflation for RAB indexation of the equity-funded component of the RAB, then this would also not match the 10-year forecast it proposed we deduct from capital-related revenues.

Appendix B provides a simple example that demonstrates the difference in expected capital-related revenues under each of the two inflation term approaches. The example shows that under a regulatory term-matching approach, the regulated firm could expect to receive its allowed revenues regardless of whether shorter-term expected inflation over the regulatory period were higher or lower than longer-term (10-year) expected inflation. This differs from using a 10-year expected inflation, under which the regulated firm could expect to receive a lower (higher) nominal rate of return than its allowed nominal rate of return if 10-year expected inflation were to be higher (lower) than shorter-term expected inflation.

A regulatory term-matching approach for estimating expected inflation would also allow for the recovery of nominal debt costs to be more closely matched, in expectation, over the regulatory

[38] While the regulatory term-matching approach would not remove the implicit difference between expected inflation embodied in the nominal WACC and shorter-term expected inflation, we would expect this difference to balance out over the long term.

[39] The AER also noted that if this mismatch was not addressed then it could lead to insufficient investment going forward. See AER, *Regulatory treatment of inflation*, final position paper, 2020, pp. 39–41.

[40] For example, if inflationary expectations over a 10-year horizon are higher than inflationary expectations over the shorter regulatory period, then more inflation would tend to be deducted from revenues relative to the inflation by which the RAB is expected to be actually indexed.

period, irrespective of whether they had been derived using a regulatory on-the-day or a trailing average benchmark.

This approach would also reduce the level of uncertainty associated with longer-term forecasting periods. Our existing approach to estimating 10-year expected inflation uses only contemporary forecasts for the first two years of the forecast period, with the remaining years assumed as the midpoint of the RBA's target range. As also noted by the AER, our proposed approach would derive inflation expectations that are more responsive to current market conditions.[41]

Draft position

Our draft position is to match the term when estimating expected inflation used for calculating the return on capital with the length of the regulatory period.

2.3 Different uses of inflation

Inflation has other uses in addition to calculating the return on capital. Estimates of expected inflation are also used to calculate renewals annuities, escalate input prices, and smooth prices to maintain them in real terms.

Regulators in Australia generally index the RAB in terms of CPI inflation rather than asset-specific cost indices.[42] This is because the RAB represents the recovery of financial investment, as opposed to the value of physical capital, which reflects the productive capacity of the assets. RAB indexation adjusts the real return provided in cash flows for actual inflation outcomes.

Regulators in Australia and overseas generally use the same (smoothed) estimate of the expected inflation rate for all uses of general CPI inflation in deriving maximum revenues and prices. However, input-specific or sector-specific cost escalators have been used if the underlying cost drivers are materially different from those underlying the general price level. Table 3 summarises the most recent approaches adopted by other Australian regulators.

Table 3 Other (non-capital-related revenue) uses of expected inflation measures by other Australian regulators

Regulator	***Measure of expected inflation employed***
AER	The AER generally applies an average of forecasts from two consultants of sector- and state-specific wage price index (WPI) estimates for the labour price component of forecast opex and capex. The AER considers that an averaging approach accounts for the consultants' forecasting history, selecting consultants that cover forecasts typically higher and lower than actuals. The AER generally applies its expected CPI inflation rate estimate for non-labour costs.
ESC	The ESC has previously assessed the drivers of real input cost increases, including whether its allowance for customer connection growth for a service would reasonably cover real input cost increases for the service.
IPART	IPART requires regulated firms to explain the cost drivers of forecast opex and capex, including changes in the real cost of cost components. IPART requires prices and bill impacts over the new regulatory period to be presented in nominal terms using an inflation forecast of 2.5 per cent, based on the RBA midpoint.
ESCOSA	ESCOSA used its best estimate of inflation over the four-year regulatory period for adjusting the tax allowance and CSO payments between real and nominal terms.

[41] AER, *Regulatory treatment of inflation*, final position paper, 2020, p. 70.
[42] Similarly, regulators in the UK (such as Ofwat and Ofgem) escalate the RAB using the UK's retail price index.

Regulator	*Measure of expected inflation employed*
ERA (electricity)	ERA used sector- and state-specific WPI estimates for the labour price component of forecast opex and capex. ERA determined a premium for the utilities' industry WPI based on historical ABS estimates and applied this to the Western Australian Treasury's WPI forecasts.
ICRC	The ICRC approved input-specific escalation rates for input price changes to labour and electricity costs. Other operational costs increased by the forecast CPI inflation. These cost escalation factors were developed by BIS Oxford Economics for the ACT region.

Sources: AER, Energex Distribution Determination 2020 to 2025, Attachment 6 Operating Expenditure, final decision, 2020, pp. 6–22; ESC, Western Water final decision—2020 Water Price Review, 2020; IPART, Review of prices for Sydney Water from 1 July 2020, final report, 2020; ESCOSA, SA Water Regulatory Determination 2020, final determination: statement of reasons, 2020; ERA, Final Decision on Proposed Revisions to the Access Arrangement for the Western Power Network, final decision, September 2018; ICRC, Regulated water and sewerage services prices 2018–23, final report, 2018.

Stakeholder comments

DBI said that while not a material issue for it, it considered it was appropriate to apply a single forecast of inflation in building block calculations of efficient costs.[43]

Sunwater, GAWB, Aurizon Network and Seqwater all supported a framework that allowed for the use of different inflation forecasts for different applications.

Sunwater supported a framework that continued to allow different input cost escalation factors to be applied to different cost categories, as appropriate.[44]

GAWB said that we should apply an escalator that differed from CPI inflation when the alternative escalator was more likely to generate an unbiased forecast of inflation in the specific cost item. GAWB considered this consistent with s. 168A(a) of the QCA Act, as it provided the firm with a reasonable opportunity to recover its efficient costs.[45]

Aurizon Network considered that we should retain the flexibility to apply different forecasts of inflation that are best suited to the intended purpose.[46]

Seqwater said that the relevant inflation parameter should generally be estimated in a manner consistent with the role of that parameter. However, Seqwater suggested that it may be appropriate to adopt the simpler and most easily available and transparent approach where different approaches produce estimates that are not materially different.[47]

Analysis and draft position

General price-level inflation

Draft position

Our draft position is to use the same estimation approach to derive expected CPI inflation for different uses for those situations where it is appropriate to do so but use different estimation terms depending on the relevant purpose of the analysis.

Opex and capex escalation

We generally estimate opex of regulated businesses in nominal terms by estimating an efficient base year for opex, making allowance for step changes in the efficient base year opex and

[43] DBI, sub. 3, p. 6.
[44] Sunwater, sub. 7, p. 2.
[45] GAWB, sub. 4, pp. 2–3.
[46] Aurizon Network, sub. 1, p. 5.
[47] Seqwater, sub. 6, p. 19.

adjusting for trend growth over the regulatory period using a range of escalation factors. These escalation factors include input cost escalation factors (including expected CPI inflation for some cost components) and may also include usage growth factors and efficiency gains.

We also convert the efficient capex program of regulated businesses from real terms to nominal dollars using input cost escalators.

We use an estimate of expected CPI inflation to escalate base year opex for some input cost categories where the cost drivers do not materially differ from CPI inflation (such as operations costs and the non-labour component of maintenance costs). We use input-specific or sector-specific cost escalators in cases where the underlying cost drivers are materially different from the general CPI inflation measure. For example, in recent years, insurance premiums for industrial special risks have grown at a rate higher than CPI inflation.

In our view, measures of expected inflation (including input-specific or sector-specific cost escalators) should be derived using transparent and replicable processes that are understood by key stakeholders. An important principle of our regulatory reviews is that customers should be able to understand the basis on which prices are calculated. We believe that it is not possible to achieve our desired level of transparency from the forecasts of proprietary models, because we and stakeholders are unable to verify how such forecasts are derived. Those forecasts tend to be licensed, subscription-based products that are not freely available or in the public domain.

For estimates of expected CPI inflation, the RBA provides publicly available data, with its forecasts for a year and two years out.

For labour cost escalation, we have previously used Queensland Treasury's most recent forecasts of the Queensland wage price index (WPI) for up to three years ahead, with the long-term (10-year) historical average Queensland WPI thereafter. We consider the Queensland WPI to be the best estimate of wage cost escalation, as it measures the pure price change in labour costs independent of compositional changes such as variations in the quality or quantity of work performed.

We have also used expected CPI inflation and other cost escalators to convert forecast capex over the regulatory period from real to nominal terms. For example, in our recent GAWB review we applied our forecast Queensland WPI to the labour cost component of GAWB's capital program.[48]

Draft position

Our draft position is to use expected CPI inflation to escalate opex and capex input costs where the underlying cost drivers are not materially different from CPI inflation; however, to use input-specific or sector-specific cost escalators where underlying cost drivers are materially different from CPI inflation.

Revenue/price smoothing

Some of our recent reviews have used an estimate of expected CPI inflation to derive prices that increase by expected inflation over the regulatory period and ensure that the present value of expected revenue from prices recovered the allowable revenue requirement over this period.[49]

In practice, prices typically rise annually at the expected percentage change in the CPI to reflect the general movement in prices within the economy. However, if the nominal discount rate we

[48] QCA, *GAWB price monitoring 2020–25*, final report, 2020.
[49] QCA, *GAWB price monitoring 2020–25*, final report, 2020; QCA, *Rural irrigation price review 2020–24*, final report, 2020.

apply is equal to the allowed nominal rate of return, revenues or prices can be defined in terms of any growth rate and still result in revenues or prices that are expected to recover costs in present value terms.[50]

Draft position

Our draft position is to use an estimate of expected CPI inflation over the regulatory term to smooth allowable revenue and prices unless the potential for price shocks over subsequent regulatory periods warrants using different growth rates.

Renewals annuity calculation

In our previous irrigation price reviews, we accepted the use of a rolling indexed annuity approach to recovering prudent and efficient expenditure on renewing existing assets. In our 2020–24 irrigation price review, we used the nominal rate of return to reflect the regulated firm's opportunity cost of funds, and indexed the annuity using our estimate of long-term (10-year) expected CPI inflation.[51]

The indexed annuity formula uses an adjusted discount rate (r_a) that reflects the nominal discount rate (i.e. r = nominal rate of return), adjusted by the chosen rate of indexation or growth (g), where:[52]

$$r_a = \left[\frac{1+\mathrm{r}}{1+\mathrm{g}}\right] - 1$$

As stated above, if we use the allowed nominal rate of return as the nominal discount rate, any indexation or growth rate will result in an annual annuity charge for the regulated firm that is expected to recover efficient renewals expenditure over the remaining life of its assets in present value terms.[53] Moreover, the chosen indexation rate will not affect the inflation risk of the regulated firm or customers.[54]

Notwithstanding this characteristic of the annuity calculation, and in keeping with our objective of regulatory predictability, we consider that it is appropriate to use an estimate of expected CPI inflation to index renewals annuities. Given that we derive indexed annuities using a planning period longer than the regulatory period, we consider it is appropriate to use a long-term estimate of expected CPI inflation.[55] Consistent with our use of a 10-year nominal WACC as the discount rate to derive the present value of renewals expenditure over the planning period, we consider it is appropriate to also use a 10-year term for the inflation estimate.

Draft position

Our draft position is to use an estimate of expected CPI inflation over a 10-year term to index renewals annuities.

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[50] QCA, *Financial Capital Maintenance and Price Smoothing*, information paper, 2014, pp. 15–16.
[51] QCA, *Rural irrigation price review 2020–24*, final report, Part B, 2020, p. 88.
[52] QCA, *Issues in the Application of Annuities*, information paper, 2014, pp. 31–32.
[53] QCA, *Financial Capital Maintenance and Price Smoothing*, information paper, 2014, pp. 10–11.
[54] Note that the annuity balance is rolled forward over the regulatory period by adding the allowed annual renewals annuity charge, subtracting prudent and efficient renewals, and applying the nominal rate of return each year. While this approach provides compensation for expected inflation (via the nominal rate of return), it exposes the regulated firm and customers to uncontrollable inflation risk.
[55] For example, in the 2020–24 rural irrigation price review we calculated renewals annuities over a 30-year planning period.

3 ASSESSMENT OF INFLATION FORECASTING APPROACHES

We have assessed four methods for estimating expected CPI inflation and escalation, for use in revenue and price modelling. These are RBA-based, market-based, survey-based and model-based methods.

3.1 Key points

Our draft position is to:

- derive CPI forecasts using short-term RBA forecasts for the first two years ahead and derive forecasts up to the fifth year ahead using a linear glide path from the RBA's short-term forecast in year two to a rules-based anchor-point forecast in the fifth year ahead
- use the annual CPI forecasts derived from this approach for relevant escalation purposes
- derive the geometric mean of the annual forecasts produced over the applicable regulatory period to estimate expected inflation for capital revenue purposes
- assume the midpoint of the RBA's target range (2.5%) beyond the fifth year ahead, in the limited circumstances that this longer-term forecast is required.

3.2 Forecasting approaches

Expected inflation is a forward-looking concept and is not about actual inflation outcomes. If the actual inflation outcome diverges from an expected inflation estimate, this does not mean that the estimate was incorrect. Divergences will occur due to unexpected inflation outcomes[56], for which we are seeking to provide compensation under our regulatory framework.

We note that expected inflation is not observable and therefore needs to be estimated.

The estimation methods that we have investigated are:

- RBA-based methods, such as our current approach, that derive the geometric mean of the RBA's one-year and two-year ahead CPI forecasts combined with alternative options for transition (including a glide path) to the long-term inflation forecast
- market-based methods that use bond or inflation swap data to estimate market participants' expectations for inflation
- survey-based methods that use survey information on the inflation expectations of professional forecasters, union officials and consumers
- model-based methods that use economic modelling, such as a Phillips curve model, to estimate short-term inflation.

3.2.1 RBA-based methods

RBA-based methods combine publicly available short-term forecasts of inflation expectations from the RBA with longer-term forecasts of inflation expectations. Typically, these approaches

[56] That is, the difference between actual inflation outcomes and the true level of the market's inflation expectations.

take the geometric mean of short-term RBA inflation forecasts one year and two years out[57] and medium to longer-term forecasts for the remaining years of the forecast period.

In recent reviews, we have used a version of this approach with an immediate transition from the RBA's two-year ahead forecast, to the midpoint of the RBA's inflation target range (2.5%), for the remaining years of the forecast period.

Until recently, most other Australian regulators also used this version of the RBA-based approach. However, in recent times, some regulators have applied a glide path, whereby there is a gradual (multi-year) transition from the RBA's short-term forecasts to the longer-term forecast.[58]

RBA-based approaches rely on the assumption that long-term inflation expectations are anchored within the RBA's inflation target range. Evidence relating to the anchoring of inflation expectations is discussed in Appendix D.

3.2.2 Market-based methods

Market-based measures of inflation expectations are typically derived from bond yield data (the bond break-even approach) or inflation swap data (the inflation swap approach).

These approaches use the expected inflation rate implied by relationships between nominal and real financial market instruments or related derivative products to provide evidence of market expectations of inflation, as market participants have strong incentives to make well informed decisions, given the financial stakes.

The bond break-even method assumes that the difference between nominal and indexed bond yields reflects investors' inflationary expectations. This method derives the expected inflation rate that equalises nominal and indexed bond yields, by applying the Fisher equation[59] to the yields to maturity of nominal and inflation-indexed ('indexed') Treasury bonds with similar maturity dates.

In an inflation swap, counterparties agree to exchange payments that are linked to a predetermined (or fixed) inflation rate and the actual inflation rate. The fixed rate of an inflation swap can be interpreted to reflect market expectations of inflation, given that one party to the swap will be required to make a net cash payment, should the fixed inflation rate vary from the actual inflation rate over the term of the swap.[60] For example, the 10-year inflation swap rate measures market expectations of average inflation over the next 10 years.

Conceptually, inflation expectations incorporated in market data should closely reflect the true level of investors' expected inflation. However, in some of our previous reviews we noted that market-based measures may contain distortions such as risk premia.[61] A more detailed discussion of the potential distortions associated with market-based approaches is provided in Appendix E.

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[57] These forecasts are published in February, May, August and November every year, in the RBA's *Statement on Monetary Policy*.

[58] See Appendix C for a summary of the inflation forecasting methods used by other Australian regulators.

[59] The Fisher equation outlines the relationship between the nominal interest rates, expected inflation and real interest rates.

[60] The party paying the fixed rate (e.g. a pension fund) typically has a long-term indexed liability and may be seeking to mitigate its exposure to unexpected increases in inflation. The party paying the actual inflation rate (e.g. a utility) typically has revenues linked to changes in inflation and may be seeking to hedge its exposure to variable revenues. One of the counterparties to the inflation swap will generally be a swaps dealer.

[61] QCA, *Aurizon Network's 2017 access undertaking*, decision, 2018, pp. 52–55; QCA, *Queensland Rail's 2020 access undertaking*, decision, 2020, p. 76.

3.2.3 Survey-based methods

Survey-based methods measure expected inflation by surveying professional forecasters, union officials and consumers.

