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Electricity Distribution Price Review 2022-26

Appendix 10B: AER's Approach To Forecasting Labour Escalation Rates

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ASSESSMENT OF THE AER'S APPROACH TO FORECASTING LABOUR ESCALATION RATES

A REPORT PREPARED FOR AUSNET SERVICES,
CITIPOWER, JEMENA, POWERCOR AND UNITED ENERGY

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1 EXECUTIVE SUMMARY

1.1 Background

The Australian Energy Regulator (AER) uses a base-step-trend approach to set operating expenditure (opex) allowances for the businesses it regulates. The trend component of the opex allowance is determined, in part, using forecasts of real labour cost escalation rates.

Since 2013, the AER has combined forecasts of labour cost escalation rates produced by different forecasters.¹ In a number of very recent decisions, the AER has averaged the forecasts produced by Deloitte Access Economics (DAE) and BIS Oxford Economics (BIS).²

On 8 October 2019, the AER released its Draft Decision for SA Power Networks' (SAPN's) 2020-25 regulatory control period. In that Draft Decision, the AER evaluated the forecasting performance of DAE and BIS by comparing their past forecasts against the Wage Price Index (WPI) outturns for the Electricity, Gas, Water and Waste Services (EGWWS) sector published by the Australian Bureau of Statistics (ABS). The AER concluded that the forecasts of its own adviser, DAE, aligned more closely to WPI outturns than did forecasts prepared by BIS, and on that basis chose to rely exclusively on DAE's forecasts for the purposes of determining real labour cost escalation rates in the SAPN Draft Decision.³ By doing so, the AER departed from the approach it has used in decisions since 2013.

In its analysis, the AER compared the forecasters' projections to outturns of the WPI Australia, rather than a South Australian WPI—notwithstanding that the AER's longstanding approach is to set labour cost escalation allowances using jurisdiction-specific data. The AER stated that it could not use jurisdiction-specific data in SAPN's case because the ABS does not publish a South Australian WPI. The AER therefore assumed in its Draft Decision for SAPN that its analysis of forecast performance against the national WPI could be extrapolated to a jurisdictional level.

1.2 Our instructions

We have been engaged by Ausnet Services, CitiPower, Jemena, Powercor and United Energy to advise whether the AER's decision to abandon its previous approach of combining forecasts from different sources is reasonable. We have been asked, when preparing our advice, to:

- Assess the accuracy of DAE's and BIS's past forecasts of the rate of change in the EGWWS WPIs for Victoria and for Australia;
- Assess the strengths and weaknesses of the methodology used by the AER to validate the forecasting accuracy DAE and BIS in the SAPN Draft Decision; and
- Consider the strengths and weaknesses of alternative methodologies for validating forecasting accuracy.

¹ For example: Ausgrid Final Decision 2014-19, April 2015, Attachment 7, p. 28.

² For example: Ausgrid Draft Decision 2019-24, April 2019, Attachment 6, p. 37.

³ SAPN Draft Decision 2020-25, October 2019, Attachment 6, p. 6.

1.3 Key findings

In this study, we conclude that the AER's decision to rely exclusively on the forecasts of labour cost escalations produced by a single adviser, rather than follow its previous approach of averaging forecasts produced by different advisers, is unreasonable. The AER should revert to the practice it has followed since 2013 and adopt the average of forecasts produced by different advisers when setting real labour cost escalation rates.

Combined forecasts are likely to be more accurate than individual forecasts

- There is a significant body of forecasting literature that concludes that forecast accuracy can be improved substantially by combining forecasts from different sources. The AER has accepted this in past decisions.
- The forecasting literature shows that a less accurate forecast may still lead to an improvement in the performance of the more accurate forecast when the forecasts are combined. For example, a well-known review of the forecasting literature concludes that:⁴

The results have been virtually unanimous: combining multiple forecasts leads to increased forecast accuracy. In many cases one can make dramatic performance improvements by simply averaging the forecasts.

- This is because even the more accurate forecast will involve some errors (unless the forecast is perfect each time). Combining that forecast with another forecast (even if less accurate) may result in an improvement in accuracy, because the errors associated with each forecast may (to some extent) offset one another, as long as the errors are not perfectly positively correlated.

The AER should not rely on DAE forecast alone

- There is no evidence that DAE has been a more accurate forecaster of the real EGWWS WPI for Victoria than BIS.⁵ To the contrary, BIS appears to have been the more accurate forecaster—the empirical evidence shows that BIS's forecasts of the real growth in the Victorian EGWWS WPI have greater accuracy than DAE's forecasts. That suggests that discarding BIS's forecasts for Victoria would be inappropriate.
- Even if the findings were reversed, and BIS were shown to be a less accurate forecaster than DAE, that alone would not justify exclusive reliance on DAE's forecasts as the AER has done in the 2019 SAPN Draft Decision. The empirical evidence indicates that, in the past, both DAE and BIS have forecast real growth rates in labour cost escalation rates with error (at both the jurisdiction and national level).
- For Victoria, the evidence suggests that the average of DAE's and BIS's past forecasts would have resulted in more accurate outcomes than exclusive reliance on either of those advisers' forecasts individually.

⁴ Clemen, R. (1989), Combining forecasts: A review and annotated bibliography with discussion, *International Journal of Forecasting* 5(4), 559–583.

⁵ We focus on real growth forecasts in this study because the AER sets real labour cost escalation rates. The AER explained in the 2019 SAPN Draft Decision that it considers the accuracy of real WPI forecasts to be more relevant than the accuracy of nominal WPI growth forecasts, since the AER uses real WPI growth forecasts to set opex allowances. See: SAPN Draft Decision 2020-25, October 2019, p. 31.

The AER should not use national data as a proxy for jurisdictional forecasts

- The results of assessments of forecasting accuracy at the national level do not necessarily apply at the jurisdiction level. Our findings contradict directly the AER's assertion in the 2019 SAPN Draft Decision that: "In the absence of South Australian specific data, we consider the forecasting performance at the national level is indicative of the consultants' performance at the state level."⁶ Therefore, the AER should not set labour cost escalation rates using forecasts of the real growth in the EGWWS WPI for the whole of Australia.

1.4 Structure of this report

The remainder of this report is structured as follows:

- Section 2 explains the regulatory and theoretical case for averaging forecasts from different sources;
- Section 3 summarises how the AER's treatment of competing forecasts has evolved over time; and
- Section 4 describes the methodology and data we have relied on in this study to test DAE's and BIS's forecasting accuracy, and presents our empirical findings.

⁶ SAPN Draft Decision 2020-25, October 2019, p. 32.