We have focused on surveys of professional forecasters and union officials, as the available research suggests that consumers' expectations do not closely align with actual inflation outcomes. Consumers' responses to surveys tend to be clustered around round numbers (e.g. 5 per cent) and overly responsive to movements in headline prices of particular items such as petrol. [62]

Surveys of professional forecasters in Australia include:

- the quarterly RBA survey of market economists—short-term (up to two years ahead) and longer-term (average over the next five to 10 years ahead)
- the Consensus Economics' surveys—short-term (up to two years ahead) and longer-term (three, four and five years ahead and the average for between six and 10 years ahead).

The survey of union officials is a quarterly survey by the Australian Council of Trade Unions.[63]

Each of these surveys asks for forecasters' expectations for headline inflation, although the RBA survey also asks about trimmed mean (underlying) inflation. [64]

Regarding short-term expectations, the RBA and union surveys ask for forecasts of inflation expectations one year and two years ahead.[65] In contrast, Consensus Economics asks in its monthly surveys for year-average inflation for the current calendar year and the next calendar year (i.e. forecasts are one year ahead and two years ahead for the January survey but a month ahead and a year ahead for the December survey).[66]

Longer-term measures of inflation expectations include market economists' and union officials' expectations for average annual inflation over the next five to 10 years and Consensus Economics' survey of expectations of average annual inflation for the period between six to 10 years ahead (included in the April and October surveys).[67]

3.2.4 Model-based methods

Model-based methods assume a set of interrelationships between inflation and other economic variables and empirically estimate these relationships. For example, a Phillips curve model typically relates the rate of inflation to a measure of capacity utilisation in the economy (such as the unemployment rate) and inflation expectations.[68] Estimates of the inflation rate generated from such a model might then inform the forecaster's expectations of future inflation.

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[62] See A Moore, 'Measures of Inflation Expectations in Australia', *Bulletin*, RBA, December 2016, p. 25.
[63] A Moore, 'Measures of Inflation Expectations in Australia', Bulletin, RBA, December 2016.
[64] A Moore, 'Measures of Inflation Expectations in Australia', *Bulletin*, RBA, December 2016, p. 24.
[65] One-year ahead expectations are for inflation over the year to the subsequent December quarter (for surveys held in the December and March quarters) or June quarter (for surveys held in the June and September quarters). Two-year ahead expectations are for year-ended inflation as at the December quarter of the following year (for March and June quarter surveys) or the June quarter of the following year (for September and December quarter surveys).
[66] A Moore, 'Measures of Inflation Expectations in Australia', *Bulletin*, RBA, December 2016, p. 24.
[67] A Moore, 'Measures of Inflation Expectations in Australia', *Bulletin*, RBA, December 2016.
[68] That is, these models use economic agents' expectations about the future rate of inflation, and the level of slack in the economy, as inputs in forecasting the future rate of inflation. The formation of expectations can be modelled in

These models are typically proprietary models. For example, central banks typically maintain in-house models of this type for the purposes of policy analysis. In addition, private modellers such as Deloitte Access Economics maintain proprietary macroeconomic models that can derive inflation forecasts.

The RBA uses a range of single-equation models (including its Phillips curve models) and a full-system economic model to provide guidance to its forecasts.[69] The weight applied to each of the models in deriving its final forecast for inflation can vary over time. The RBA also applies a layer of judgement when using models to develop its externally published forecasts.[70]

The RBA models inflation expectations, for use in its single-equation and full-system economic models, by combining the range of inflation expectations measures that it monitors (including survey-based measures) into a single 'trend' measure that controls for each measure's co-movement with recent inflation.[71]

Given the lack of inflation expectations measures over the range of three- to five-years ahead, the Australian Treasury used a model-based approach, which combined available survey- and market-based measures, to develop three-years ahead inflation expectations to use as an input in its recently updated Phillips curve model.[72]

3.3 Stakeholder comments

3.3.1 RBA-based methods

In general, stakeholders considered that our current approach yielded biased forecasts, because it gave greater weight to the midpoint of the RBA's target range, regardless of economic conditions. They considered that a multi-year transition from the RBA's short-term forecast to a suitable longer-term estimate would produce better results.

Aurizon Network

Aurizon Network submitted that the assumption that expected inflation reverts to the midpoint of the RBA's target range from year three, regardless of market conditions, produces biased estimates of expected inflation under prolonged periods of low or high inflation.[73]

Aurizon Network said that if we retain the use of short-term RBA forecasts, we should implement a framework enabling a multi-year transition path to long-term inflation expectations that is more responsive to market conditions. This transition path should be based on an independent and objective approach that remains appropriate in all market conditions.[74]

If we were to adopt a forecast term that matched the length of the regulatory period, Aurizon Network considered that it would be questionable whether the objective would be to transition

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a variety of ways—for example, it might be assumed that economic agents form their expectations on the basis of past values of inflation.

[69] N Cassidy, E Rankin, M Read and C Seibold, 'Explaining Low Inflation Using Models', *Bulletin*, RBA, June 2019, p. 144.

[70] N Cassidy et al., 'Explaining Low Inflation Using Models', *Bulletin*, RBA, June 2019, p. 158.

[71] T Cusbert, 'Estimating the NAIRU and the Unemployment Gap', *Bulletin*, RBA, June 2017, pp. 17–18; N Cassidy et al.,'Explaining Low Inflation Using Models', *Bulletin*, RBA, June 2019, p. 152.

[72] H Ruberi, M Ball, L Lucas and T Williamson, *Estimating the NAIRU in Australia*, working paper 2021-01, The Treasury, Australian Government, 2021, pp. 12–13.

[73] Aurizon Network, sub. 1, p. 5.

[74] Aurizon Network, sub. 1, p. 14.

to an estimate of medium to long-term expected inflation.[75] It said that there was no strong evidence to suggest that 2.5 per cent is the anchor point for inflation expectations in the medium to long term and that, in practice, expectations could be anywhere within the target range, or, in exceptional circumstances, even remain outside the target range.[76]

Aurizon Network considered that a better alternative would be to use a range of measures of inflation expectations (including survey- and market-based measures) to forecast inflation for the remaining years of the forecast term.[77]

However, in the event that we specified an anchor point, Aurizon Network considered that the relevant question would be where inflation expectations were forecast to be, relative to the RBA's target range, in the last year of the forecast period.[78] Aurizon Network said that we could consider different data sources to assess where inflation expectations were expected to be in the last year of the forecast period and that, in doing so, we should place more emphasis on market-based measures that provide estimates of expected inflation over a number of different horizons.[79]

Dalrymple Bay Infrastructure

Dalrymple Bay Infrastructure (DBI) said that our current approach did not produce a best estimate and, in the current market conditions, was likely to incorporate an upward bias, since most of the annual forecasts in the forecast horizon equalled the midpoint of the RBA's target range.[80]

DBI considered that it would be appropriate to apply a multi-year transition to our estimate of long-term inflation expectations stating that, in its view, there is no demonstrably superior alternative to the adoption of a linear glide path between estimates of expected inflation applying at different points in the future.[81]

DBI submitted that the medium- to long-term anchor point could be informed by a range of information including:

- commentary from the RBA
- surveys of long-term inflation expectations
- market-based measures.

DBI considered that drawing on a breadth of information would mitigate the risk of bias arising from reliance on any single source.[82]

Seqwater

Seqwater submitted that in the current low inflationary environment, our current approach was unlikely to reflect inflationary expectations and that we should seek alternative approaches that were more likely to produce estimates that reasonably reflect expected inflation.[83] Seqwater also said that there was mounting evidence that the RBA tended to systematically over-forecast future inflation in the current low interest rate/low inflation environment.[84]

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[75] Aurizon Network, sub. 1, pp. 14–15.
[76] Aurizon Network, sub. 1, pp. 15–16.
[77] Aurizon Network, sub. 1, p. 14.
[78] Aurizon Network, sub. 1, p. 16.
[79] Aurizon Network, sub. 1, p. 17.
[80] DBI, sub. 3, p. 1.
[81] DBI, sub. 3, p. 11.
[82] DBI, sub. 3, p. 9.
[83] Seqwater, sub. 6, pp. 11–13.
[84] Seqwater, sub. 6, pp. 13–14.

Seqwater considered that if we were to move to an approach of implementing a transition from the RBA's short-term forecasts to a long-term forecast, the anchor point could be the midpoint of the RBA's target range so long as the transition period was long enough to ensure that inflation expectations would be anchored at the midpoint of the target range.[85] However, Seqwater said that inflation expectations would not necessarily transition to the midpoint anchor over a short-term regulatory period; rather, Seqwater considered that it would be open to us to take a geometric mean of the yearly forecasts produced over the regulatory period.[86]

Seqwater said that any glide-path transition period should be informed by evidence and be transparent and replicable, rather than arbitrary or subjective. Seqwater said that the length of the glide path could be informed by market data on long-term inflationary expectations or historical evidence of the RBA's ability to move inflation back to the midpoint of the target range.[87]

Gladstone Area Water Board

Gladstone Area Water Board (GAWB) considered that our existing approach had persistently overestimated actual inflation over the past 10 years. GAWB said that the fundamental problem with our approach was that it placed excessive weight on the midpoint of the RBA's inflation target range in a low inflationary environment.[88]

GAWB was not opposed to the use of a multi-year transition path between short- and long-term inflation expectations, assuming that a material divergence existed between the two, but said that the main problem with transition paths is that they are likely to be arbitrary in nature, given that identifying a non-linear path could potentially be intractable.[89] For this reason, GAWB said that its preference would be to use a forecasting methodology that minimises the use of transition paths between short-term and long-term inflationary expectations to the extent that they exist.[90]

GAWB considered that the best measure of medium- to long-term inflationary expectations is likely to be a market-based measure. It stated that there is evidence to suggest that market-based measures have more successfully captured medium- to long-term inflationary expectations in Australia over the past decade.[91]

Queensland Treasury Corporation

QTC said that if we retain our approach of targeting an approximate real rate of return at the firm level, our current forecasting approach could be improved by combining the RBA's short-term forecasts with market-based estimates of medium-term to long-term inflation expectations.[92] QTC considered that there would be some non-overlapping information in market and non-market estimates of expected inflation and that giving meaningful weight to non-market-based estimates could also reduce the extent to which the inflation risk premium would bias estimates that were based solely on the zero coupon inflation swap (ZCIS) rate.[93]

[85] Seqwater, sub. 6, p. 20.
[86] Seqwater, sub. 6, p. 20.
[87] Seqwater, sub. 6, p. 20.
[88] GAWB, sub. 4, p. 3.
[89] GAWB, sub. 4, p. 4.
[90] GAWB, sub. 4, p. 4.
[91] GAWB, sub. 4, p. 5.
[92] QTC, sub. 5, pp. 4–6.
[93] QTC, sub. 5, p. 7.

To arrive at an estimate of inflation expectations in year 5 of a five-year regulatory period, QTC considered that it would be reasonable to either:

- determine an anchor point using the implied forward one-year ZCIS rate in year 5 and then apply a glide path to the anchor point
- use the implied forward one-year ZCIS rates for each of the remaining years of the regulatory period.[94]

Sunwater

Sunwater said that it was open to the adoption of other forecast methods, such as a linear glide path (that gradually transitions from short-term forecasts to long-term forecasts), as such methods could result in a gradual, less volatile year-on-year change in expected inflation and potentially reduce the difference between estimates of expected inflation and actual inflation.[95]

3.3.2 Market-based methods

Aurizon Network, DBI, GAWB, Seqwater and QTC all proposed that we should have regard for market-based measures, either as the primary method or in combination with other methods.[96] These stakeholders noted the perceived advantages of these measures and contended that these measures had performed better than other approaches over the past decade.[97]

Aurizon Network considered market-based measures to be conceptually the most appropriate way of estimating expected inflation, as they reflected views of informed market participants over a range of time periods and were constantly updated to reflect new relevant information. However, Aurizon Network recognised that there are potential time-varying biases and distortions associated with these measures in practice.[98]

DBI said that we should have regard to market-based measures (along with other sources of information) of inflation expectations in forming our view of long-term inflation expectations. DBI said that information on inflation expectations implied by nominal and indexed bond yields should inform medium- to long-term expectations and not be discarded in their entirety.[99]

GAWB said that market-based measures should be used either as a primary estimation method, or to derive long-term inflationary expectations. GAWB said that there was evidence to suggest that market-based measures have more successfully captured medium- to long- term inflationary expectations in Australia over the past decade.[100]

For adjustments to the equity-funded portion of the RAB, QTC proposed deriving a market estimate of inflation expectations (inclusive of inflation risk premia but exclusive of liquidity premia) as the midpoint of break-even inflation with and without an adjustment for the upper bound of the liquidity risk premia.[101] For debt-related deductions for inflation, QTC proposed estimating five-year expected inflation using RBA short-term forecasts combined with implied

[94] QTC, sub. 5, p. 7.
[95] Sunwater, sub. 7, p. 2.
[96] Aurizon Network, sub. 1, pp. 17–19; DBI, sub. 3, p. 9; GAWB, sub. 4, pp. 5–6; Seqwater, sub. 7, pp. 15–17, 21.
[97] We assess stakeholder comments on forecasting performance of different methods in section 3.3.
[98] Aurizon Network, sub. 1, pp. 17–18; QTC, sub. 5, pp. 6–7, 9–12.
[99] DBI, sub. 3, p. 9.
[100] GAWB, sub. 4, pp. 5–6.
[101] QTC, sub. 5, pp. 9–12.

forward inflation swap rates, noting that giving weight to non-market estimates may reduce the impact of the inflation risk premium.[102]

Seqwater proposed the use of inflation swaps as the primary estimation method but said if we maintained the use of RBA short-term forecasts, we should not disregard the market evidence entirely. Seqwater said this evidence came from market participants who have real money at stake, where outcomes depend exclusively on the very same inflation outcomes that we are seeking to forecast.[103]

3.3.3 Survey-based methods

Aurizon Network noted that Consensus Economics' long-term forecasts appear comparatively stable around the midpoint of the RBA's target range compared to forecasts made by unions and market economists. Aurizon Network suggested that this raises the question as to how responsive Consensus Economics' forecasts are to changes in market conditions.[104] Aurizon Network noted that the forecast for each economist would be based on an underlying economic model with specific assumptions, economic relationships and parameters, the details of which are unknown.

Notwithstanding these drawbacks, Aurizon Network submitted that we should fully investigate the use of survey-based measures, to inform our assessment of long-term inflation expectations.[105]

DBI said that we should have regard to all available information that can inform expectations on medium- and long-term inflation expectations, including survey-based measures of expectations.[106]

Seqwater said that the reliability of survey-based measures is affected by the fact that there are no obvious costs to being systematically incorrect.[107]

3.3.4 Model-based methods

Stakeholders did not raise any specific comments on model-based methods. However, in the context of a discussion of survey-based forecasts, Aurizon Network noted that forecasts would be based on an underlying economic model with unknown assumptions. Aurizon Network further noted that it is unknown how well individual models perform in different situations, including the current environment, where certain structural relationships that may have held in the past could have temporarily (or permanently) broken down.

3.3.5 Stakeholders' preferred approaches

Aurizon Network said that our forecasting approach should have the overarching objective of producing the best unbiased forecast of expected inflation under all market conditions.[108] Aurizon Network said that in comprehensively reviewing the relative efficacy of different measures, we should evaluate the cumulative error and root mean square error (RMSE) of different methods over varying time horizons (including over shorter horizons such as the length of the regulatory

[102] QTC, sub. 5, pp. 6–7.
[103] Seqwater, sub. 7, pp. 15–17, 21.
[104] Aurizon Network, sub. 1, pp. 16–17.
[105] Aurizon Network, sub. 1, p. 17.
[106] DBI, sub. 3, pp. 8–9.
[107] Seqwater, sub. 7, p. 15.
[108] Aurizon Network, sub. 1, p. 14.

period). Aurizon Network said that ultimately, we should assess which approach is most likely to minimise forecast error to meet our objectives of a robust and accurate estimate.[109]

Aurizon Network said that over the period from June 2010 to June 2019, for forecasts for two-years-ahead and five-years ahead, the market-based measures have less error (i.e. are more accurate) than the AER's glide path approach, with the break-even approach having the lowest error.[110]

Seqwater said that an implication of the 'take out what we expect to put back in' framework was that what was required was the best possible forecast of actual inflation over the regulatory period. Seqwater said that the various inflation forecasting approaches should be assessed to determine which approach best forecasts future inflation outcomes.[111]

Seqwater said that evidence (based on forecast error using RMSE and mean absolute deviation) showed that, over the last decade, the inflation swaps forecast was superior to the RBA forecast for year-ahead and two-year-ahead inflation. Based on this evidence, Seqwater submitted that the forecast rate of inflation for each year of the regulatory period should be determined using the 40-day average of the forward inflation rate for that year implied by Australian traded zero-coupon inflation swaps.[112]

Sunwater cautioned against adopting methods that are specifically designed to address the current period of low inflation, as such methods may not be fit-for-purpose once there is an uplift in inflation.[113]

3.4 Analysis

We have assessed the four forecasting approaches against our assessment criteria, taking into account stakeholder submissions on our issues paper.