2 THE CASE FOR COMBINING FORECASTS

2.1 The regulatory task

The AER's role is to set opex allowances for regulated business over a regulatory control period by assessing the forecasts of opex submitted by those businesses. The National Electricity Rules (NER) require that the forecast opex for a regulatory control period submitted by a Distribution Network Service Provider (DNSP) should be the amount required in order to achieve each of the following *opex objectives*:⁷

- (1) meet or manage the expected demand for standard control services over that period;*
- (2) comply with all applicable regulatory obligations or requirements associated with the provision of standard control services;*
- (3) to the extent that there is no applicable regulatory obligation or requirement in relation to:*
 - (i) the quality, reliability or security of supply of standard control services; or*
 - (ii) the reliability or security of the distribution system through the supply of standard control services, to the relevant extent;*
 - (iii) maintain the quality, reliability and security of supply of standard control services; and*
 - (iv) maintain the reliability and security of the distribution system through the supply of standard control services; and*
- (4) maintain the safety of the distribution system through the supply of standard control services.*

Under the NER, the AER must accept the forecast of required opex submitted by a DNSP if the AER is satisfied that it reasonably reflects the following *opex criteria*:⁸

- (1) the efficient costs of achieving the operating expenditure objectives;*
- (2) the costs that a prudent operator would require to achieve the operating expenditure objectives; and*
- (3) a realistic expectation of the demand forecast and cost inputs required to achieve the operating expenditure objectives.*

In summary, the NER requires that the opex allowances set by the AER be the efficient, prudent and realistic costs required in order to meet the NER's opex objectives. In our view, this means that the

⁷ NER, Rule 6.5.6(a).

⁸ NER, Rule 6.5.6(c).

forecasts labour cost escalation rates adopted by the AER should be as accurate as possible. The question then is, what is the best method of obtaining the most accurate forecasts of labour cost escalation rates? We address this question in the remainder of this section.

2.2 Why combine forecasts from different sources?

In 1969, Bates and Granger put forward theoretical arguments and empirical evidence indicating that combining forecasts can often improve forecast accuracy.⁹ The intuition underlying this proposal was that the variance of a weighted average of different variables is often smaller than the variance of any of the individual variables. For example, if we consider two different forecasts for the same variable, and if the forecasts are unbiased and have the same variance, then the combined forecast (i.e. the average of the forecasts) is always better than the individual forecasts. If the errors of the two forecasts are uncorrelated, then the mean square error (MSE) of the combined forecast will be only half as large as the MSE of the individual forecasts.¹⁰ The more negatively the errors of the two forecasts are correlated the better the performance of the combined forecast becomes.

A comprehensive discussion of the theory underpinning the combination of forecasts was provided in 2006 by Timmermann.¹¹ The conditions he derived for when the combination of forecasts is better than either of the individual forecasts are quite complex and depend on a range of factors—e.g., the bias and variance of the two sets of forecasting errors, their correlation, and the sets of data used by the forecasts. The performance of the combined forecast vis-à-vis the individual forecasts also depends on whether there is structural change in the data series.

There is strong empirical evidence in favour of combining forecasts. A review of the literature published 20 years after the Bates-Granger paper of the literature found that:¹²

The results have been virtually unanimous: combining multiple forecasts leads to increased forecast accuracy. In many cases one can make dramatic performance improvements by simply averaging the forecasts.

In 2001, Armstrong noted that:¹³

[C]ombining is especially relevant when there is uncertainty about the method or situation and when it is important to avoid large errors.

And Timmermann concluded that:¹⁴

⁹ Bates, J. & C. Granger (1969), The combination of forecasts, *Operational Research Quarterly* 20(4), 451–68.

¹⁰ The mean square error is the sum of the squares of the forecasting errors.

¹¹ Timmermann, A. (2006), Forecast Combinations, in *Handbook of Economic Forecasting*, Vol 1, 135–196.

¹² Clemen, R. (1989), Combining forecasts: A review and annotated bibliography with discussion, *International Journal of Forecasting* 5(4), 559–583.

¹³ Armstrong (ed.) (2001), *Principles of Forecasting: A Handbook for Researchers and Practitioners*, p.434.

¹⁴ Timmermann, A. (2006), Forecast Combinations, in *Handbook of Economic Forecasting*, Vol 1, p.182.

Choosing the single forecast with the best track record is often a bad idea

Many studies have found that combination dominates the best individual forecast in out-of-sample forecasting experiments. For example, Makridakis et al. (1982) report that a simple average of six forecasting methods performed better than the underlying individual forecasts. In simulation experiments Gupta and Wilton (1987) also find combination superior to the single best forecast. Makridakis and Winkler (1983) report large gains from simply averaging forecasts from individual models over the performance of the best model. Hendry and Clements (2002) explain the better performance of combination methods over the best individual model by misspecification of the models caused by deterministic shifts in the underlying data generating process.

The AER has previously recognised that there exists a significant body of literature that concludes that forecast accuracy can be improved substantially by combining forecasts from different sources. For example, when the AER compared the accuracy of DAE's and BIS's forecasts in 2012, the AER concluded that:¹⁵

The AER found that for the six forecast series included in the analysis the average forecast had the lowest mean absolute error on three occasions, Deloitte Access Economics' forecasts on two and BIS Shrapnel's once. This result is consistent with a significant body of literature concluding forecast accuracy can be substantially improved by combining multiple individual forecasts. It is also consistent with Deloitte Access Economics' finding that its forecasts were too pessimistic but BIS Shrapnel's were too optimistic.

¹⁵ Powerlink Final Decision 2013-17, April 2012, p. 54.

3 THE AER'S TREATMENT OF COMPETING FORECASTS

3.1 The 2012 Powerlink Final Decision

The AER has typically relied on DAE (or Access Economics, prior to 2011) to provide forecasts of labour cost escalation rates. During the Powerlink 2012-17 regulatory reset process, the AER compared DAE's forecasting accuracy to those of BIS. In order to do this, the AER compared the sets of DAE and BIS forecasts submitted in six Queensland Draft or Final Decisions between June 2007 and May 2010.

The AER concluded that for the six sets of forecasts, the forecasts obtained by averaging the individual DAE and BIS forecasts had the lowest mean absolute error on three occasions, DAE's forecasts on two and BIS's forecasts once. The AER concluded that:¹⁶

This result is consistent with a significant body of literature concluding forecast accuracy can be substantially improved by combining multiple individual forecasts.

However, the AER noted that it had only been able to test the accuracy of national (i.e., All Australia) forecasts, since the ABS does not publish outturn EGWS WPI data for Queensland.¹⁷

In its Powerlink Final Decision in April 2012, the AER determined not to use the average of the DAE and BIS forecasts, even though the averaged forecasts appeared to be more accurate than the individual forecasts. This was partly because the AER had been unable to test the accuracy of DAE's and BIS's forecasts for Queensland specifically, and partly due to some concerns expressed by the Australian Competition Tribunal (Tribunal) about averaging economic estimates in certain circumstances.¹⁸

3.2 The 2013 SP AusNet Final Decision

During the SP AusNet 2013-17 Access Arrangement review, SP AusNet submitted that the AER should apply labour cost escalation rates derived by taking an average of forecasts produced by DAE and BIS. This submission was supported by an expert opinion by Professor Jeff Borland, who argued the following:¹⁹

¹⁶ Powerlink Final Decision 2013-17, April 2012, p. 54.

¹⁷ At the time the AER undertook this analysis, the WPI was referred to as the Labour Price Index (LPI). From September 2012 onwards, the ABS discontinued the publication of non-wage and labour price indices. The wage price indices were unaffected by this change and continued to be published. In order to reflect the change in content, the ABS's regular LPI publication was renamed the WPI. See the ABS's Explanatory Notes to the September 2012 issue of the WPI.

¹⁸ The concerns raised by the Tribunal were in the quite different context of using fair value yield curves from different sources to estimate the debt risk premium. That Tribunal noted a previous judgment, which explained that it was appropriate to combine published data from different sources if they "are widely used and market respected." The AER also noted in the 2012 Powerlink Final Decision that in a different judgement, the Tribunal had accepted the averaging of estimates from different models and methodologies.