3.4.1 Assessment criteria

Taking into consideration the matters we are required under the QCA Act to consider in our investigations[114], we have assessed the relative performance of the methods of estimating expected inflation according to whether they are:

- accurate and robust—as expected inflation is unobservable, it is desirable that the method minimises differences between forecast and actual inflation over the forecasting period—that is, the method should provide the best unbiased estimate of the inflation rate over the forecasting period
- credible and authoritative—the underlying inflation expectations estimated by the method should be based on authoritative (or expert) analysis of credible information sources
- simple, transparent and predictable—the method should estimate expected inflation using a simple, transparent and predictable process that is understood by stakeholders.

[109] Aurizon Network, sub. 1, pp. 18–19.
[110] Aurizon Network, sub. 1, p. 19.
[111] Seqwater, sub. 7, p. 11.
[112] Seqwater, sub. 7, pp. 15–18.
[113] Sunwater, sub. 7, p. 1.
[114] These include the matters set out in s. 26 (in relation to pricing investigations of monopoly business activities) and ss. 120(1) and 138(2) (in relation to access undertakings).

3.4.2 Performance against assessment criteria

We note that the true level of investors' expected inflation rate is unobservable and therefore needs to be estimated. Given that this expected inflation rate is likely to be generated by an unbiased estimate of actual inflation, we are seeking a method that provides an unbiased estimate of the inflation rate over the forecasting period.

However, a method that provides an unbiased estimate can still have a high variance and therefore might not be preferred for forecasting purposes. The best estimate of the actual inflation rate is one that has both low bias and low variance. The typical way of evaluating different forecasting methods (taking both bias and variance into account) is by calculating their root mean square errors (RMSEs).[115]

Several Australian studies have assessed the past forecasting accuracy of alternative estimation methods (see Table 4).

Table 4 Australian studies of past forecasting performance for CPI inflation

Study	*Measures*	*Horizons*	*Period*	*Results*
Tulip and Wallace (2012)	RBA short-term forecasts; midpoint of RBA target range; Consensus Economics	1 year ahead 2 years ahead	1994–2011	• The RBA's 1-year and 2-years-ahead forecasts were superior to the midpoint of the RBA's target range (although the results for 2-years-ahead forecasts were not statistically significant) based on lower RMSE. • The RBA's forecasts had slightly lower RMSE than those of Consensus Economics at short-term horizons, although not statistically significant.
Adeney, Arsov and Evans (2017)	Consensus Economics; consumer survey; inflation swaps	1 year ahead 4–5 years ahead	1990–2016 (swaps from 2005–2016)	• The RBA benchmark was superior to professional forecasters and inflation swaps for the 1-year and 4–5 years-ahead forecasts based on lower RMSE. • Professional forecasters had lower RMSE than inflation swaps at all horizons, although the difference was not statistically significant at shorter horizons.
Lally (2020)	RBA forecasts; RBA midpoint; Consensus Economics; break-even; inflation swaps	1, 2, 3, 4, 5 and 10 years ahead 7 and 10 years	1994–2019	• Across the range of approaches considered, the lowest RMSE came from the RBA's forecasts for the first and second years ahead, and the midpoint of the RBA's target band for all other years. • The midpoint of the RBA's target band was superior to Consensus Economics forecasts at all horizons from two years ahead on the basis of RMSE. • RBA-based geometric mean approaches were superior to market-based measures on the basis of RMSE.

Sources: P Tulip and S Wallace, Estimates of Uncertainty around the RBA's Forecasts, RBA research discussion paper no. 2012-07, 2012, pp. 11, 16; R Adeney, I Arsov and R Evans, 'Inflation Expectations in Advanced Economies', Bulletin, RBA, March 2017, p. 38; M Lally, Review of the AER's Inflation Forecasting Methodology, 2020, p. 25.

While survey-based approaches (sourced from Consensus Economics) have historically performed better than market-based measures in terms of anticipating future inflation, forecasts beyond two years ahead are not publicly available and cannot be easily replicated because of their proprietary nature. While the RBA publishes some shorter-term survey-based forecasts on a quarterly basis, Consensus Economics' short-term forecasts are not publicly available.

[115] See, for example, JA Mincer and V Zarnowitz, 'The Evaluation of Economic Forecasts' in JA Mincer (ed) in *Economic Forecasts and Expectations Analysis of Forecasting Behavior and Performance*, National Bureau of Economic Research, 1969, pp. 3–46.

Model-based approaches tend to use proprietary models that are not freely available or in the public domain. While RBA and Australian Treasury both outline the functional form of their Phillips curve and full-system economic models, the up-to-date versions of these models and some of the underlying input data are not publicly available. Private modellers, such as Deloitte Access Economics, derive forecasts using proprietary models, which makes it difficult to verify how their forecasts are derived.

While survey-based and model-based forecasts are inconsistent with providing transparency of pricing to stakeholders, we note that these sources are likely to be taken into account in the RBA's forecasts.

To further assess the relative performance of RBA-based and market-based methods, we extended the forecasting analysis (outlined in Table 4 above) to assess these methods over different forecast horizons, using up-to-date data. As this comparison requires a common sampling period, our initial assessment is limited to 2008 onwards, which is the period for which Australian inflation swaps data is available.

Table 5 shows that over shorter forecast horizons, the inflation swaps method displays lower bias[116] and a slightly lower RMSE since 2008 than our existing RBA-based method. However, over longer terms, the RBA-based and break-even methods perform better on these metrics.[117]

Table 5 Forecasting performance of expected inflation measures, from 2008 onwards

Forecast measure	*Year 1 forecast*		*Year 2 forecast*		*Next 5 years*		*Next 10 years*	
	RMSE (%)	*Bias (%)*	*RMSE (%)*	*Bias (%)*	*RMSE (%)*	*Bias (%)*	*RMSE (%)*	*Bias (%)*
RBA-based method	1.06	0.61	1.10	0.54	0.72	0.57	0.61	0.52
Bond break-even estimate	n.a.	n.a.	n.a.	n.a.	0.70	0.36	1.05	0.67
Inflation swaps estimate	0.99	0.21	0.99	0.43	0.87	0.63	1.19	0.91

Notes: These metrics cover semi-annual forecasts over forecast horizons within the period June quarter 2008 to December quarter 2020. Market-based estimates are derived based on a 40-day averaging period ending at the end of each quarter. Indexed bond yield data cannot be reliably calculated for 1-year and 2-year break-even estimates due to the infrequency of maturity dates for Treasury indexed bonds (see Appendix E).

Sources: RBA, Statement on Monetary Policy, various issues; RBA, Statistical Tables, RBA: F16—Indicative Mid Rates of Australian Government Securities, RBA website, 2021, accessed 2 June 2021; Bloomberg; QCA analysis.

The period since 2008 (in Table 5) is dominated by a long period of lower-than-expected inflation, which may affect the applicability of the results to the extent that the persistent low inflation was unexpected across all methods.[118] Figure 3 shows that over the five-year horizon, actual inflation was lower than expected inflation for all of these methods from 2010 onwards.[119]

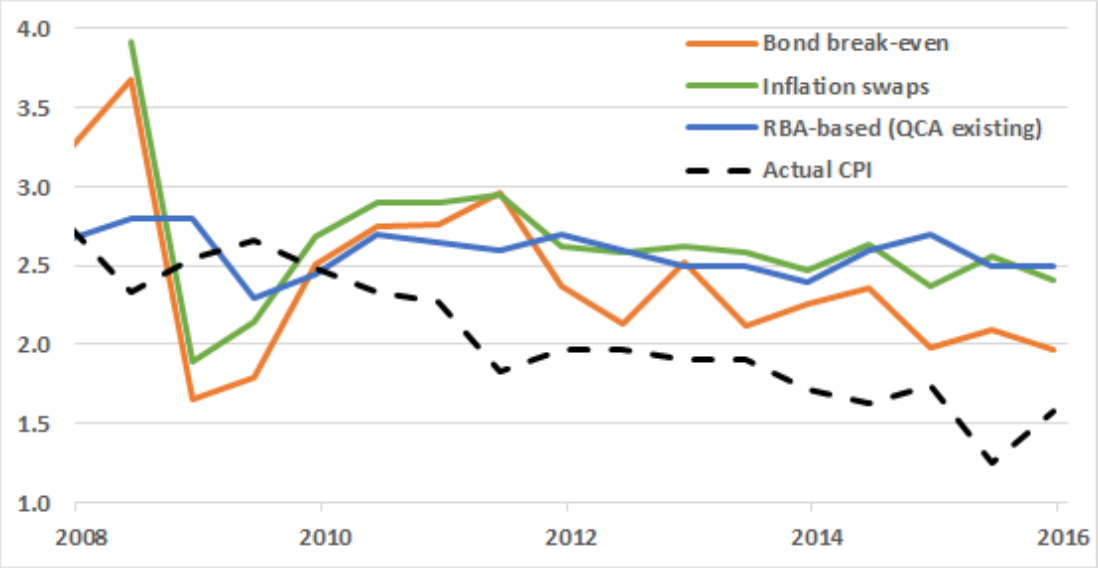
[116] In terms of the average difference between the estimate of expected inflation and actual inflation.

[117] We derived market-based measuring using a 40-day average, consistent with the suggestion by Moore (RBA *Bulletin*, December 2016, p. 29) regarding inflation swap data and consistent with Seqwater's proposal. These did not differ materially from using a daily rate or 20-day average. Averages were to the last business day of the relevant quarter but did not change materially when we aligned these to the RBA's time of forecast.

[118] R Adeney, I Arsov and R Evans, 'Inflation Expectations in Advanced Economies', *Bulletin*, RBA, March 2017, p. 35.

[119] As noted in subsection 3.3.1, GAWB cited evidence to suggest that market-based measures have been more successful in capturing medium- to long-term inflationary expectations in Australia over the past decade. However, this evidence did not use consistent time periods for comparing forecast and actual inflation. For consistency, we have compared estimates of inflation expectations at a five-year horizon, across the different methods, with realised inflation over that same horizon.

Figure 3 Comparison of expected and actual 5-year inflation, time of forecast 2008 onwards (%)



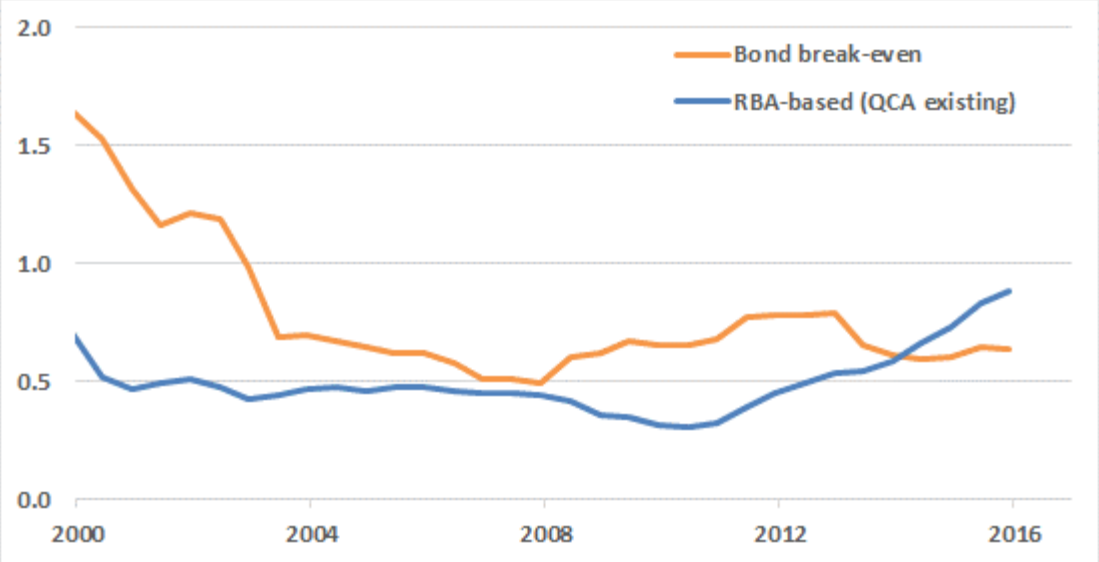
Notes: These metrics cover semi-annual forecasts covering 5-year forecast horizons commencing from the June quarter 2008 to the December quarter 2015. Market-based estimates are derived based on a 40-day averaging period ending at the end of each quarter. Actual CPI is derived over the same 5-year horizons as the forecasts.

Sources: RBA, Statement on Monetary Policy, various issues; RBA, Statistical Tables, RBA: G1—Consumer Price Inflation; RBA, Statistical Tables, RBA: F16—Indicative Mid Rates of Australian Government Securities, RBA website, 2021, accessed 2 June 2021; Bloomberg; QCA analysis.

From 2013 onwards, the break-even method produced the lowest measure of expected inflation and was therefore closest to realised inflation. However, it cannot be discounted that this may have been because of the impacts of biases over this period.

Figure 4 shows that while the bond break-even method has performed better in recent years, our existing RBA-based approach has been more accurate over the longer period that covers a larger range of economic conditions.

Figure 4 Rolling 5-year RMSE for RBA-based (existing QCA approach) and bond break-even approach (%)



Sources: RBA, Statement on Monetary Policy, various issues; RBA, Historical Forecasts, CPI inflation (year-ended), RBA website, 2021, accessed 2 June 2021; RBA, Statistical Tables, RBA: F16—Indicative Mid Rates of Australian Government Securities, RBA website, 2021, 2 June 2021; QCA analysis.

Table 6 shows that our existing RBA-based approach has performed significantly better than the bond break-even approach since inflation targeting by the RBA commenced.

Table 6 Forecasting performance of long-term expected inflation measures, from 1993 onwards

Forecast measure	*Next 5 years*		*Next 10 years*	
	RMSE (%)	*Bias (%)*	*RMSE (%)*	*Bias (%)*
RBA-based measure	0.62	0.15	0.36	–0.04
Bond break-even estimate	0.97	0.21	0.89	0.21

Notes: These metrics cover semi-annual forecasts covering forecast horizons within the period June quarter 1993 to the December quarter 2020. Market-based estimates are derived based on a 40-day averaging period ending at the end of each quarter.

Sources: RBA, Statement on Monetary Policy, various issues; RBA, Historical Forecasts, CPI inflation (year-ended), RBA website, 2021, accessed 2 June 2021; RBA, Statistical Tables, RBA: F16—Indicative Mid Rates of Australian Government Securities, RBA website, 2021, accessed 2 June 2021; QCA analysis.

Reductions in long-term market-based measures of inflation expectations over the past five years have differed markedly from corresponding movements in RBA-based and survey-based measures. As noted in Appendix E, there are no Australian studies that have assessed the extent to which a potentially negative inflation risk premium (or other distortions related to liquidity issues) have contributed to the substantial decreases in market-based measures over this period.

In response to the reductions in market-based measures of inflation expectations in 2016 and 2019, the RBA noted similar declines in other major advanced economies and noted that caution should be applied in interpreting these measures, because they can be affected by other developments in financial markets and may, in part, reflect changes in the inflation risk premium.[120] For example, the European Central Bank estimated that around 80 per cent of the decreases in long-term inflation expectations implied from inflation swaps[121], both in 2016 and 2019, were due to a decrease in the inflation risk premium.[122]

Market-based measures, including inflation swaps, also perform poorly during times of financial distress. Following the outbreak of covid-19 in early 2020, the RBA said that the magnitude of the decline in market-based measures was difficult to interpret, given the significant impairment in these markets.[123] The RBA reinstated its analysis of Australian market-based measures in May 2021, noting that long-term market-based measures had picked up from these very low levels in early 2020 and that the covid-19 related market dysfunction observed at times over the past year was no longer affecting market-based measures.[124]

Table 7 summarises our assessment of inflation forecasting methods.

[120] RBA, *Statement on Monetary Policy*, May 2016, pp. 12, 54; RBA, *Statement on Monetary Policy*, August 2016, p. 63; RBA, *Statement on Monetary Policy*, August 2019, pp. 11, 56.
[121] Specifically, with reference to the five-year forward inflation swap rate five years ahead.
[122] B Coeure, *Inflationary expectations and the conduct of monetary policy*, speech at the SAFE Policy Center, Frankfurt am Main, 11 July 2019.
[123] RBA, *Statement on Monetary Policy*, May 2020, pp. 81–82.
[124] RBA, *Statement on Monetary Policy*, May 2021, pp. 68–69.