¹⁹ Professor Jeff Borland, Recommendations for methodology for forecasting WPI: report for Envestra Limited, SP AusNet, APA GasNet and Multinet Gas, October 2012, p. 10.

Each forecast of the change in WPI made by DAE and BIS can be thought of as being equal to the actual change in WPI plus a forecast error. Suppose the forecast error associated with any forecast made by DAE and BIS is regarded as being 'independent'; that is, knowing the forecast error made by DAE does not provide information about what the forecast error made by BIS is likely to be (and vice-versa). Then it follows that a forecast that is the average of the two forecasts will have a lower expected absolute prediction error than using either of the DAE or BIS forecasts. One way to think of this result is that, because the forecast errors are independent, taking the average of the DAE and BIS forecasts will tend to reduce the average size of the forecast error; that is, the forecast errors offset each other. Hence, the average of the DAE and BIS forecast will be a better estimate of the actual change in WPI. The approach of taking an average, putting equivalent weight on the forecasts made by DAE and BIS, is optimal where it is considered that those forecasts are likely to be associated with equal-sized forecast errors (Bates and Granger, 1969, pages 452-53)... This discussion applies equally to combining forecasts of WPI for Victoria, as to combining forecasts of LPI for Australia.

As part of his opinion, Professor Borland assessed the forecasting accuracy of DAE and BIS individually, and also the accuracy of forecasts derived by taking a simple average of DAE's and BIS's forecasts. Professor Borland concluded that:²⁰

- There was no reason to regard DAE's forecasts as preferable to those of BIS, since the mean absolute error of DAE's and BIS's forecasts were very similar. In the majority of cases, BIS's showed a smaller mean absolute prediction error than those of DAE; and
- In almost all the cases he considered, using the average of the DAE and BIS forecasts was associated with a lower mean absolute prediction error than using either the DAE or BIS forecasts.

In its March 2013 Final Decision on SP AusNet's 2013-17 Access Arrangement, the AER accepted Professor Borland's findings. In doing so, the AER stated that:²¹

For the AER's final decision on real labour cost escalations for opex, the AER considers the average of DAE and BIS Shrapnel's LPI forecasts...represent the best possible forecast of opex in the circumstances and one that is arrived at on a reasonable basis. This reflects both Professor Borland's recommendation that the average is the best labour price measure...

The AER also went on to explain that:²²

²⁰ Professor Jeff Borland, Recommendations for methodology for forecasting WPI: report for Envestra Limited, SP AusNet, APA GasNet and Multinet Gas, October 2012, p. 5.

²¹ SP AusNet Final Decision 2013-17, March 2013, Part 3: Appendices, p. 7.

²² SP AusNet Final Decision 2013-17, March 2013, Part 3: Appendices, p. 7.

...the AER agrees with SP AusNet and Professor Borland that the average of the two forecasts produces a better forecast of the labour price than using either BIS Shrapnel's or DAE's forecast exclusively. This is consistent with the AER's own analysis [in relation to the 2012 Powerlink Final Decision] of six forecast series of LPI where the average had the lowest mean absolute error on three occasions, DAE on two occasions and BIS Shrapnel once.

As far as we are aware, in every decision since (until the 2019 SAPN Draft Decision) the AER has adopted labour cost escalation rates constructed by taking the average between the forecasts of its adviser (DAE, typically) and the forecasts produced by another consultant (BIS, in most instances).

3.3 The 2019 SAPN Draft Decision

In its October 2019 SAPN Draft Decision, the AER decided to re-examine the accuracy of DAE's and BIS's past forecasts of growth rates in the EGWWS WPI. In order to do this, the AER examined real and nominal WPI growth forecasts, spanning the years 2007 to 2018 presented in:

- 18 reports prepared by DAE; and
- 14 reports prepared by BIS.²³

As the ABS does not make public outturn EGWWS WPI data for South Australia, the AER conducted this analysis at the national level, using the Australian indices.

The AER used two measures to test forecasting accuracy:

- Mean absolute error, as it did in 2012 Powerlink Final Decision; and
- Mean error.

The AER found that over the period 2007 to 2018:²⁴

- DAE's real WPI growth forecasts exhibited a lower mean error than BIS's. The AER concluded that this meant that BIS's forecasts had a tendency to overshoot more than DAE's forecasts;
- DAE's real WPI growth forecasts exhibited a smaller mean absolute error than BIS's. The AER concluded from this that DAE's forecasts tended to be closer to the actual WPI than BIS's forecasts;
- DAE's mean error (in relation to real WPI growth forecasts) was significantly lower than its mean absolute error. By contrast, BIS's mean error and mean absolute error were almost the same. The AER concluded from this that DAE had not consistently over-forecast or under-forecast, but that BIS had almost always over-forecast; and
- Both DAE's and BIS's mean error (in relation to nominal WPI growth forecasts) were similar to their respective mean absolute errors. However, DAE's mean errors and mean absolute errors were lower than those of BIS. The AER concluded from this that both advisers had consistently over-forecast on a nominal basis, with DAE over-forecasting less than BIS.

²³ The AER noted in the 2019 SAPN Draft Decision that it had examined growth forecasts from 16 reports prepared by BIS. However, Table A6.1 in the 2019 SAPN Draft Decision presented forecasts from just 14 BIS reports. See SAPN Draft Decision 2020-25, October 2019, pp. 59-60.

²⁴ SAPN Draft Decision 2020-25, October 2019, p. 32.

Notably, the AER did not test (as it had done in the 2012 Powerlink Final Decision) whether the average of DAE's and BIS's forecasts performed better than the forecasts produced DAE or BIS individually.

The AER acknowledged in the 2019 SAPN Draft Decision that, due to lack of data, it had been unable to test the accuracy of DAE's and BIS's WPI growth forecasts for South Australia. The AER asserted, without providing any supporting evidence, that:²⁵

In the absence of South Australian specific data, we consider the forecasting performance at the national level is indicative of the consultants' performance at the state level.

The AER decided, on the basis of its findings, that it would rely exclusively on DAE's forecasts. In doing so, the AER departed from the approach it has used consistently since 2013. The approach the AER has taken to reach this decision is also inconsistent with the advice given by Timmermann in his comprehensive discussion of the theoretical underpinnings for combining forecasts. Timmermann advises that:²⁶

Simple tests of whether one forecast dominates another forecast are neither sufficient nor necessary for settling the question of whether or not to combine...What is called for more generally is a test of whether one forecast – or a set of forecasts – encompasses all information contained in another forecast (or sets of forecasts).

²⁵ SAPN Draft Decision 2020-25, October 2019, p. 32.

²⁶ Timmermann, A. (2006), Forecast Combinations, in *Handbook of Economic Forecasting*, Vol 1, p.157.

4 ASSESSMENT OF DAE AND BIS FORECASTS

In this section we assess the accuracy of DAE's and BIS's forecasts of the real growth rates in the EGWWS WPI, for Victoria and at the Australian level. We then explain how to interpret these findings for the purposes of setting opex allowances.

4.1 Overview of our approach to assessing forecasting accuracy

We approach the task of assessing the accuracy of DAE's and BIS's past forecasts using broadly the same approach used by the AER in the 2019 SAPN Draft Decision. That is, we:

- identify forecasts of the growth in real EGWWS WPI produced by DAE and BIS in the past; and
- then compare those forecasts to outturns of the real EGWWS WPI using a number of commonly-used statistical measures for assessing the accuracy of forecasts.