Table 7 Summary of assessment of inflation forecasting methods

Assessment criteria	*Method*			
	RBA-based approach	***Survey-based approach***	***Market-based approaches***	***Model-based approaches***
Accurate and robust	Since inflation targeting began: • the RBA's short-term forecasts have been more accurate than those obtained using other methods • the RBA-based geometric mean estimate has performed better than market-based estimates. RBA's short-term forecasts incorporate information from the other methods discussed. While long-term expectations appear well anchored, there are greater uncertainties associated with short- to medium-term expectations.	These approaches have been less accurate than RBA's short-term forecasts. The relatively small number of survey respondents may not be representative of the broader population. Longer-term survey-based measures have remained relatively stable through all economic circumstances.	Since inflation targeting began, these have been less accurate than RBA-based approaches. There are time-varying premia, biases and distortions that are difficult to quantify. Market-based measures could more quickly respond to structural changes. However, they perform poorly during times of financial distress.	Accuracy depends on the appropriateness of the model specification. Models may lose their predictive ability if the structural relationships in the model change over time.
Credible and authoritative	The RBA has strong policy and technical expertise to apply to inflation forecasting. The RBA, being the agency responsible for Australia's monetary policy, also has a fundamental influence on inflation expectations (and therefore the forecasts derived using the other methods).	Respondents are well informed and invest substantial resources into forming their inflation expectations suggesting strong incentives to form accurate expectations.	Market participants have strong and direct incentives to form accurate expectations for inflation.	Public and some private modellers are well respected and would carry out expert analysis of credible information sources.
Simple, transparent and predictable	While the underlying models are not publicly available, the RBA produces credible and authoritative research and commentary on its forecasting approach. The calculation method is transparent and used by most other Australian economic regulators.	Forecasts tend to be licenced, subscription-based products. There is little visibility regarding the number of forecasters, or the methodology they employ, for long-term measures.	Break-even inflation can be replicated using publicly available data but may require subjective judgements due to a material deficiency of indexed bonds. Inflation swap data is not publicly available.	RBA publishes relevant research, but latest model and input data are not in the public domain. Private models are proprietary, making it difficult to verify how forecasts are derived.

This assessment shows that the RBA-based approach has relatively strong explanatory power. Further, while the process by which the RBA's short-term forecasts are generated may not be entirely transparent, the RBA is a highly credible and authoritative source with publicly available forecasts. This is in contrast to survey and model-based approaches, where the forecasts tend to be proprietary, which makes it difficult for us to verify how forecasts are derived.

As discussed in greater detail in Appendix D, the RBA-based approach also benefits from evidence that expected inflation is anchored within the RBA's inflation target band over the medium- to long-term horizon. When these benefits are combined with our overall concerns with using market- and survey-based measures, we consider that there is a strong case in favour of an RBA-based approach.

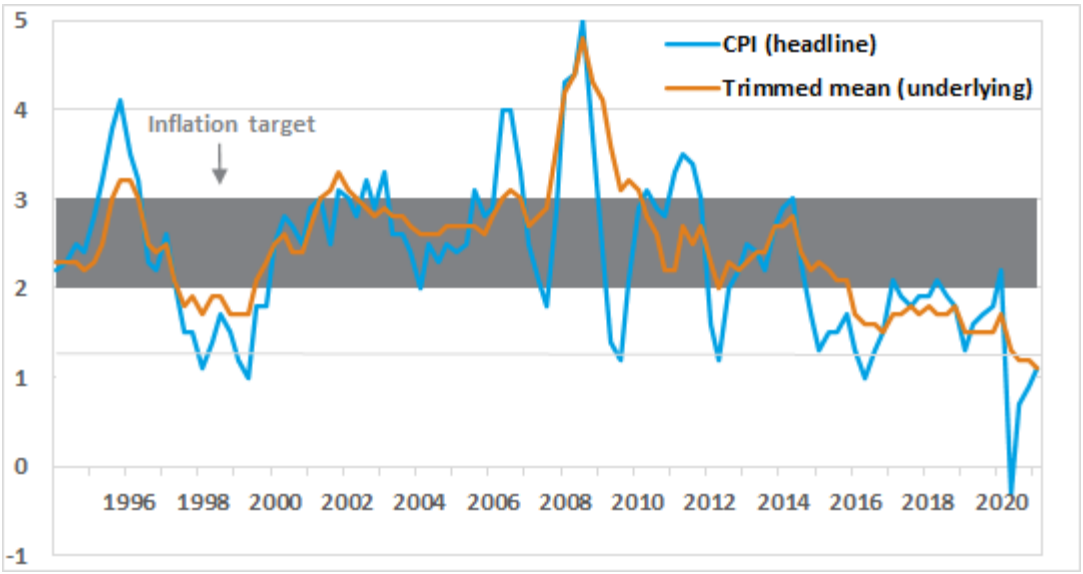
Overall, we consider that an RBA-based approach retains the key advantage that it is likely to produce unbiased forecasts where economic circumstances are such that it is reasonable to conclude that inflation expectations are well anchored within the RBA's target range.

However, we agree with stakeholders that, to the extent that we retain the use of an RBA-based approach, a version incorporating a glide path from short-term to long-term expectations might be necessary to ensure that the transition path from short-term to longer-term expectations reflects, as far as practical, market and broader economic considerations.

3.4.3 The case for incorporating a glide path in our RBA-based approach

Inflation has been relatively subdued in recent years, remaining below the RBA's target range for an extended period (Figure 5).

Figure 5 Australia—CPI inflation (year-end on a quarterly basis) (%)



Notes: Excludes interest charges. Adjusted for the tax changes of 1999–2000.

Sources: RBA, Statistical Tables, RBA: G1 – Consumer Price Inflation, RBA website, 2021, 2 June 2021; ABS, Consumer Price Index, Australia, March 2021, Table 8: CPI: Analytical Series, Weighted Average of Eight Capital Cities, cat. no. 6401.0, accessed 2 June 2021.

We note that prior to covid-19, the RBA had observed that Australia and other advanced economies were operating under a new normal of relatively low inflation due to, among other things, structural factors related to technology and globalisation.

For example, in July 2019, the Reserve Bank Governor noted that globalisation and technological advances had lowered the costs of producing many goods and services and increased competition in many markets, leading to lower prices and, over time, low inflation.[125]

The RBA has also noted that while pre-pandemic employment growth (over the period 2017 to 2019) was stronger than expected, the labour force participation rate also rose substantially, resulting in residual spare capacity in the economy and subdued wages growth. The uplift in the participation rate is likely to be another structural change, with the greater flexibility of labour supply meaning that strong demand for labour does not as readily result in the economy reaching its supply capacity as before. Consequently, it appears that stronger aggregate demand growth is now required for the economy to reach the limits of its capacity.

The likelihood that structural changes may have impacted the speed with which inflationary pressures now develop in Australia increases the possibility that a transition back to the RBA's target range, following a sustained period of low inflation, may now take longer than was previously assumed.

Thus, while survey-based measures of inflation expectations and recent studies suggest that long-term inflation expectations remain well anchored within the RBA's target band[126], there are greater uncertainties as to whether, moving forward, short- to medium-term expectations will remain within the target range.

3.4.4 Refinements to our RBA-based approach

Length of glide path

Evidence supports the view that, under normal economic conditions, inflation expectations are anchored close to the midpoint of the RBA's target range at around the five-year horizon:

- The AER concluded from its recent analysis of proprietary and confidential data that expected inflation would reach 2.5 per cent by about the fifth year ahead.[127]
- RBA research demonstrated that expected inflation would be close to the RBA midpoint by the fifth year ahead (see Appendix D).

Although a measure that is enduring across different, rather than normal, economic circumstances, would be desirable, we consider this five-year horizon approach to be appropriate in current economic conditions. Since October 2020, the RBA has stated that it does not expect actual inflation to be sustainably within the RBA target range for at least three years.[128] In addition, the RBA has consistently noted since early in 2020 that survey-based measures of long-term inflation expectations were around 2 to 2.5 per cent, remaining consistent with its medium-term target range.[129]

The survey-based measures referred to by the RBA include:

[125] P Lowe, *Inflation Targeting and Economic Welfare*, speech at an Anika Foundation luncheon, Sydney, 25 July 2019, RBA website, 2021, accessed 10 June 2021.
[126] See Appendix D for further details.
[127] AER, *Regulatory treatment of inflation*, final position paper, 2020, p. 50.
[128] See, for example, P Lowe, *The Recovery from a Very Uneven Recession*, speech at Citi's 12th Annual Australia and New Zealand Investment Conference, Sydney, 15 October 2020, RBA website, 2021, accessed 10 June 2021; RBA, *Minutes of the Monetary Policy Meeting of the Reserve Bank Board*, 1 June 2021, RBA website, 2021, accessed 10 June 2021.
[129] See, for example, RBA, *Statement on Monetary Policy*, February 2021, p. 55.

- the Consensus Economics' survey of professional forecasters for average inflation over six to 10 years ahead, which remains close to the RBA midpoint.[130] The RBA considers that the Consensus Economics' survey is ideal for assessing the anchoring of long-term inflation expectations, because it best abstracts from short-term influences on inflation.[131]
- the quarterly RBA survey of market economists for average inflation over the next five to 10 years ahead, which is generally between 2.2 and 2.5 per cent.[132] Given this survey measure includes short-term influences, the lower inflation forecasts in this survey for one and two years ahead[133] imply that average inflation expectations beyond two years are closer to the RBA midpoint.

Anchor point for glide path

Although the evidence suggests that inflation expectations could be anchored within the inflation target range at a horizon of five years ahead, the RBA has previously clarified that the target range should not be taken to imply that inflation should average the midpoint of the range.[134] The RBA has a flexible medium-term inflation targeting regime, which aims to keep inflation between 2 and 3 per cent, on average, over time.[135]

The RBA has, however, previously noted a preference for returning inflation to around the midpoint of the target range, as this would allow scope for surprises in either direction.[136] However, the RBA has applied this target in a flexible way by sometimes pursuing a more gradual transition to the midpoint. For example, from late 2016 to early 2019, the RBA maintained a constant cash rate target, while average actual inflation remained below 2 per cent and expected two-year ahead inflation remained between 2 and 2.5 per cent. Recent RBA commentary suggests that the cash rate will not be increased until actual inflation is sustainably within the target range.[137]

We note that the anchor point for the fifth year ahead is likely to be affected by economic conditions. We have therefore considered the following options from which to choose our anchor point, for it to be as robust as possible:

- The anchor point is the RBA midpoint under all circumstances (indicating strong confidence in the anchoring of medium- to long-term expectations at the midpoint of the target range)
- The anchor point depends on the RBA's second-year inflation forecast (as a proxy for prevailing economic conditions). For example, if the second-year forecast is:
  - less than or equal to 2 per cent, the anchor point could be set at 2.25 per cent

[130] RBA, *Statement on Monetary Policy*, May 2021, p. 69.
[131] A Moore, 'Measures of Inflation Expectations in Australia', *Bulletin*, RBA, December 2016, p. 24; L Ellis, *Re: Regulatory treatment of inflation expectations*, letter to the AER, 5 July 2017, p. 3.
[132] RBA, *Statement on Monetary Policy*, May 2021, graph 4.14, p. 69.
[133] RBA, *Statistical Tables*, RBA: G3—Inflation Expectations, RBA website, 2021, accessed 2 June 2021.
[134] J Kearns and P Lowe, *Australia's prosperous 2000s: Housing and the Mining Boom*, research discussion paper no. 2011-07, RBA, 2011, p. 8.
[135] RBA, *Inflation Target*, RBA website, 2021, accessed 5 July 2021. This differs, for instance, with the objectives of the Reserve Bank of New Zealand, which require a focus on keeping future inflation near the 2 per cent midpoint of the inflation target range of 1 to 3 per cent (Reserve Bank of New Zealand, *Monetary Policy Statement*, May 2021).
[136] P Lowe, *Inflation Targeting and Economic Welfare*, speech at an Anika Foundation luncheon, Sydney, 25 July 2019, RBA website, 2021, accessed 10 June 2021.
[137] For example, RBA, *Statement by Philip Lowe, Governor: Monetary Policy Decision*, media release, 1 June 2021, RBA website, 2021, accessed 5 July 2021.

  - between 2 per cent and 3 per cent, the anchor point could be set at 2.5 per cent
  - greater than or equal to 3 per cent, the anchor point could be set at 2.75 per cent[138]
- The anchor point is a market-based measure for the implied one-year forward rate in the fifth year ahead (which could be more responsive to anticipated economic conditions)
- The anchor point is a judgement-based approach based on an assessment of available information, including the level of the RBA's short-term forecasts, RBA forward guidance and market-based measures.

While we consider that an anchor point of 2.5 per cent remains appropriate in most market conditions, there may be times when inflation may not be expected to reach the midpoint of the RBA's target range for an extended period. In such instances, it may be appropriate to apply a different anchor point.

Our second option above is a rules-based approach based on the RBA's policy of setting a target range for inflation without an explicit reference to the midpoint of this range. These rules are intended to reflect the reasonable expectations of economic agents of how the RBA's monetary policy would attempt to move inflation back within the target range under different economic circumstances.

The lower-range anchor point is consistent with recent economic conditions where the second-year forecast has repeatedly been less than or equal to 2 per cent. Noting that RBA forecasts are rounded to the nearest quarter-percent, it is likely that a second year forecast that is clearly within the target range (i.e. 2.25, 2.5 or 2.75 per cent) would be consistent with expectations converging to the midpoint of the target range by the fifth year ahead. A second-year forecast that was not clearly within the target range could signal persistently low or high inflation, with a corresponding effect on expectations.[139] This rules-based approach would apply symmetrically during periods of persistently low or high inflation.

Our third option uses inflation swaps, as this market-based method is more amenable to deriving one-year implied forward rates. The irregular maturities of indexed bonds make it difficult to accurately derive one-year implied forward rates using the break-even method.

Our fourth option (a judgement-based approach) would determine the appropriate anchor point for a given situation based on assessment of the prevailing economic circumstances, forward guidance from the RBA regarding the medium-term outlook, and other relevant information such as the term structure of market-based expectations.

The use of a linear glide path approach from RBA short-term forecasts to long-term inflation expectations results in a large weighting for the RBA forecasts (around 60 per cent, assuming a

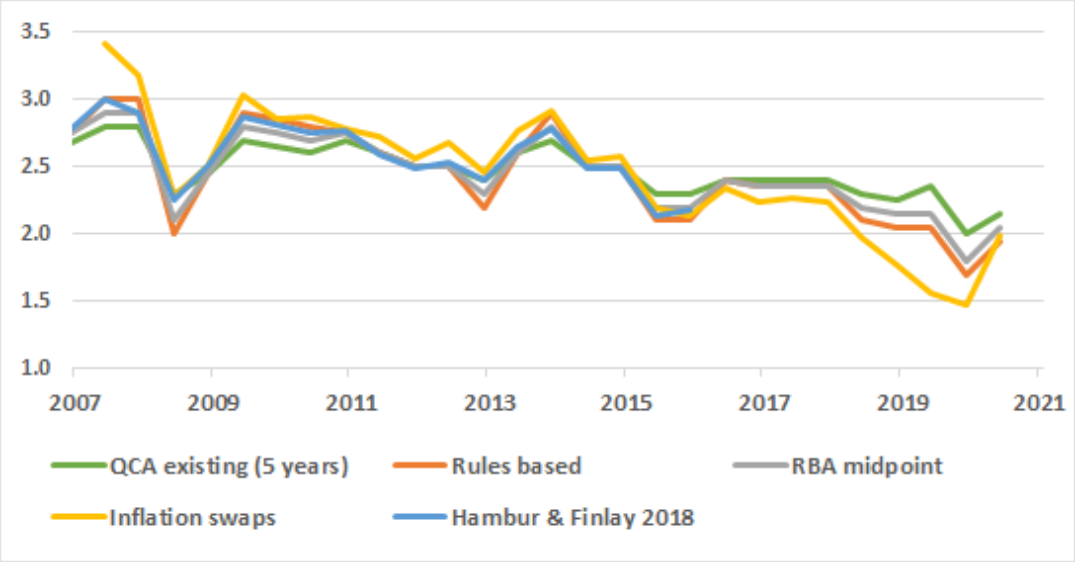
[138] Given that the RBA rounds its forecasts to the nearest quarter percent, an estimate of 2 or 3 per cent could be outside the target range when unrounded.

[139] For example, the RBA noted in its August 2019 Statement on Monetary Policy that persistent low inflation had lowered measures of inflation expectations. The RBA has regularly noted since then that survey-based long-term measures have remained around 2 to 2.5 per cent, which is consistent with its inflation target.

five-year forecast horizon)[140] as compared to the anchor point (40 per cent).[141] Using a market-based measure as an anchor point will, for example, give 60 per cent weight to non-market estimates and 40 per cent weight to market estimates.[142]

Given this relatively high weighting applied to RBA short-term forecasts, the resultant derived five-year inflation expectations estimates are closely aligned across the three non-judgement-based anchor point options. Figure 6 compares five-year inflation expectations derived using the alternative anchor points across the available time series from 2008 onwards. The rules-based approach aligns closest to the expectations derived by combining RBA short-term forecasts with the RBA's market-based estimate adjusted to remove risk premia.[143] The use of inflation swaps results in slightly more volatility in the estimates. Our existing version of the RBA-based approach and the RBA-based approach with a linear glide path to the RBA midpoint tend to align closer to the RBA midpoint, given the higher weighting of the RBA midpoint.

Figure 6 Comparison of the 5-year geometric mean using alternative anchor points (%)



Notes: These metrics cover semi-annual forecasts over forecast horizons within the period December quarter 2007 to June quarter 2021. Inflation swap anchor point estimates are derived based on a 40-day averaging period ending at the end of each quarter.

Sources: RBA; Bloomberg; J Hambur and R Finlay, Affine Endeavour: Estimating a Joint Model of the Nominal and Real Term Structures of Interest Rates in Australia, Research Discussion Paper 2018-02, RBA, 2018, p.16; QCA analysis.

Our key concerns with using the market-based measure anchor point are that:

[140] This reflects the weighting from the first two years of the forecast horizon from using RBA forecasts (40 per cent weighting) and is due to the third- and fourth-year-ahead forecasts effectively being a weighted average of the second year RBA forecast (66.7 per cent and 33.3 per cent weightings for the third- and fourth-year-ahead forecasts, respectively) and the long-term anchor point.

[141] As noted in section 3.3.1, QTC suggested that estimation bias could be reduced by combining market and non-market estimates. However, we consider that this would depend on the extent of biases in market and non-market measures.

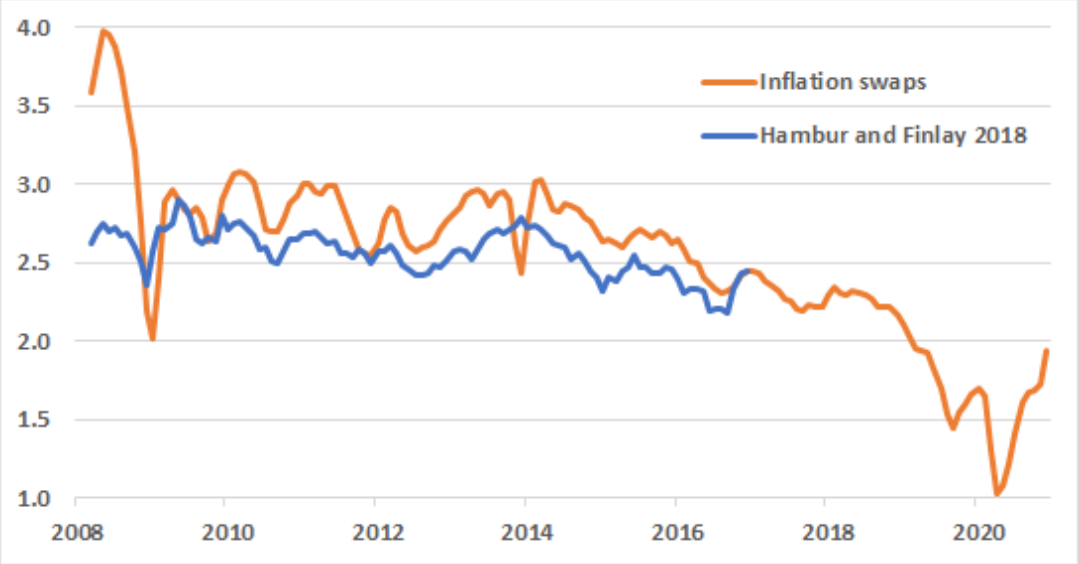
[142] While we refer to RBA estimates as 'non-market', the RBA is likely to consider market-based forecasts in developing its forecasts.

[143] J Hambur and R Finlay, *Affine Endeavour: Estimating a Joint Model of the Nominal and Real Term Structures of Interest Rates in Australia*, Research Discussion Paper 2018-02, RBA, 2018, p. 16.

- because risk premia are incorporated in this measure, the anchor point is not unbiased[144]
- the market-based estimate can exhibit periods of high volatility due to a pronounced increase in uncertainty
- inflation swaps data are not publicly available, making it difficult for some stakeholders to be able to access and replicate our estimates.

Figure 7 compares the fifth-year-ahead forecast derived from inflation swap data to RBA estimates of market-based inflation expectations adjusted to remove risk premia. The difference between these two measures shows the possible impact of risk premia. It also shows the increased volatility of the inflation swaps method during the global financial crisis and covid-19 outbreak in 2008 and 2020.

Figure 7 Comparison of 5-year ahead inflation expectations estimates (%)



Notes: These metrics cover end-of-month forecasts covering forecast horizons from March 2008 to June 2021. Inflation swap estimates are derived based on a 40-day averaging period ending at the end of each month.

Sources: Hambur and Finlay 2018, Bloomberg; QCA analysis.

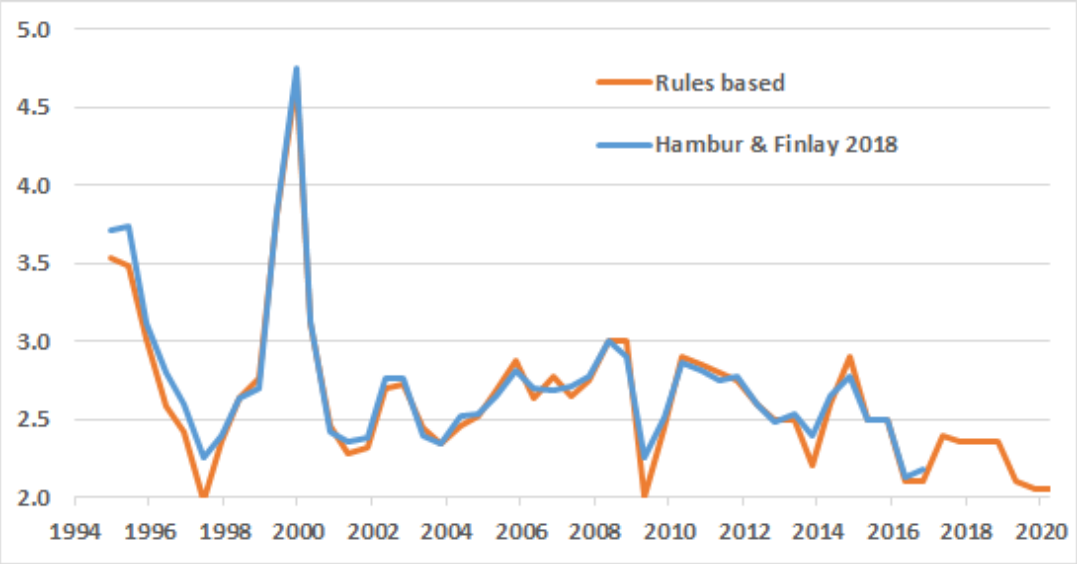
As noted in Appendix D, when the RBA has assessed long-term inflation expectations in recent years, it has focused more on survey-based measures of inflation expectations in its quarterly Statement on Monetary Policy. The RBA has provided caveats when assessing market-based inflation expectations, due to the increased influence of risk premia on movements in these measures. The RBA also ceased its assessment of market-based measures from May 2020 until reinstating these in May 2021, noting that these measures were difficult to interpret, given the significant impairment in these markets.

While an element of judgement could be used to determine the appropriate anchor point, we consider that our approach should be as objective as reasonably practicable so that it retains the advantages of simplicity, transparency and predictability. We consider that, given the low relative weighting of the chosen anchor point, our proposed rules-based approach is a simple, transparent and predictable approach that can perform well in different economic circumstances. Figure 8

[144] In general, we would expect this risk premia to be positively correlated with the level of expected inflation. Therefore, periods of higher-than-average expected inflation would generally be associated with higher positive risk premia, and periods of lower-than-average expected inflation would generally be associated with low or negative risk premia.

shows a very close alignment between five-year inflation expectations derived with anchor points using our proposed rules-based approach and the RBA's five-year ahead market-based forecasts, adjusted to remove risk premia effects.

Figure 8 Comparison of 5-year inflation expectations using alternative anchor points (%)



Notes: These metrics cover available semi-annual forecasts over forecast horizons within the period December quarter 1994 to June quarter 2021. The two charts coincide in years where the rules-based line is not shown.

Sources: RBA; Bloomberg; J Hambur and R Finlay, Affine Endeavour: Estimating a Joint Model of the Nominal and Real Term Structures of Interest Rates in Australia, Research Discussion Paper 2018-02, RBA, 2018, p. 16; QCA analysis.

For the limited applications that require CPI forecasts over the long-term beyond the fifth year ahead,[145] we assume the midpoint of the RBA's target range beyond the fifth year ahead. Given the difficulties in forecasting inflation over the very long-term, we consider that the midpoint of the RBA's target range is reasonable in these circumstances.

3.5 Draft position

Our draft position is to use short-term RBA forecasts for the first two years of the regulatory period and derive forecasts up to the fifth year ahead, using a linear glide path—from the RBA's short-term forecast in year two to a rules-based anchor-point forecast in the fifth year ahead. Specifically, if the second-year forecast is:

- less than or equal to 2 per cent, the anchor point would be set at 2.25 per cent
- between 2 per cent and 3 per cent, the anchor point would be set at 2.5 per cent
- greater than or equal to 3 per cent, the anchor point would be set at 2.75 per cent.

The annual CPI forecasts derived using this approach will be used for relevant escalation purposes. To estimate expected inflation for capital revenue purposes, we propose to take the geometric mean of the annual forecasts produced over the applicable regulatory period.

We will assume the midpoint of the RBA's target range (2.5%) beyond the fifth year ahead, in the limited circumstances that this longer-term forecast is required.

[145] For example, when we use a planning (or smoothing) horizon that is longer than the regulatory period, such as in the 2020–24 rural irrigation price review where we calculated renewals annuities over a 30-year planning horizon.

4 OTHER METHODOLOGICAL ISSUES

We have assessed other methodological issues related to the use of inflation in revenue and price modelling, including the appropriate measure of general CPI inflation and the choice between national CPI and location-specific CPI.

4.1 Key points

Our draft position on the appropriate treatment of other methodological issues is to:

- use headline CPI, rather than trimmed mean estimates, as the appropriate measure of general CPI inflation in revenue and price modelling, other than in abnormal and transient economic circumstances when the appropriate measure will be considered on a case-by-case basis at the time of the review process (see section 4.2)
- use national CPI for capital revenue purposes (i.e. inflation deduction and RAB indexation), and use location-specific (Brisbane) cost escalators in cases where there are underlying cost drivers that are materially different to the national CPI inflation measure (see section 4.3).

4.2 Measure of inflation

The RBA produces forecasts of two key measures of CPI inflation—CPI (or 'headline' measure) and trimmed mean inflation (underlying measure).

CPI is the RBA's forecasts of the Australian Bureau of Statistics' (ABS's) national, all groups CPI.

Trimmed mean inflation is the RBA's key forecast of the ABS's underlying trend series estimate of inflation. It seeks to reduce the impact of irregular or temporary price changes in the components of the CPI. This estimate is derived by:

- ranking the expenditure classes of goods and services in the CPI in the order of their quarterly price changes (in seasonally adjusted terms)
- using the weighted average of the percentage changes from the middle 70 per cent of the distribution of rankings, with expenditure classes at the lower and upper ends 'trimmed'.

Stakeholder comments

Stakeholders generally agreed that, except under extreme circumstances, headline CPI inflation was the appropriate inflation measure for revenue and price modelling. In particular:

- QTC said that trimmed mean CPI forecasts may be appropriate when very large headline CPI outcomes are expected to reverse in the short term.[146]
- Seqwater said that if we decided to continue to use RBA forecasts, then it would be reasonable for us to have the option of using trimmed mean forecasts in the limited circumstances of unusual and transient economic conditions that result in anomalous changes in headline inflation.[147]
- Aurizon Network said that there may be exceptional circumstances where replacing the RBA's headline forecast with the trimmed mean would produce a better forecast of

[146] QTC, sub. 5, p. 8.
[147] Seqwater, sub. 6, p. 21.

expected inflation. An objective decision rule should be applied before any adjustments are made—for example, where the difference between the forecast headline and trimmed mean was greater than 1 per cent.[148]

- GAWB supported us using the trimmed mean at some future point in time in response to exceptional economic circumstances.[149]

Analysis

We consider that headline CPI, rather than trimmed mean inflation, is the appropriate measure for deriving expected inflation estimates for revenue and price modelling purposes. Headline CPI is relatively timely and simple, and provides good coverage of goods and services commonly purchased by Australian households.

The headline CPI series can sometimes be affected by expenditure categories where price shocks may be transient (and reverse in subsequent periods) or be unrepresentative of changes in the aggregate price level. As noted by Aurizon Network, other than in exceptional periods, there is typically very little difference between the headline CPI and the trimmed mean.

Other than in exceptional circumstances, the headline CPI series is used by all other Australian regulators. The key exception was when the AER and ESCOSA used the RBA's trimmed mean forecasts in the first two years of their RBA-based forecasts for regulatory periods commencing 1 July 2020. This was to address covid-19 related volatility in the year to June 2021 CPI estimates (that reversed June 2020 price shocks). AER considered that the trimmed mean series better reflected core inflation, as it smoothed the transient volatility.[150] ESCOSA used this series to deal with the impact of timing differences between the bond yields used to calculate the risk-free rate and the RBA inflation forecasts for the regulatory period.[151]

We do not consider that an objective decision–rule would be appropriate for determining when to use trimmed mean inflation forecasts. While trimmed mean inflation is the RBA's key forecast of underlying inflation, the RBA has noted that the appropriate underlying inflation measure to isolate short-term volatility in CPI inflation may depend on the nature of the price shock.[152]

Draft position

Our draft position is to use headline CPI forecasts, other than in abnormal and transient economic circumstances that result in anomalous changes in headline CPI forecasts. We would consider these special circumstances on a case-by-case basis at the time of the review process.

4.3 National or Brisbane inflation

In our recent reviews, we have used an estimate of expected national CPI inflation[153] to index the RAB for forecast inflationary gain, make the associated adjustment to revenue, and escalate some

[148] Aurizon Network, sub. 1, pp. 21–23.
[149] GAWB, sub. 4, p. 6.
[150] AER, *SA Power Networks Distribution Determination 2020 to 2025, Attachment 3: Rate of return*, final decision, June 2020, pp. 3–10. Note that under the AER's approach, the inflationary gain deduction is based on June year-ended CPI forecasts (which would only be affected in the June quarter 2021 for the 2020–25 regulatory period), while RAB indexation is based on December year-ended actual CPI inflation (which is unaffected by this volatility).
[151] ESCOSA, *SA Water Regulatory Determination 2020*, final determination: statement of reasons, June 2020, p. 228.
[152] T Richards and T Rosewall, 'Measures of Underlying Inflation', *Bulletin*, RBA, March 2010, pp. 7, 12. Trimmed mean estimates are one of various underlying inflation measures used by the RBA to better understand the current trend in inflation and develop its headline CPI forecasts.
[153] That is, the weighted average across the eight capital cities.

input cost components. For other input costs, such as labour, we have used other Brisbane-based measures such as the wage price index given that this is the closest location-specific index publicly available in terms of relevance.[154]

While we have used an estimate of expected national CPI inflation to index the RAB for forecast inflationary gain, we have generally accepted Brisbane CPI for the purpose of indexing the RAB to reflect actual inflation.[155] Other regulators, however, tend to use national CPI for this purpose.

Stakeholder comments

Sunwater said that to reflect the local nature of its business, we should apply Brisbane or Queensland-based measures, including cost escalation factors such as the wage price index.[156]

DBI said that we should estimate expected inflation by reference to national CPI, reflecting the geographic spread of investors.[157]

Seqwater said that to be consistent with the NPV=0 principle, the inflation removed in the inflationary gain adjustment (e.g. national CPI) should be on the same basis as the inflation that is to be 'put back' through RAB indexation.[158]

Aurizon Network said that the choice of measure depends on where it is being applied. For example, for the inflation deduction and RAB indexation, the national measure is more consistent with the estimate of the risk-free rate. For input cost escalation, it may be more appropriate to use a measure that is more reflective of local economic conditions.[159]

Analysis

The RAB represents the recovery of financial investment, as opposed to the value of physical capital, which typically reflects the productive capacity of the underlying assets (see section 2.3). Given that the investor base is not location-specific, and for consistency with the inflation measure incorporated in the risk-free rate and deducted from allowable revenues, we consider that it is appropriate to index the RAB using national CPI inflation.

We also consider it reasonable to use location-specific (Brisbane) cost escalators in cases where there are underlying cost drivers that are materially different to the national CPI inflation measure. For example, in escalating some capex categories, it may be reasonable to use a location-specific measure if cost drivers in the local market (e.g. the cost of procuring local materials and services) vary significantly from those in the national market.

Draft position

Our draft position is to use national CPI for capital revenue purposes (i.e. inflation deduction and RAB indexation) and to use location-specific (Brisbane) cost escalators in cases where there are underlying cost drivers that are materially different to the national CPI inflation measure.

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[154] For example, see QCA, *Rural irrigation price review 2020–24*, final report, 2020.

[155] With the exception of previous access undertakings for DBCT Management, where we used national CPI. For example, see QCA, *Aurizon Network's 2017 access undertaking*, decision, 2018; QCA, *Queensland Rail's 2020 access undertaking*, decision, 2020; QCA, *Seqwater Bulk Water Price Review*, final report, 2018, pp. 53–54; QCA, *DBCT Management's 2015 draft access undertaking*, final decision, 2016, p. 163.

[156] Sunwater, sub. 7, p. 2.

[157] DBI, sub. 3, p. 11.

[158] Seqwater, sub. 6, p. 19.

[159] Aurizon Network, sub. 1, p. 24.