The AER determines real labour cost escalation rates. Therefore, the AER should be primarily concerned with the accuracy of forecasts of the real growth in labour costs. The AER acknowledged this in the 2019 SAPN Draft Determination:²⁷

We note that our 2012 analysis tested the accuracy of the two consultants' nominal WPI growth forecasts. However, we now use the real WPI growth forecasts and consider the accuracy of the real WPI growth forecasts is a more relevant consideration.

Therefore, we focus on testing the accuracy of real EGWWS WPI growth forecasts.

In this study, we improve on the assessment of forecasts undertaken by the AER in the 2019 SAPN Draft Decision in the following ways:

- We assess a larger number of forecasts than was considered by the AER in the 2019 SAPN Draft Decision (see section 4.2.1).
- In the 2019 SAPN Draft Decision, the AER was restricted to considering forecasts at the national level, since the ABS does not publish outturns of the EGWWS WPI for South Australia. However, in this study, we have made comparisons at both the national and jurisdictional level, since the ABS does release data on the EGWWS WPI for Victoria (see section 4.2.2).
- The AER's analysis in the 2019 SAPN Draft Decision failed to account for the fact that some forecasts were made for years ending June (i.e., financial years), others were made for years ending December (i.e., calendar years) and yet others were made for years ending March (i.e., March years). The AER compared all of these forecasts to financial year outturns of the WPI. Nearly all of DAE's forecasts relate to financial years, whereas several of BIS's forecasts relate to either calendar years or March years. This meant that the way in which the AER compared forecasts would, in principle, tend to make BIS's forecasts appear less accurate than they otherwise were, due to a misalignment between

²⁷ SAPN Draft Decision 2020-25, October 2019, p. 31.

the year basis of forecasts and actuals.²⁸ In order to ensure that forecasts are compared to the appropriate actual growth rates, we match forecasts to actuals using the same year basis (see section 4.2.1). We note that during the course of our investigations, we identified several other concerns with the AER's analysis in the 2019 SAPN Draft Decision.²⁹ These errors are documented in Appendix A of this report.

- We use a broader range of appropriate statistical measures for assessing the accuracy of forecast than was considered by the AER in the 2019 SAPN Draft Decision (see section 4.3).
- In the 2019 SAPN Draft Decision, the AER failed to assess whether averaging DAE's and BIS's forecasts would produce more accurate outcomes than DAE's and BIS's forecasts individually—even though the AER did this as part of its analysis in the 2012 Powerlink Final Decision, and considered evidence of this kind in the 2013 SP AusNet Final Decision. We investigate whether averaging DAE's and BIS's forecasts results in more accurate outcomes than DAE's and BIS's forecasts on their own (see section 4.4).

4.2 Data

4.2.1 Forecasts analysed

We analysed forecasts spanning the years 2007 to 2019 presented in:

- 20 reports prepared by DAE (two more than was considered by the AER in the 2019 SAPN Draft Decision); and
- 22 reports prepared by BIS (eight more than was considered by the AER in the 2019 SAPN Draft Decision).

All of the reports we have analysed in this study (which include all of the reports considered by the AER in the 2019 SAPN Draft Decision) are presented in Appendix B. All the reports that we used in this study that were not considered by the AER in the 2019 SAPN Draft Decision are summarised in **Table 4** in Appendix B.

As explained in section 4.1, in the 2019 SAPN Draft Decision, the AER compared forecasts that were made on either a calendar year basis or March year basis to WPI outturn growth rates measured on a financial year basis. In order to ensure that forecasts are compared to the appropriate actual growth rates, we match forecasts to actuals using the same year basis. That is, we ensure that:

- Forecasts relating to financial years are compared to WPI outturns relating to financial years;
- Forecasts relating to calendar years are compared to WPI outturns relating to calendar years; and
- Forecasts relating to March years are compared to WPI outturns relating to March years;

It is reasonable to expect that, in general, the longer the range of a particular forecast, the less accurate that forecast will be. In the 2019 SAPN Draft Decision, the AER did not explain whether it took into consideration the length of time between the year in which the forecast was made and the year to which the forecast applies. However, we note that the AER's approach appeared to limit inclusion of forecasts

²⁸ Under the AER's approach, BIS's forecasts would only appear better than they truly were due to pure chance.

²⁹ Briefly, the concerns we identified include: comparison of calendar year or March year forecasts to financial year outturns (as explained above); in one instance, the AER appears to have used forecasts relating to Victoria instead of forecasts relating to All Australia; data collection/entry errors; and calculation errors. Nearly all of these issues have the effect of making BIS's forecasts appear less accurate.

to six years including the first forecast year.³⁰ We adopt the same approach to limit the impact of forecast staleness. That is, we exclude from our analysis any forecasts that are seven years or more into future.

4.2.2 WPI outturns

We obtained growth rates of nominal WPI using data obtained from the ABS. Specifically, we use quarterly indices for the total hourly rates of pay excluding bonuses, private and public, for the EGWWS industry. The ABS publishes quarterly data on WPI EGWWS outturns for Australia on its website.³¹ Outturn EGWWS WPI data for Victoria for every quarter between September 2008 and September 2019 (inclusive) were obtained via special request from the ABS. We calculated the outturn growth rate in both the Australian and Victorian EGWWS WPI as the percentage change between the average of the four quarters in the relevant year and the average of the four quarters in the preceding year.³²

Our study analyses the accuracy of forecasts of the growth in the real WPIs. We obtained real growth rates by first deflating the average nominal WPI by the average CPI over the same period. That is:

- The real outturn growth rate in the EGWWS WPI for Victoria was calculated by first deflating the nominal EGWWS WPI for Victoria by the average outturn CPI over the same period; and
- The real outturn growth rate in the national EGWWS WPI was calculated by first deflating the nominal Australian EGWWS WPI by the average outturn Australian CPI over the same period.

Consistent with the approach taken by the AER in the 2019 SAPN Draft Decision, we then calculated the real WPI growth rate as the percentage change between the average of the four quarters of the real WPI in the relevant year and the average of the four quarters in the preceding year.

4.3 Statistical measures for assessing forecasting accuracy

In both the 2012 Powerlink Final Decision and the 2019 SAPN Draft Decision, the AER applied the mean error and mean absolute error measures to compare the accuracy of DAE's and BIS's forecasts. However, there are several alternative approaches that could, in principle, be applied. The most commonly-used techniques used in the forecasting literature are the following:

- The **mean error (ME)** is the average of the values of the forecasting errors over the forecast period, where the forecasting error is the difference between the forecast and the actual value. It measures the bias in the forecasts—i.e., whether the forecasting approach tends to over-forecast or under-forecast.³³
- The **mean absolute error (MAE)** is the average of the absolute values of the forecasting errors over the forecast period, where the forecasting error is the difference between the forecast and the actual value.
- The **root mean square error (RMSE)** starts by taking the squares of the forecasting errors. It then takes the average of these squared errors, and finally takes the square root of this average.

³⁰ With the exception of the November 2010 BIS Shrapnel forecasts, for which seven forecast years are used.

³¹ Series A2603489A of ABS 6345.0.

³² Growth rates are only used if four quarters of data are available for both years.

³³ In the forecasting literature, it is more common to define the forecasting error as the actual value minus the forecast. However, the AER has defined the forecasting error as being equal to the forecast value minus the actual value, which is more intuitive. We have adopted the same terminology in this report.

- The **mean percentage error (MPE)** first calculates the value of each forecasting error as a percentage of the outturn value and then takes the average of these percentages. The MPE can be thought of as turning the ME into a relative or scale-free measure of the average forecast error.
- The **mean absolute percentage error (MAPE)** first calculates the absolute value of each forecasting error as a percentage of the absolute actual value and then takes the average of these percentages. The MAPE can be thought of as turning the MAE into a relative or scale-free measure, which facilitates the comparison of forecasting performance across different applications. It may also be useful when the data is trending,

The ME and RMSE measures are the mean and standard deviation of the forecast errors and hence are the basic summary measures for describing the bias³⁴ and spread of the forecast errors. The MAE is an alternative to the RMSE that is often preferred because it is easier to interpret.³⁵ However, it puts less weight on large forecasting errors than the RMSE does. Hence, in the present context, we should have greater regard to the RMSE than the MAE. The RMSE and MAE are the key statistics used to assess the accuracy of forecasts.

The measures based on percentage errors, MPE and MAPE, are useful when comparing the accuracies of forecasts for different data series that have different scales or different units of measurement. That does not apply in the current situation. Moreover, these measures have the disadvantage that they take on extreme values if any outturn value is close to zero. In such situations, they become unstable. Since EGWWS WPI growth rates can be close to zero, or even negative, the MPE and MAPE measures of forecast accuracy are inappropriate for assessing the accuracy of forecasts of EGWWS WPI growth rates. We therefore do not use them in this study and note that the AER was correct to not consider them in previous decisions either.

4.4 Results

4.4.1 Comparison of forecasts

The curves in **Figure 1** below present the forecasting error (i.e., the distance between forecasts and outturns) of the real growth rates of the Victorian EGWWS WPI for (respectively) DAE and BIS. In the top panel, the blue shaded region represents the range (maximum and minimum) of DAE's forecasting errors in each year and the red lines represent BIS's forecasts; in the bottom panel, the red shaded region represents the range of BIS's forecasting errors in each year, and the blue lines represent DAE's forecasts.³⁶

Figure 1 illustrates three key points:

- Firstly, neither DAE nor BIS have forecast the real growth in the Victorian EGWWS WPI accurately. This is evident from the fact that neither DAE's nor BIS's forecast error in any given year is close to zero.
- Secondly, DAE's forecast errors have generally been larger than BIS's. This can be seen from the fact that DAE's forecasting errors typically sit outside BIS's forecasting error range (i.e., the red shaded region), whereas BIS's forecasting errors typically sit within DAE's forecasting error range. The maximum negative and positive forecasting errors for the DAE forecasts (-1.9% and +2.0%) are also considerably larger than for the BIS forecasts (-1.4% and +1.3%).

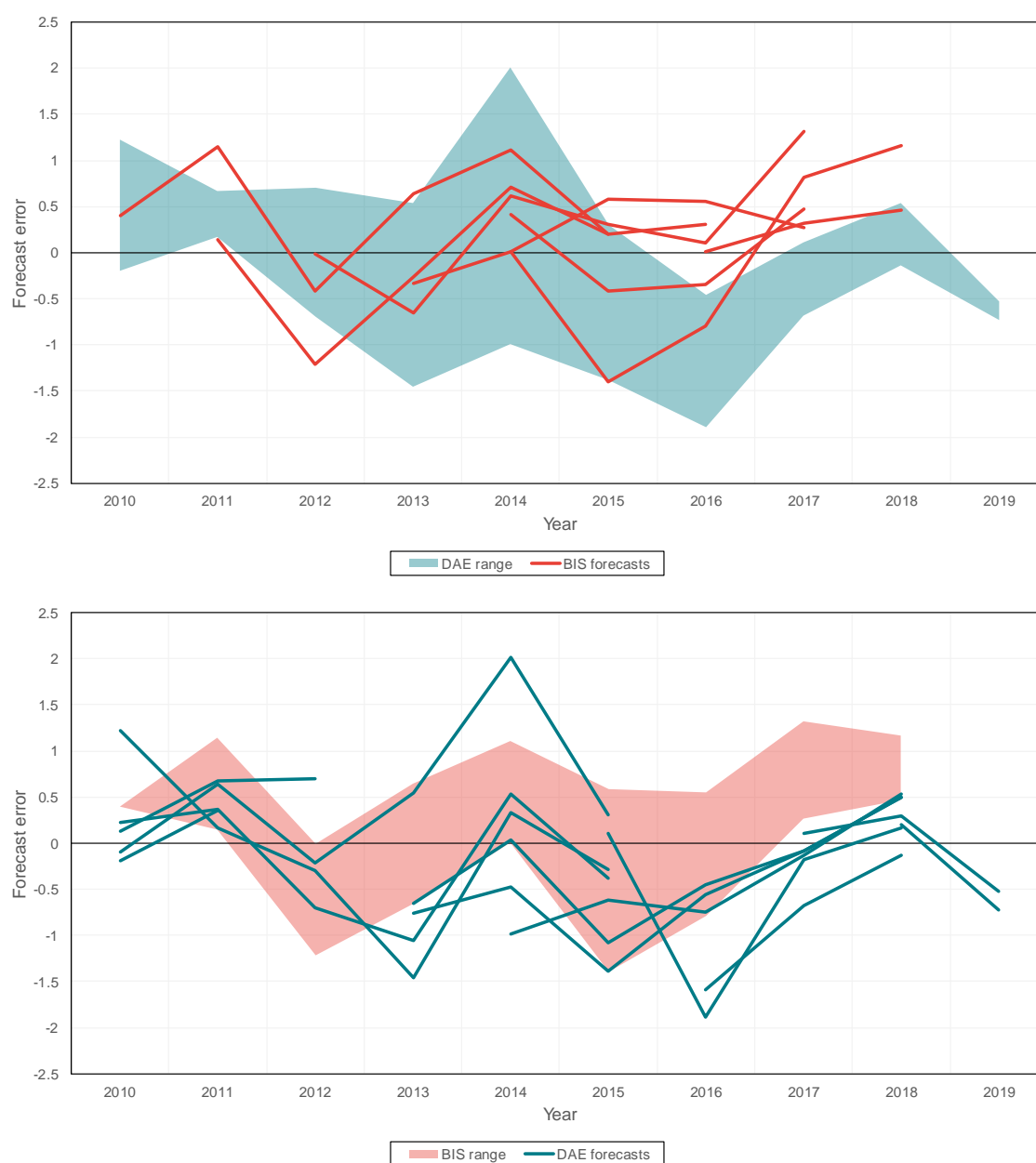
³⁴ ME actually measures the negative of the bias.

³⁵ For normally distributed forecast errors, and under the assumption that the forecast errors are independent and homoscedastic, the MAE is about 80% of the RMSE.

³⁶ DAE's and BIS's forecasts in each year, compared to WPI outturns, are presented in Appendix C.

- Thirdly, DAE in particular has made large forecasting errors in both directions. This highlights one of the problems with relying exclusively on the ME to assess forecasts. Under the ME approach, positive and negative errors will cancel each other out—as acknowledged by the AER in the 2019 SAPN Draft Decision.³⁷ This would result in a relatively low ME. If one were to rely only on the ME statistic, one may be left with the false impression that DAE's forecasts had performed reasonably well—when in fact in some years it had made very large forecasting errors. Hence, to get a truer picture of forecasting accuracy, it is important to consider assessment approaches that account for absolute forecasting errors.