GLOSSARY

ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
AER	Australian Energy Regulator
capex	capital expenditure
CAPM	capital asset pricing model
CGS	Commonwealth Government security
CPI	consumer price index
DBI	Dalrymple Bay Infrastructure
ESC	Essential Services Commission
ESCOSA	Essential Services Commission of South Australia
ERA	Economic Regulatory Authority, Western Australia
GAWB	Gladstone Area Water Board
ICRC	Independent Competition and Regulatory Commission
IMF	International Monetary Fund
IPART	Independent Pricing and Regulatory Tribunal
opex	operating expenditure
OTTER	Office of the Tasmanian Economic Regulator
QCA	Queensland Competition Authority
QTC	Queensland Treasury Corporation
RAB	regulatory asset base
RBA	Reserve Bank of Australia
RMSE	root mean square error
WACC	weighted average cost of capital
WPI	wage price index
ZCIS	zero coupon inflation swap

APPENDIX A: LIST OF SUBMISSIONS

The submissions that we received on our issues paper are listed below. They are numbered for reference purposes only—the numbers are used in the footnotes in the report. The submissions are available on our website.

Table 8 Submissions

Stakeholder	*Sub. number*	*Date*
Aurizon Network	1	28 May 2021
Dalrymple Bay Coal Terminal User Group (DBCT User Group)	2	28 May 2021
Dalrymple Bay Infrastructure	3	28 May 2021
Gladstone Area Water Board	4	28 May 2021
Queensland Treasury Corporation	5	28 May 2021
Seqwater	6	28 May 2021
Sunwater	7	27 May 2021

APPENDIX B: COST RECOVERY UNDER THE INDEXATION APPROACH

At present, our building blocks model approach escalates the RAB annually for inflation. As a nominal WACC is also applied, it is necessary to adjust the allowed capital revenues by deducting an amount equivalent to the inflationary gain in the RAB value to avoid the double counting of inflation that would otherwise occur from indexing the RAB by inflation and applying a nominal WACC that embodies inflation.

At a given point in time, the regulated firm should be able to recover the current value of its assets from its expected revenues (in present value terms) over the remaining life of its assets. However, the indexation approach will only be consistent with this principle if the same (expected) inflation rate is used across all parts of the calculation[160] and the appropriate inflation rate is a suitable estimate of expected inflation.

For simplicity, assume an asset with an economic life of 10 years and capital revenues only. Further, assume an initial RAB value of $1,000, straight line depreciation and a nominal WACC of 7 per cent. Assume that the inflation rate is expected to be lower in the shorter term, averaging 2 per cent over the initial 5 years and 2.5 per cent thereafter.

Table 9 shows expected future capital revenues when a 10-year expected inflation estimate (i.e. 2.25 per cent) is used to calculate allowed capital revenues.

Table 9 Indexation of the asset value with 10-year expected inflation

Scenario	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
1. Beginning of regulatory period					
Opening asset value	1,000	920	836	748	656
add inflationary gain	23	21	19	17	15
less depreciation	102	105	107	109	112
Closing asset value	920	836	748	656	559
Return of capital (depreciation)	102	105	107	109	112
Return on capital	70	64	59	52	46
less inflationary gain	23	21	19	17	15
Allowed capital revenues (nominal)	150	148	147	145	143
Allowed capital revenues (real)	146	142	137	133	128
2. End of regulatory period					
Opening asset value	1,000	918	832	741	647
add inflationary gain	20	18	17	15	13
less depreciation	102	105	107	109	112
Closing asset value	918	832	741	647	548
Present value (7% nominal WACC)	**992**				
Present value (4.6% real WACC)	**992**				

Notes: The depreciation amount for a given year is calculated by dividing the opening asset value in that year (including the inflationary gain amount for that year) by the length of the remaining asset life. Real allowed revenues and the real WACC are derived by deflating the nominal WACC by the 10-year expected inflation estimate.

[160] We use an estimate of the expected inflation rate to adjust the depreciation allowance and to calculate the inflationary gain that is subtracted from allowed revenues. On the other hand, at the end of the regulatory period we use the actual inflation rate, as measured by the CPI, to index the RAB value over the regulatory period.

As shown in Table 9, the expectation in year 1 is that the inflationary gain deduction (using the 10-year expected inflation of 2.25 per cent) will be higher than the indexation of the RAB by the shorter-term inflation estimate (i.e. 2 per cent) at the end of the regulatory period, resulting in the present value of expected future revenues ($992) being lower than the initial asset value ($1,000).

Table 10 shows expected future capital revenues at the beginning of the regulatory period when a 5-year expected inflation estimate (i.e. 2 per cent) is used to calculate allowed capital revenues. This will result in the present value of expected future revenues equalling the initial asset value.

Table 10 Indexation of the asset value with 5-year expected inflation

Scenario	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
1. Beginning of regulatory period					
Opening asset value	1,000	918	832	743	649
add inflationary gain	20	18	17	15	13
less depreciation	102	104	106	108	110
Closing asset value	918	832	743	649	552
Return of capital (depreciation)	102	104	106	108	110
Return on capital	70	64	58	52	45
less inflationary gain	20	18	17	15	13
Allowed capital revenues (nominal)	152	150	148	145	143
Allowed capital revenues (real)	149	144	139	134	129
2. End of regulatory period					
Opening asset value	1,000	918	832	743	649
add inflationary gain	20	18	17	15	13
less depreciation	102	104	106	108	110
Closing asset value	918	832	743	649	552
Present value (7% nominal WACC)	**1,000**				
Present value (4.9% real WACC)	**1,000**				

Notes: The depreciation amount for a given year is calculated by dividing the opening asset value in that year (including the inflationary gain amount for that year) by the length of the remaining asset life. Real allowed revenues and the real WACC are derived by deflating the nominal WACC by the 5-year expected inflation estimate.

This example shows that the present value of the future cash flows equals the initial asset value, provided that the inflation rate applied to the depreciation allowance and the deduction from allowed capital revenues are expected to equal the actual inflation applied to index the RAB over the regulatory term.[161]

The financial capital maintenance principle can be demonstrated in either nominal or real terms.[162] However, for this principle to equivalently apply in real terms, the nominal discount factor and nominal allowable revenues would need to be converted to real terms using the same expected inflation rate.[163] Given that the relevant expected inflation rate for this principle to apply in nominal terms is the regulatory-term-matched expected inflation rate, this implies that this principle would only apply in real terms if the nominal discount rate and allowable revenues were converted to real terms using this inflation rate.

[161] Note that, in practice, the use of an average expected inflation rate, derived as the geometric mean of expected annual inflation over the term of the regulatory period, will derive slightly different annual capital revenues than the application of the annual expected inflation rates over the same period.

[162] QCA, *Financial Capital Maintenance and Price Smoothing*, information paper, 2014, p. 4.

[163] QCA, *Financial Capital Maintenance and Price Smoothing*, information paper, 2014, pp. 4–5.

APPENDIX C: FORECASTING METHODS USED BY OTHER REGULATORS

The table below summarises the inflation forecasting methods recently used by other Australian regulators.

Table 11 Inflation forecasting methods used by other regulators

Regulator	*Approach*
QCA	Our approach in recent reviews has been to derive the 10-year geometric mean of the RBA's short-term CPI forecasts with an immediate transition to the midpoint of RBA's target band (2.5 per cent) for the remaining years of the adopted inflation term.
ACCC	In its draft position on Australian Rail Track Corporation's 2017 Hunter Valley Access Undertaking, the ACCC said that an appropriate method for expected inflation was to use a geometric average of the RBA's inflation forecasts and mid-band target inflation over a 10-year period.
AER	In the final position paper on its inflation treatment in December 2020, the AER decided to estimate expected inflation as the 5-year geometric mean of 1-year and 2-year forecasts from the RBA's Statement on Monetary Policy, with a 3-year linear glide path (i.e. until year 5) to the midpoint of the RBA target band (2.5%).
ESCOSA	In its review of prices for SA Water from 1 July 2020, ESCOSA estimated expected inflation as the 10-year geometric mean of 1-year and 2-year forecasts from the RBA's Statement on Monetary Policy, with a 5-year linear glide path (i.e. until year 7) to the midpoint of the RBA target band (2.5%).
IPART	In its review of prices for Sydney Water from 1 July 2020, IPART estimated expected inflation as the 4-year geometric mean of a 1-year forecast from the RBA's Statement on Monetary Policy, with immediate transition to the midpoint of the RBA target band (2.5%).
ESC	In its final decision for its 2021 water price review for Melbourne Water, the ESC estimated expected inflation based on the midpoint of: • the 10-year geometric mean of the RBA forecast CPI for 1 year and 2 years ahead and the midpoint of the RBA target inflation band from 3 to 10 years ahead • the 'bond break-even' inflation rate implied by the difference between the yields on 10-year nominal and indexed (inflation-linked) Treasury bonds.
ERA	ERA generally applies the break-even method to estimate expected inflation, using the Fisher equation and the observed yields of nominal and indexed Treasury bonds.
OTTER	In its water and sewerage price and service plan guidelines for its 2022 price determination investigation for TasWater, OTTER said that forecast inflation values must be the CPI inflation forecast for the furthest future period as presented in the RBA's most recently published Statement of Monetary Policy.
ICRC	In the final report for its review of WACC methodologies, the ICRC decided to adopt the AER's approach to forecasting inflation. In its 2018 review of Icon Water, the ICRC used the midpoint of the RBA's target band for inflation of 2 to 3 per cent to determine a forecast inflation rate of 2.5 per cent.

Sources: ACCC, Australian Rail Track Corporation's 2017 Hunter Valley Access Undertaking, draft decision, April 2017, pp. 169–170; AER, Regulatory treatment of inflation, final position paper, 2020, p. 6; IPART, Review of our WACC method, final report, 2018, pp. 76–80; IPART, Review of prices for Sydney Water from 1 July 2020, final report, 2020, pp. 65–72; ESC, Melbourne Water Final Decision—2021 water price review, 2021, pp. 47–49; ESCOSA, SA Water Regulatory Determination 2020, final determination: statement of reasons, 2020, pp. 223–229; ERA, 2018 and 2019 Weighted Average Cost of Capital, For the Freight and Urban Networks, and the Pilbara Railways, final determination, 2019, pp. 79–80; ICRC, Regulated water and sewerage services prices 2018–23, final report, 2018, p. 107; OTTER, Tasmanian Water and Sewerage Industry 2022 Price Determination Investigation, Price and Service Plan Guideline, 2021, p. 22; ICRC, Review of Methodologies for the Weighted Average Cost of Capital, report 8 of 2021, final report, 2021, p. 43.

APPENDIX D: ANCHORING OF LONG-TERM INFLATION EXPECTATIONS

The RBA-based methods assume that inflation expectations are well anchored and converge to the midpoint of the RBA's target range over the medium to long term.

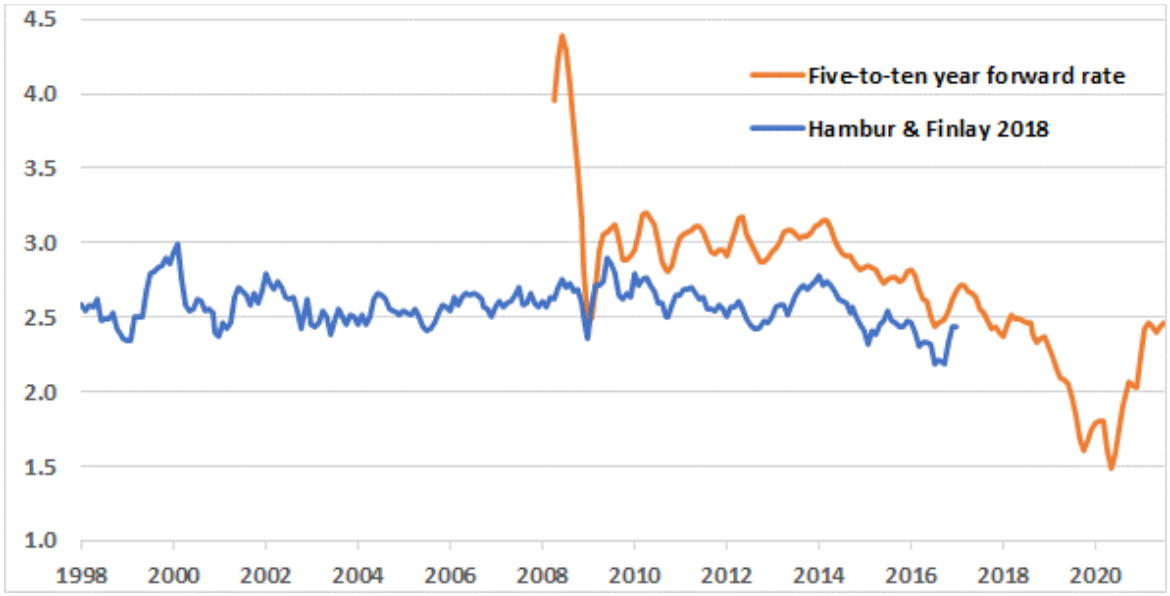
RBA research on the anchoring of inflation expectations

Several studies suggest that medium- to long-term inflation expectations have remained well anchored around the midpoint of the RBA's target range since the commencement of inflation targeting by the RBA.

Hambur and Finlay in 2018 used a model-based approach to decompose break-even estimates between inflation expectations and risk premia.[164] Their estimates of three-, five- and 10-year ahead inflation expectations initially decreased following the start of the inflation targeting regime in the mid-1990s, after which they have remained well entrenched in the RBA's target range.[165] Between 1998 and 2016, the five- and 10-year inflation expectations averaged around 2.6 per cent, with a standard deviation of 0.13 per cent.

Figure 9 compares the five-year ahead inflation expectations derived by Hambur and Finlay with the implied five- to ten-year forward inflation swap rate published in the RBA's Statement on Monetary Policy.

Figure 9 Medium- to long-term inflation expectations in Australia, end-of-month (%)



Notes: Five- to ten-year forward rate derived from zero coupon inflation swap rates and averaged over 40 days.

Sources: Bloomberg; J Hambur and R Finlay, Affine Endeavour: Estimating a Joint Model of the Nominal and Real Term Structures of Interest Rates in Australia, research discussion paper 2018-02, RBA, 2018; QCA analysis.

The RBA noted that declines in market-based measures of long-term inflation expectations in Australia and other advanced economies in 2019 reflected unusually low perceived uncertainty about future inflation outcomes.[166] The RBA also noted that market-based measures were difficult to interpret because the markets were not very liquid in Australia, also noting that these contain time-varying inflation risk

[164] J Hambur and R Finlay, *Affine Endeavour: Estimating a Joint Model of the Nominal and Real Term Structures of Interest Rates in Australia*, research discussion paper 2018-02, RBA, 2018.
[165] J Hambur and R Finlay, *Affine Endeavour: Estimating a Joint Model of the Nominal and Real Term Structures of Interest Rates in Australia*, research discussion paper 2018-02, RBA, 2018, p. 16.
[166] RBA, *Statement on Monetary Policy*, August 2019, pp. 11, 56.

premium.[167] The RBA ceased its assessment of market-based measures from May 2020 until reinstating these in May 2021, noting that these measures were difficult to interpret given the significant impairment in these markets.

The RBA has noted that the Consensus Economics estimate of expectations of average inflation between six- to ten-years ahead is particularly useful for assessing anchoring of long-term inflation expectations as it best abstracts from near-term influences on inflation.[168] This measure has consistently remained around the RBA midpoint since the late 1990s.[169]

The RBA also derives a 'trend' measure that extracts a common signal of inflation expectations from various (mainly survey-based) measures after controlling for each measure's co-movement with recent inflation.[170] This measure also adjusts for typical upward biases in some individual measures. This produces a fairly flat long-run trend series that aligns closely with the midpoint of the RBA's target range.[171]

Studies based on the impact of changes in actual inflation

McKibbin and Panton[172] tested whether long-term inflation expectations were influenced by movements in actual inflation.[173]

Using a time series of the 10-year break-even inflation rate (as a proxy for long-term inflation expectations) and a one-quarter lag in CPI (for actual inflation), they found that since the introduction of inflation targeting, a one standard deviation shock to actual inflation has tended to have a contemporaneous impact on long-term expectations (indicating incomplete anchoring of expectations) but that the impact has tended to dissipate over time, with expectations returning to baseline levels within a year (indicating stronger anchoring over time).

Gillitzer and Simon[174] looked at revisions in inflation expectations at different time horizons, in response to a surprise in current-year inflation. Specifically, using Consensus Economics' forecasts of inflation at different time horizons, they looked at the impact of a change in actual inflation between the March and September quarters of a given year, on the corresponding change in inflation expectations.

Using data from 1991 to 2013 and splitting the data between the pre- and post-2000 period, they found that pre-2000, a one standard deviation surprise in current-year inflation tended to raise professional forecasters' inflation expectations (at a five-year horizon) but that post-2000, such inflation surprises had a negligible effect on expectations.

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[167] Cassidy, N, Rankin, E, Read, M, and Seibold, C, 'Explaining Low Inflation Using Models', *Bulletin*, RBA, June 2019, p. 152.