Figure 1: DAE's and BIS's forecasting errors in relation to the real growth in Victorian EGWWS WPI



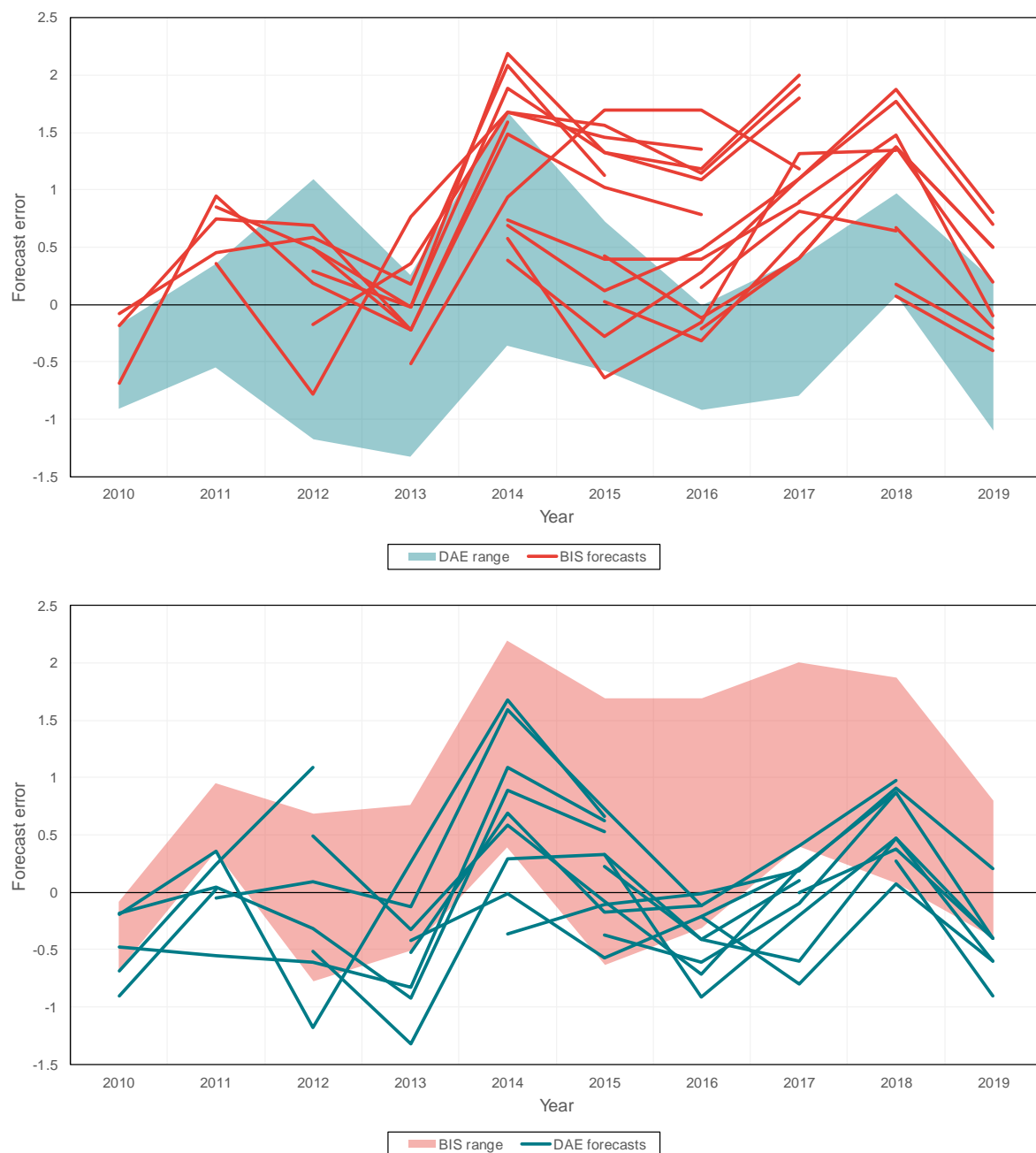
Source: Various DAE and BIS reports; ABS data

³⁷ SAPN Draft Decision 2020-25, October 2019, p. 31.

Figure 2 presents DAE's and BIS's forecast errors for the real growth in the Australian EGWWS WPI. This Figure indicates that:

- Both DAE's and BIS's forecasts of labour cost escalation rates have tended to be inaccurate. Both advisers have made large forecasting errors in some years;
- BIS has tended to over-forecast the growth in the EGWWS WPI; and
- DAE has both over-forecast and under-forecast the growth in the EGWWS WPI.

Figure 2: DAE's and BIS's forecast errors in relation to the real growth in the Australian EGWWS WPI



Source: Various DAE and BIS reports; ABS data

4.4.2 Assessment of forecasts using statistical measures

It is challenging to draw reliable conclusions through simple visual inspection of the data. In order to analyse DAE's and BIS's forecasting errors more systematically, we apply the ME, RMSE and MAE measures to the data. We also apply these measures to the average of the DAE and BIS forecasts in order to test whether the accuracy of the forecasts improves when the competing forecasts are combined. The results are presented in the four Tables below.

Table 1: Performance of forecasts – real EGWWS WPI growth, Victoria

| FORECASTER | ME | RMSE | MAE | LAG | OBS |
|------------|-------|------|------|------|-----|
| DAE | -0.14 | 0.72 | 0.55 | 2.84 | 53 |
| BIS | 0.18 | 0.65 | 0.52 | 2.39 | 35 |

Source: Frontier Economics analysis

Note: LAG refers to the average of the number of years the forecasts are made ahead into the future

Table 2: Performance of forecasts – real EGWWS WPI growth, Australia

| FORECASTER | ME | RMSE | MAE | LAG | OBS |
|------------|------|------|------|------|-----|
| DAE | 0.08 | 0.82 | 0.58 | 2.67 | 92 |
| BIS | 0.69 | 1.00 | 0.81 | 2.52 | 101 |

Source: Frontier Economics analysis

Note: LAG refers to the average of the number of years the forecasts are made ahead into the future

Table 2 above indicates that BIS has tended to underperform compared to DAE when forecasting real growth rates of the EGWWS WPI for Australia as a whole. Specifically:

- The ME of both DAE's and BIS's forecasts are positive. However, BIS's ME is significantly larger than DAE's. This suggests that BIS has tended to over-forecast the real growth in the EGWWS WPI for Australia.
- The MAE of BIS's forecasts is larger than DAE's. This suggests that DAE has tended to forecast real growth in the EGWWS WPI for Australia more accurately than BIS.
- The RMSE of BIS's forecasts is larger than DAE's. This suggests that BIS's forecasts have been influenced by larger errors than has DAE's.

However, the picture is quite different in relation to forecasts of the real growth in the Victorian EGWWS WPI. **Table 1** shows that:

- The ME of DAE's forecasts is slightly negative, whereas the ME of BIS's forecasts is slightly positive. This suggests that, on average, DAE has under-forecast the real growth in the Victorian EGWWS WPI slightly, while BIS has, on average, over-forecast the real growth in the Victorian EGWWS WPI slightly.
- The MAE of BIS's forecasts is slightly lower than that of DAE's. This suggests that BIS had tended to forecast the real growth in the Victorian EGWWS WPI slightly more accurately than DAE.
- The RMSE of BIS's forecasts is lower than that of DAE's. This suggests that DAE's forecasts of the real growth in the Victorian EGWWS WPI have been influenced by larger errors than has BIS's.

These results suggest two things:

- Firstly, there is no evidence that DAE has been a more accurate forecaster of the real EGWWS WPI for Victoria than BIS. To the contrary, BIS appears to have been the more accurate forecaster—in terms of the average magnitude of forecasting errors.
- Secondly, the results of assessments of forecasting accuracy at the national level do not appear to apply at the jurisdiction level. Our findings contradict directly the AER's assertion in the 2019 SAPN Draft Decision that: "In the absence of South Australian specific data, we consider the forecasting performance at the national level is indicative of the consultants' performance at the state level."³⁸

In our view, since the AER sets labour cost escalation rates using forecasts of real WPI growth rates at the jurisdiction level, it is this last set of results (i.e., relating to the performance of forecasts of the real growth in the Victorian EGWWS WPI) that are most relevant.

We note that the Tables above also report a measure labelled 'Lag', which refers to the average of the number of years the forecasts are made ahead into the future. The Tables indicate that, on average, DAE and BIS tend to forecast ahead by a similar number of years. This suggests that differences between DAE and BIS in terms of the staleness of forecasts is unlikely to explain the results presented above.

4.4.3 Assessment of accuracy of combined forecasts

Thus far, we have assessed the accuracy of DAE's and BIS's forecasts individually. However, in the 2012 Powerlink Final Decision, the AER considered whether the average of the DAE and BIS forecasts resulted in more accurate outcomes than DAE's and BIS's forecasts individually.³⁹ We therefore investigated whether combining DAE's and BIS's real forecasts by means of averaging improved the accuracy of the individual forecasts. In order to do this, we searched for matched pairs of real DAE and BIS forecasts—i.e., forecasts produced by DAE and BIS that were no more than two years apart and/or were considered together as part of the same regulatory determination process by the AER. We then applied the ME, MAE and RMSE measures to those individual forecasts and the average of the matched DAE and BIS forecasts. The results are presented in **Table 3** below.

Table 3: Performance of combined real forecasts and correlations between DAE and BIS forecasts

| SCENARIO | FORECASTS | ME | MAE | RMSE | OBS | RHO |
|-----------|-----------|-------|------|------|-----|------|
| VICTORIA | BIS | 0.21 | 0.55 | 0.63 | 16 | 0.41 |
| | DAE | -0.02 | 0.64 | 0.80 | | |
| | Averaged | 0.10 | 0.49 | 0.59 | | |
| AUSTRALIA | BIS | 0.61 | 0.73 | 0.91 | 56 | 0.73 |
| | DAE | -0.08 | 0.48 | 0.59 | | |
| | Averaged | 0.26 | 0.51 | 0.64 | | |

Source: Frontier Economics

Note: RHO refers to the correlation between DAE's and BIS's forecast errors.

³⁸ SAPN Draft Decision 2020-25, October 2019, p. 32.

³⁹ The AER also considered similar evidence presented by Professor Borland in the 2013 SP AusNet Final Decision.

The Table above shows that BIS's past real forecasts for Victoria have been more accurate than DAE's (i.e., lower MAEs and RMSEs). However, combining DAE's and BIS's past real forecasts for Victoria would have resulted in more accurate outcomes than relying on either DAE's or BIS's forecasts individually. One possible reason for this is because DAE's and BIS's real forecast errors for Victoria are weakly correlated (i.e., 41%). The ME reported in Table above does indicate that there would be some small positive bias in the combined forecasts. That is, the errors associated with the average of the DAE and BIS forecast would be slightly positive. However, the more relevant consideration is that the errors associated with the combined forecast tend to be smaller than the errors associated with the individual forecasts.

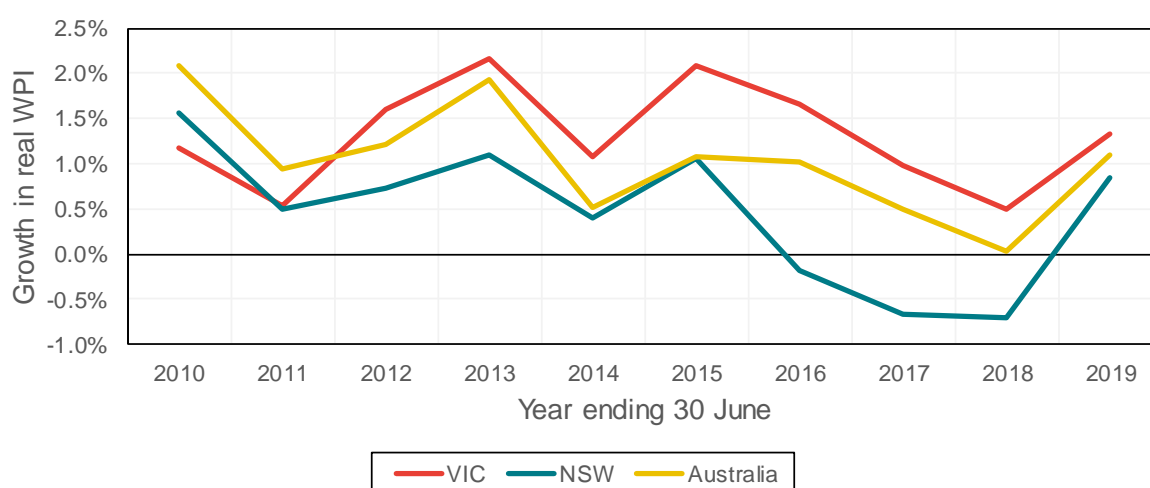
By contrast, it appears that combining DAE's and BIS's past real forecasts for Australia would not have improved on the accuracy of DAE's forecasts. This may be because DAE's and BIS's forecasts for the whole of Australia appear to be fairly strongly positively correlated (i.e., 73%), and because BIS's forecasts for the whole of Australia appear to be strongly positively biased.

4.4.4 Relevance of results at the national level

It has long been the AER's practice to set labour cost escalation rates using forecasts at the jurisdiction level, rather than at the national level—even when actual data on WPI outturns at the jurisdiction level are not available. The data suggest that the AER is right to focus on jurisdiction-specific forecasts.

Figure 3 presents outturns of the real growth in the EGWWS WPI for Victoria, NSW and Australia. As the Figure shows, there can be very large differences between real labour cost growth rates at the jurisdiction level and at the national level. For example, over the period between 2010 and 2019, the absolute difference between the real EGWWS WPI growth rate in Victoria and across all of Australia has ranged between 0.23% and 1.01%, which is very material.

Figure 3: Real growth in EGWWS WPI



Source: ABS data; Frontier Economics calculations

As the Figure above shows, the gap between the real growth in the EGWWS WPI for NSW and across all of Australia has been even larger than the gap for Victoria—as high as 1.2% (in absolute terms) in some years.

This suggests that real growth in the EGWWS WPI for all of Australia is a poor indicator of the real growth in the EGWWS WPI at the jurisdiction level. Therefore, the AER should not set labour cost escalation rates using forecasts of the real growth in the EGWWS WPI for the whole of Australia.

4.5 Implications of the results for the purposes of determining regulatory opex allowances

Section 2.1 explained that when determining labour cost escalation rates, the AER's regulatory task under the NER is to adopt the most accurate forecasts of the growth in the price of labour inputs.