[168] Moore, A, '*Measures of Inflation Expectations in Australia*, *Bulletin*, RBA, December 2016, p. 24; Ellis, L, *Letter re: Regulatory treatment of inflation expectations*, 5 July 2017, p. 3.

[169] Graph 4.14 in the May 2021 Statement on Monetary Policy.

[170] Cassidy, N, Rankin, E, Read, M, and Seibold, C, 'Explaining Low Inflation Using Models', *Bulletin*, RBA, June 2019.

[171] Cassidy, N, Rankin, E, Read, M, and Seibold, C, 'Explaining Low Inflation Using Models', *Bulletin*, RBA, June 2019, p. 153.

[172] WJ McKibbin and AJ Panton, *Twenty-five Years of Inflation Targeting in Australia: Are There Better Alternatives for the Next 25 Years?*, working paper no. 41, Hutchins Centre on Fiscal and Monetary Policy at Brookings, July 2018, pp. 12–18.

[173] McKibbin and Panton assumed that long-term expectations are a weighted average of the inflation target and a one period lag of the actual inflation rate, with a zero per cent weight for lagged inflation indicating firmly anchored expectations, and a 100 per cent weight for lagged inflation indicating completely de-anchored expectations. They then tested the hypothesis that expected inflation has no relationship with lagged inflation in the historical data —that is, that expectations are firmly anchored at target.

[174] C Gillitzer and J Simon, 'Inflation targeting: A victim of its own success?', *International Journal of Central Banking*, vol. 11, no. S1, September 2015, pp. 259–87.

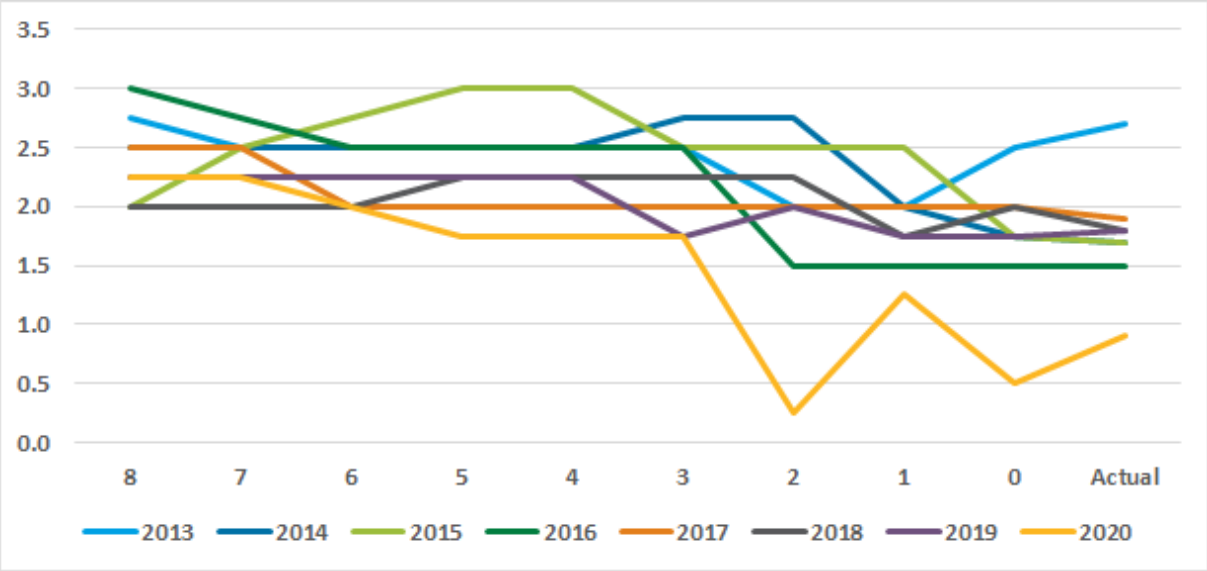
Anchoring of inflation expectations at different horizons

AER derived implied forward rates over horizons of one year ahead to 10 years ahead, using Consensus Economics' annual surveys from 2001 to 2020.[175]

By grouping the results according to whether the one-year forward rate from a given survey was higher or lower than the midpoint of the RBA's target range, this analysis determined that in all the instances where the one-year forward rate diverged from the midpoint of the target range in either direction, expected inflation returned to the target range by the third year.[176]

Following Mehrotra and Yetman (2018)[177], we also looked at the pattern in the RBA's forecasts of headline inflation over different time horizons and found that as the forecast horizon increases, expectations converge to the RBA's target band by the end of two years ahead (Figure 10).

Figure 10 RBA's forecasts of headline inflation in Australia over different time horizons (%)



Note: Each line reflects the respective December-ended forecast. The horizontal axis shows forecast horizons from eight quarters ahead (i.e. forecasts made eight quarters before the end of the year being forecast) to one quarter ahead.

Sources: RBA, Statement on Monetary Policy, various issues; QCA analysis.

Studies into impact of prolonged low inflation

Several studies have assessed the implications of a low inflationary environment for the anchoring of expectations, including:

- Moessner and Takats[178] used survey data on inflation expectations across countries and over time to conclude that persistent deviations of inflation from target affect long-term expectations, with periods where inflation is persistently above target having a greater impact than periods where inflation is persistently below target.[179]

[175] AER, *Regulatory treatment of inflation,* final position paper, December 2017, p. 14; Deloitte Access Economics, *Review of the regulatory treatment of inflation,* prepared for the AER, 2020, pp. 23–24.

[176] That is, the implied 3-year-ahead forward rate tended to be within the target range in all these instances.

[177] AJ Mehrotra and J Yetman, 'Decaying expectations: what inflation forecasts tell us about the anchoring of inflation expectations', *International Journal of Central Banking*, 56th issue, December 2018, pp. 55–101.

[178] R Moessner and E Takats, *How well anchored are long term inflation expectations?*, working paper no. 869, Bank for International Settlements, 2020.

[179] Moessner and Takats hypothesised that if long-term expectations did not react to short-term expectations (i.e. shocks that affected short-term expectations did not influence expectations over long horizons), and deviations of

- Ehrmann[180] found that under persistently low inflation, some de-anchoring of expectations occurs, compared to situations where inflation is around target.[181]
- Yetman observed that recent periods of low inflation had been correlated with decreased effects of short-term expectations on long-term expectations, concluding that long-term expectations remain well anchored in periods of low inflation.[182]

Table 12 summarises these studies.

Table 12 Summary of evidence for the anchoring of longer-term inflation expectations

Study	*Measure*	*Methodology*	*Time period*	*Horizon*	*Result*
Hambur and Finlay (2018)	Break-even inflation (adjusted to remove risk premia)	Separated risk premia from the 'pure' expectations component is using an affine term structure model.	1993–2016	3, 5 and 10 years ahead	Inflation expectations have remained within the RBA's target band and have been more stable than suggested by other measures such as break-even inflation.
Cassidy et al. (2019)	Long-term trend measure using survey and market-based measures	Derived a 'trend' measure that extracts inflation expectations from various measures after controlling for each measure's co-movement with recent inflation.	1993–2019	All horizons	This produces a fairly flat long-run trend series that aligns closely with the midpoint of the RBA's target range.
AER (2017) and Deloitte Access Economics (2020)	Survey-based forecasts from Consensus Economics	Assessed how long it took for expected inflation to return to the RBA's target range in instances where initial expectations differed from the midpoint of the target range in either direction.	2001–2020	1 to 10 years ahead	Expected inflation returned to the RBA's target range at horizons of 3 years ahead in all instances.
Analysis based on Mehrotra and Yetman (2018)	RBA inflation forecasts	Considered the behaviour of inflation expectations over different horizons from two years ahead to a quarter ahead.	2012–2020	1 to 8-quarters ahead	Inflation expectations at forecast horizons of 2 years ahead tended to converge on the RBA's target range.
McKibbin and Panton (2018)	10-year break-even inflation rate	Tested the hypothesis, using time series data, that there is no strong relationship between long-term inflation expectations and actual inflation (i.e. that long-term expectations are anchored	1994–2017	10 years ahead	Incomplete anchoring in the shorter-term (i.e. less than a year) but stronger anchoring over time.

long-term expectations from target did not respond to deviations of short-term expectations from target, then long-term expectations were well anchored at target.

[180] M Ehrmann, 'Targeting inflation from below: how do inflation expectations behave?', *International Journal of Central Banking*, vol. 11, no. 4, 2015, pp. 213–49.

[181] Specifically, the study found that expectations become more dependent on lagged inflation, forecasters tend to disagree more in their expectations, and expectations get revised downwards in response to lower-than-expected inflation, but expectations do not respond to higher-than-expected inflation.

[182] J Yetman, *Pass-through from short-horizon to long-horizon inflation expectations, and the anchoring of inflation expectations*, working paper no. 895, Bank for International Settlements, 2020.

Study	*Measure*	*Methodology*	*Time period*	*Horizon*	*Result*
		within the RBA's inflation target range).			
Gillitzer and Simon (2015)	Survey-based forecasts from Consensus Economics	Considered the impact of 'inflation surprises' (i.e. changes in actual inflation between the March and September quarters) on inflation expectations, using time series data.	1991–2013	5 years ahead	Expectations have been well anchored since 2000, exhibiting no significant reaction to 'inflation surprises'.
Moessner and Takats (2020)	Survey-based forecasts from Consensus Economics	Tested the hypothesis, using semi-annual time series data for emerging and advanced economies, that deviations of long-term expectations from target are not affected by deviations of short-term expectations from target.	1994–2019	1 year ahead; 6 to 10 years ahead	Persistent deviations of inflation from target affect long-term expectations. Periods where inflation is persistently above target have a greater impact than periods where inflation is persistently below target.
Ehrmann (2015)	Survey-based forecasts from Consensus Economics	Tested: • the dependence of expectations on realised inflation, using panel data and dummy variables to control for periods with persistently high or low inflation • extent of forecaster disagreement (proxied by the inter-decile range of forecasts over the relevant horizon) in periods of low or high inflation • the impact of inflation surprises on expectations.	1990–2014	1 year ahead and 2 years ahead	Expectations become more dependent on lagged inflation; forecasters tend to disagree more in their expectations; and expectations get revised downwards in response to lower-than-expected inflation but do not respond to higher-than-expected inflation.
Yetman (2020)	Survey-based forecasts from Consensus Economics	Considered the impact of changes in short-term expectations on changes in longer-term expectations using panel data.	1995–2020	1 year ahead, 2 years ahead and 6 to 10 years ahead	Periods of low inflation are correlated with a decreased effect of short-term expectations on long-term expectations.

Sources: J Hambur and R Finlay, Affine Endeavour: Estimating a Joint Model of the Nominal and Real Term Structures of Interest Rates in Australia, research discussion paper 2018-02, RBA, 2018; Cassidy, N, Rankin, E, Read, M, and Seibold, C, 'Explaining Low Inflation Using Models', Bulletin, RBA, June 2019; WJ McKibbin and AJ Panton, Twenty-five Years of Inflation Targeting in Australia: Are There Better Alternatives for the Next 25 Years?, working paper no. 41, Hutchins Centre on Fiscal and Monetary Policy at Brookings, July 2018; C Gillitzer and J Simon, 'Inflation targeting: A victim of its own success?', International Journal of Central Banking, vol. 11, no. S1, September 2015; AER, Regulatory treatment of inflation, final position paper, December 2017; Deloitte Access Economics, Review of the regulatory treatment of inflation, prepared for the AER, 2020; AJ Mehrotra and J Yetman, 'Decaying expectations: what inflation forecasts tell us about the anchoring of inflation expectations', International Journal of Central Banking, 56th issue, December 2018; R Moessner and E Takats, How well anchored are long term inflation expectations?, working paper no. 869, Bank for International Settlements, 2020; M Ehrmann, 'Targeting inflation from below: how do inflation expectations behave?', International Journal of Central Banking, vol. 11, no. 4, 2015; J Yetman, Pass-through from short-horizon to long-horizon inflation expectations, and the anchoring of inflation expectations, working paper no. 895, Bank for International Settlements, 2020.

APPENDIX E: MARKET-BASED MEASURES—BIASES AND DISTORTIONS

Bond break-even method

The bond break-even method uses bond yield data to estimate expected inflation. The break-even inflation rate is derived by applying the Fisher equation[183] to the yields to maturity of nominal and inflation-indexed ('indexed') Treasury bonds with the same maturity dates.

Break-even inflation estimates can generally be replicated by stakeholders, as bond yield data is publicly available on the RBA website. However, the break-even inflation estimate assumes that potential risk premia, biases and distortions are not significant.

Specifically, the underlying assumptions of the break-even inflation method include:

- Investors are indifferent to inflation risk on nominal bonds.
- Nominal and indexed bonds have the same liquidity.
- Nominal and indexed bonds are available with the same maturity dates.
- Inflation-indexed bonds compensate for inflation over the period from the current point in time until their maturity (i.e. there are no lags).

The most significant of these assumptions for the robustness of the estimates of expected inflation are the first two—that is, investors are indifferent to inflation risk on nominal bonds, and nominal and indexed bonds have the same liquidity.

Nominal bonds carry inflation risk, which indexed bonds do not. Investors care about their real, not nominal, returns on a bond. Therefore, nominal bonds are risky, because their real return depends on the actual inflation rate that occurs during the relevant period. It is therefore commonly assumed that nominal bonds have an inflation risk premium. The inflation risk premium reflects that an investor who is risk-averse would require a risk premium on nominal bonds, as compared to indexed bonds, to be indifferent about the two.

In addition, the market for indexed bonds is significantly smaller than that for nominal bonds, in both supply and turnover terms.[184] As a result of lower relative liquidity, the liquidity risk premium on indexed bond yields reflects the increased risk of these bonds, to the extent that investors are less certain of selling the bonds quickly without affecting the price. This premium reflects investors' expectations of future liquidity of indexed bonds relative to comparable nominal bonds.

The inflation and liquidity risk premia will therefore contribute to a difference between the break-even inflation rate and inflation expectations. These risk premia are generally thought to counteract each other. However, while the inflation risk premium is generally assumed to be positive, studies indicate that this risk premium varies over time and can sometimes be negative.[185] The relative liquidity premium can also vary

[183] The Fisher equation outlines the relationship between the nominal interest rates, expected inflation and real interest rates. The equation can be written as $(1+i) = (1+r)(1+\pi)$ where *i* is the nominal interest rate, *r* is the real interest rate and π is the inflation rate.

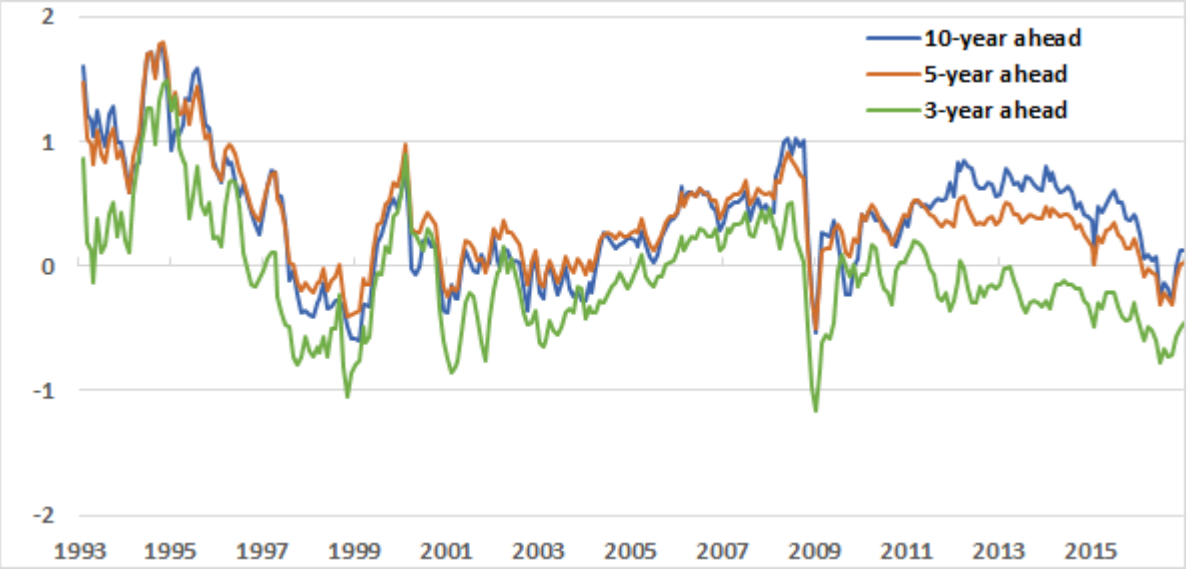
[184] AOFM, *Annual Report 2019–20*, 2020, pp. 48–49.

[185] If investors have greater concerns about the downside risks of inflation, they may be willing to pay a premium to hold nominal bonds resulting in a negative inflation risk premium. In this case, an estimate of expected inflation using the break-even method will be biased down. See, for example, empirical estimates of inflation risk premium over time in D Kim, C Walsh and M Wei, 'Tips from TIPS: Update and Discussions', *FEDS Notes*, Board of Governors of the Federal Reserve System, Federal Reserve website, 21 May 2019; Z Liu, E Vangelista, I Kaminska and J Relleen, *The informational content of market-based measures of inflation expectations derived from government bonds and inflation swaps in the United Kingdom*, staff working paper no. 551, Bank of England, 2015.

over time; for instance, it may rise due to increased risk aversion, with investors preferring to hold more liquid assets.[186]

In our view, the most relevant Australian research in quantifying the level of risk premia over time is RBA studies that decompose total risk premia from inflation expectations. Hambur and Finlay used a model-based approach to decompose break-even estimates between inflation expectations and risk premia.[187] Figure 11 shows the volatility of the estimated net impact of the inflation and liquidity risk premia in Australia over time for varying time horizons.[188]

Figure 11 Inflation risk premium (including illiquidity effects) in Australia (%)



Note: These estimates incorporate other effects including the liquidity premium and inflation indexation lag.

Source: J Hambur and R Finlay, Affine Endeavour: Estimating a Joint Model of the Nominal and Real Term Structures of Interest Rates in Australia, research discussion paper 2018-02, RBA, 2018, p. 21.

International studies have decomposed the inflation risk premium from other quantifiable effects including the liquidity risk premium and the lag between actual inflation and the compensation from indexed bonds (i.e. inflation indexation lag). However, estimates of inflation risk premia differ substantially across different studies depending on the model structure, input data and treatment of the liquidity premium and other effects.[189] For example, some studies use a term structure model that uses nominal and indexed US Treasury bond yields with a modelled liquidity factor to decompose other effects, including the liquidity risk premium,[190] while other studies use inflation swap rates and do not explicitly derive a liquidity premium.[191]

The above studies show that the inflation risk premium for a given term can vary substantially over time; however, there is no consensus on the appropriate estimate. In addition, inflation risk premium estimates

[186] W Devlin and D Patwardhan, 'Measuring market inflation expectations', *Economic Roundup issue 2*, The Treasury, Australian Government, 2012.

[187] J Hambur and R Finlay, *Affine Endeavour: Estimating a Joint Model of the Nominal and Real Term Structures of Interest Rates in Australia*, research discussion paper 2018-02, RBA, 2018.

[188] J Hambur and R Finlay, *Affine Endeavour: Estimating a Joint Model of the Nominal and Real Term Structures of Interest Rates in Australia*, research discussion paper 2018-02, RBA, 2018, pp. 20–21.

[189] A Kupfer, 'Estimating inflation risk premia using inflation-linked bonds: a review', *Journal of Economic Surveys*, vol. 32, no. 5, 2018, pp. 1326–54.

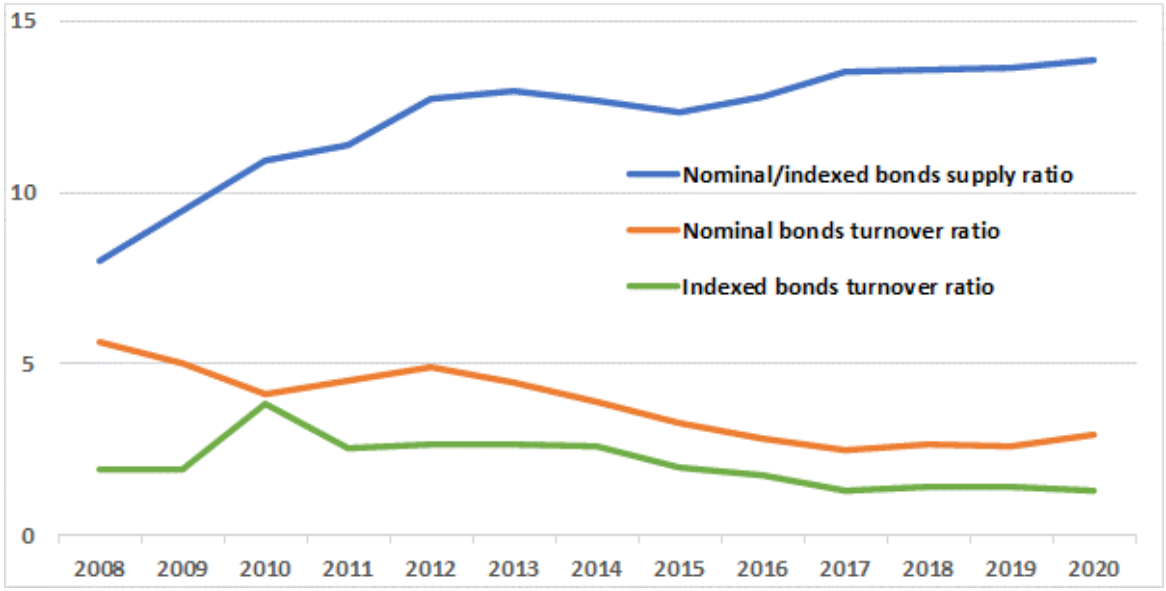
[190] S D'Amico, D Kim and M Wei, *Tips from TIPS: the Informational Content of Treasury Inflation-Protected Security Prices*, working paper no. 2014-024, Finance and Economics Discussion Series, Federal Reserve Board, Washington DC, 2014.

[191] J Haubrich, G Pennacchi and G Ritchken, 'Inflation expectations, real rates, and risk premia: evidence from inflation swaps', *The Review of Financial Studies*, vol. 25, no. 5, May 2012, pp. 1588–629, doi. 10.193/rgs/hhs003.

for Australia are not currently available. We consider that inflation risk premia may vary from country to country, and the exact quantum of an Australian inflation risk premium would need to be empirically determined to consider any adjustments.

While the supply of indexed bonds has increased in recent times, the ratio of the supply of nominal bonds to the supply of indexed bonds has slowly increased in recent years (Figure 12). The turnover ratio of nominal bonds has also remained substantially higher than that of indexed bonds in recent years. The Australian Office of Financial Management (AOFM) noted that the indexed bond market remains consistently less liquid than the market for nominal bonds, with this driven primarily by a narrower investor base (generally fund managers with long-dated liabilities who tend to 'buy and hold') and fewer active price makers.[192]

Figure 12 Nominal and indexed Treasury bond markets (ratio)



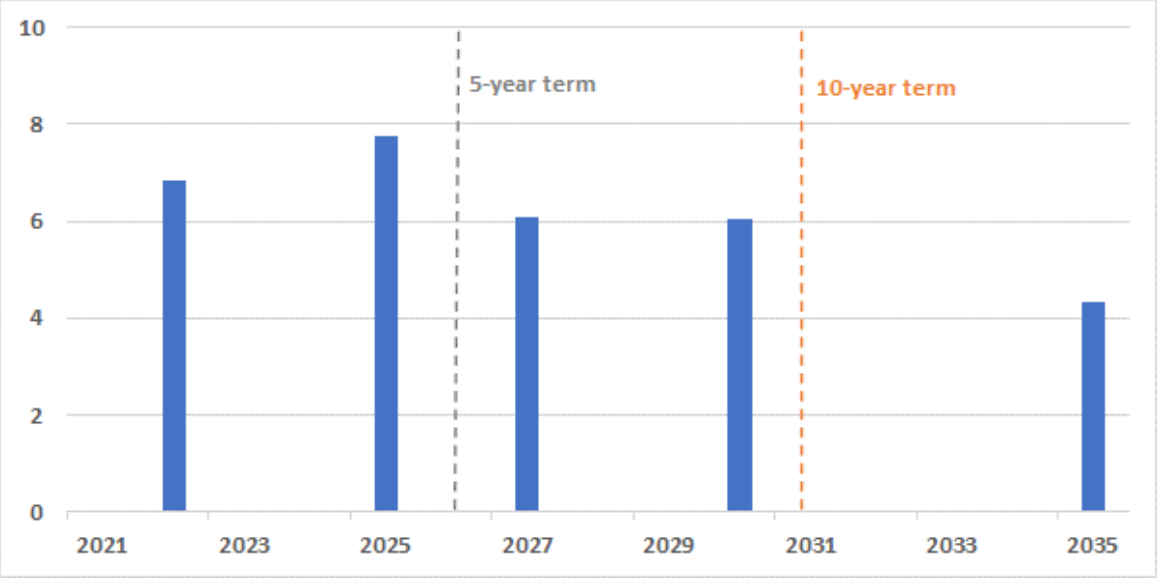
Notes: The supply of nominal and indexed bonds reflects the face value of bonds outstanding, derived as the average of monthly data on Australian Government securities for the particular financial year. Turnover ratio is derived as the annual turnover divided by the average face value of bonds outstanding in that financial year.

Sources: AOFM, Australian Financial Markets Report, various: 2012–2017; AOFM, Data Hub, AOFM website, n.d., accessed 9 July 2021.

In addition to the effects of inflation and liquidity risk premia, measurement errors also arise due to the relatively fewer issuances of Treasury indexed bonds. Nominal and indexed bonds with closely comparable maturity dates are required to calculate the break-even inflation rate. However, while nominal bonds are generally issued with biannual maturity dates, the frequency of maturity dates is much less frequent for indexed bonds (Figure 13).

[192] AOFM, 'The role of Treasury Indexed Bond's, issue 7, *AOFM Investor Insights*, 2021.

Figure 13 Treasury indexed bonds maturing 2021–2035, face value at 30 June 2021 ($ billion)



Source: Australian Office of Financial Management, Data Hub, AOFM website, n.d., accessed 9 July 2021.

The break-even inflation estimate will therefore depend on yield curve assumptions underlying the interpolation method. While we generally use a linear interpolation approach when deriving nominal risk-free rate estimates, this approach may be less effective for deriving the yield on indexed bonds given maturity dates are typically separated by three to five years.

There are also lags between actual movements in CPI and adjustments of the cash flows associated with indexed bonds. Treasury indexed bonds have a three-month indexation lag. Finlay and Wende observed that because indexed CGS are indexed with a lag, indexed CGS yields also reflect historical inflation, not just future expected inflation.[193]

Attempting to correct for these potential biases would introduce increased complexity.

Inflation swap method

In an inflation swap, counterparties agree to exchange payments that are linked to the predetermined fixed inflation rate and the actual inflation rate. The fixed rate of an inflation swap can provide a market-based estimate of long-term headline CPI inflation expectations. For example, the 10-year inflation swap rate measures the average inflation over the next 10 years.

Inflation swaps are over-the-counter transactions between two counterparties, with prices for zero coupon inflation swaps published by some third-party information vendors (such as Bloomberg). Inflation swaps reflect the fixed inflation rate a dealer is willing to pay (bid rate) or receive (ask or offer rate) on a notional principal amount at the maturity of the contract. The midpoint of these two rates (the midrate) can be interpreted as a forecast of inflation. Prices are quoted for a range of terms including one to 10 years[194], allowing implied one-year forward inflation rates to be derived for short-, medium- and long-term inflation expectations.

Inflation swaps, like break-even inflation, are likely to be impacted by an inflation risk premium that varies over time. As noted previously, this premium is generally positive, reflecting compensation required by the inflation payer for potential volatility in actual inflation over the term of the inflation swap. However, in

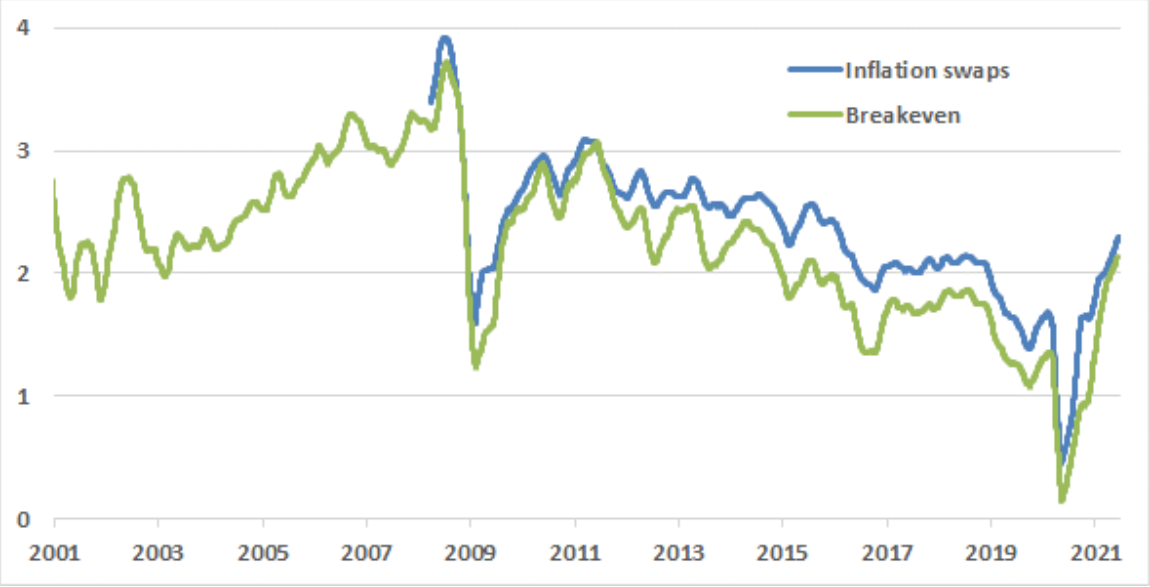
[193] R Finlay and S Wende, *Estimating Inflation Expectations with a Limited Number of Inflation-Indexed Bonds*, research discussion paper 2011-01, RBA, 2011, pp. 19–20.
[194] Australian Financial Market Association (AFMA), *Inflation Product Conventions*, 2017, p. 3.

recent years, this premium has likely been negative at times, reflecting compensation required by inflation receivers for the downside risk that may result in them paying the net cash flow at the maturity of the swap.

As noted in Australian studies[195] and overseas studies[196], when compared against indexed bond yields, inflation swap rates are likely to be significantly less affected by a liquidity premium. QTC also noted that the liquidity premium on inflation swaps in Australia was likely to be positive because the inflation swap market here was one-sided; most investors wanting to pay fixed inflation and receive actual inflation. As a result, the swap counterparty will usually require a premium to take the other side of the more popular trade.[197]

Figure 14 shows our estimates of five-year inflation expectations from inflation swaps and bond yield data over the past 20 years. Inflation expectations from inflation swaps are, on average, around 0.3 per cent higher than break-even inflation estimates. This is mainly due to the higher relative liquidity premia that downwardly biases break-even estimates. This figure also shows the higher volatility of these estimates during the global financial crisis and covid-19 outbreak in 2008 and 2020, when there were large reductions that were not in line with other measures of inflation expectations.

Figure 14 Market-based estimates of 5-year inflation expectations (%)



Note: Market-based estimates are derived based on a 40-day averaging period.

Sources: Bloomberg; RBA, Statistical Tables, RBA: F16—Indicative Mid Rates of Australian Government Securities; QCA analysis.

In addition, because of a relatively low market turnover and few market participants, the prices quoted may not reflect the broader view of inflation expectations.[198] Since the Australian Financial Markets Association (AFMA) discontinued its survey methodology in 2016[199], it has not publicly reported turnover information on the Australian inflation swaps market. However, AFMA has commented on poor liquidity in inflation

[195] A Moore, 'Measures of Inflation Expectations in Australia', *Bulletin*, RBA, December 2016, p. 28.
[196] J Haubrich, G Pennacchi and G Ritchken, 'Inflation expectations, real rates, and risk premia: evidence from inflation swaps', *The Review of Financial Studies*, vol. 25, no. 5, May 2012, p. 1600, doi. 10.193/rgs/hhs003; Z Liu, E Vangelista, I Kaminska and J Relleen, *The informational content of market-based measures of inflation expectations derived from government bonds and inflation swaps in the United Kingdom*, staff working paper no. 551, Bank of England, 2015, pp. 8–9.
[197] QTC, sub. 5, pp. 10–11.
[198] A Moore, 'Measures of Inflation Expectations in Australia', *Bulletin*, RBA, December 2016, pp. 29–30.
[199] AFMA, *2016 Australian Financial Markets Report*, 2016, p. 1.

swaps in its recent annual reports, noting that thin liquidity and ambivalent trading conditions had inhibited two-way price formation by market makers.[200] Overall, it is difficult to quantify the distorting impact of this lack of market representation and associated liquidity effects on the implied estimate of inflation expectations.

Other possible biases or distortions mentioned in the literature include:

- hedging costs—there may be greater demand for investors looking to buy inflation protection (i.e. pay fixed inflation and receive actual inflation) than for investors selling inflation protection. Inflation protection sellers may need to hedge their short exposure by taking short and long positions in nominal and indexed bonds, respectively.[201] However, while the ask/offer rate may be affected, the closing midrate values quoted are less so.
- inflation indexation lag—the swap contract is referenced to actual inflation for a fixed-term period that starts at a specific quarterly date, which can be before or after the inception date, depending on the time of year of the transaction.[202]

These issues make it difficult to infer the level or movements in inflation expectations.

[200] AFMA, *Annual Report 2018*, p. 18; AFMA, *Annual Report 2019*, n.d., p. 17; AFMA, *Annual Report 2020*, n.d., p. 18.
[201] H Mathysen, *Best estimates of expected inflation: a comparative assessment of four methods*, working paper no. 11, ACCC/AER working paper series, 2017, pp. 77–80.
[202] AFMA, *Inflation Product Conventions*, 2017, p. 3.

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