The results in section 4.4 show that BIS has generally been a more accurate forecaster of the real growth in the Victorian EGWWS WPI than has DAE. However, that does not imply that the AER should discard DAE's forecasts. Nor should the AER discard BIS's forecasts and rely exclusively on DAE's forecasts (as the AER did in the 2019 SAPN Draft Decision) in the event that BIS had been found to be less accurate than DAE.

It is evident from the Figures presented in section 4.4.1 that *both* DAE *and* BIS have made errors in forecasting the growth in the EGWWS WPI. There is a large body of forecasting literature that suggests that, in such circumstances, forecast accuracy is likely to be improved substantially by combining forecasts from different sources.

This is borne out by our findings, which suggest that the average of DAE's and BIS's real forecasts for Victoria are generally more accurate than DAE's or BIS's forecasts individually. In our view, the AER should revert to the practice it has followed since 2013 and adopt the average of forecasts produced by different advisers when setting real labour cost escalation rates.

Furthermore, the AER should:

- Avoid drawing conclusions about forecasting accuracy at the jurisdiction level by reference to evidence on forecasting accuracy at the national level—particularly when data is available at the jurisdiction level to test forecasting accuracy; and
- Not set labour cost escalation rates using forecasts for the whole of Australia, because the data show that there have been large differences between real growth rates in the EGWWS WPI at the jurisdiction level (e.g., Victoria and NSW) and at the national level.

A CONCERNS OVER THE AER'S ANALYSIS IN THE 2019 SAPN DRAFT DECISION

During our investigations for this report, we identified a number of issues in the AER's assessment of forecasts in the 2019 SAPN Draft Decision. This Appendix documents the issues that we have identified. We note that this may not be an exhaustive list of concerns in the AER's analysis. Rather, the issues documented here are those that we were able to identify in the time available to undertake our analysis for this report.

Comparison of calendar year and March year forecasts to financial year outturns

In Table A6.1 of the 2019 SAPN Draft Decision, the forecasts of DAE and BIS are compared to the actual outturn real WPI growth rates for Australia, obtained using ABS data. The actuals used are derived by averaging over the four quarters in each financial year. Thus, the forecasts are being compared to actuals on a financial year basis. Yet several of the forecasts are not provided on a financial year basis:

- Deloitte, September 2009 is provided on a calendar year basis
- Deloitte, June 2013 is provided on a year ended March basis
- BIS, July 2010 is provided on a calendar year basis
- BIS, October 2012 is provided on a calendar year basis
- BIS, November 2012 is provided on a year ended March basis
- BIS, November 2014 is provided on a calendar year basis

As a consequence, several of the forecasts are being compared to the incorrect outturns of the WPI. This is likely to increase the forecast errors of the relevant forecasts. As BIS forecasts are misrepresented more often than DAE's, the approach to comparing forecasts used by the AER is likely to make BIS's forecasts appear less accurate than they actually were. Evaluating a set of forecasts using the wrong outturns would only result in the forecaster appearing to be accurate through pure chance.

Incorrect forecasts used

We note that the BIS forecast for July 2010 in Table A6.1 of the 2019 SAPN Draft Decision appears to be incorrect, and use the wage forecasts for Victoria instead of the National series. In this case, the wrong forecasts are compared to outturns. This error will tend to make BIS appear a less accurate forecaster.

It appears that the BIS forecasts from March 2007 are entered incorrectly. We have been unable to replicate the forecasts provided in Table A6.1 using the BIS report referenced by the AER.

It appears that the DAE forecasts from April 2007 are entered incorrectly. We were unable to replicate the forecasts provided in Table A6.1 for the years 2010 to 2012 using the DAE report referenced by the AER.

Incorrect averaging

In Table A6.1 in the 2019 SAPN Draft Decision, the average forecasts of BIS are provided on the second to last row. It appears that the averages for the years 2009 to 2011 have been calculated incorrectly. For example, the average forecasts for 2009 from BIS is stated to be 1.1%, despite there being only a single forecast for 2009, 2.2%.

The second and third to last rows present average mean errors and mean absolute errors for BIS and Access forecasts. It is not clear on which basis these averages have been determined, and we have been unable to replicate the AER's figures.

B REPORTS ANALYSED IN THIS STUDY

This Appendix lists all of the DAE and BIS reports from which we gathered the forecasts analysed in this study.

DAE reports

1. Wage growth forecasts in the utilities sector, 17 November 2006
2. Labour Cost Indices for the energy sector, 12 April 2017
3. Forecasts growth in labour costs, 16 September 2009
4. Forecast growth in labour costs: March 2010 report, 16 March 2010
5. Forecast growth in labour costs: update of March 2010 report, 26 September 2010
6. Forecast growth in labour costs: Queensland and South Australia, 13 December 2010
7. Forecast growth in labour costs: Queensland and Tasmania, 15 August 2011
8. Forecast growth in labour costs: update of August 2011 report, 9 March 2012
9. Forecast growth in labour costs: Victoria and South Australia, 15 October 2012
10. Forecast growth in labour costs: Victoria and South Australia, 25 February 2013
11. Forecast growth in labour costs in Victoria, 13 June 2013
12. Forecast growth in labour costs in NSW, Tasmania and the ACT, 24 July 2014
13. Forecast growth in labour costs in NEM regions of Australia, 23 February 2015
14. Forecast growth in labour costs in NEM regions of Australia, 15 June 2015
15. Forecast growth in labour costs in NEM regions of Australia, 22 February 2016
16. Labour Price Forecasts, 6 February 2017
17. Labour Price Forecasts, 7 February 2018
18. Labour Price Growth Forecasts, 19 July 2018
19. Labour price growth forecasts, 28 February 2019
20. Labour price growth forecasts, 24 June 2019

BIS reports

1. Outlook for Wages to 2012/13: Electricity, Gas and Water Sector Australia and Victoria, March 2007
2. Wages Outlook for the Electricity Distribution Sector in Victoria, July 2010
3. Labour Cost Escalation Forecasts to 2016/17 – Australia and Queensland, November 2010
4. Labour Cost Escalation Forecasts to 2016/17 – Australia and Queensland, January 2012
5. Labour Cost Escalation Forecasts to 2017/18 – Australia and South Australia, April 2012
6. Real Labour Cost Escalation Forecasts to 2017 – Australia and Victoria, October 2012
7. Real Labour Cost Escalation Forecasts to 2017 – Australia & Victoria, November 2012
8. Real Labour Cost Escalation Forecasts to 2018/19, November 2013
9. Real Labour and Material Cost Escalation Forecasts to 2020 – Australia and Victoria, November 2014

10. Real labour cost escalation forecasts to 2018/19—Australia and New South Wales, December 2014
11. Utilities Sector Wage Forecasts to 2019/20, May 2015
12. Expected Wage Changes to 2022/23, November 2016
13. Real Cost Escalation Forecasts to 2023/24, September 2017
14. Expected Wage Changes in the EGWWS Sector to 2022/23, October 2017
15. Outlook for wages, contract services and customer connections expenditure to 2014/15: South Australia, May 2009.
16. Real labour cost escalation forecasts to 2017 –Victoria and New South Wales, November 2011.
17. Real labour cost escalation forecasts to 2017 – Australia and Victoria, September 2013.
18. Real labour and material cost escalation forecasts to 2019/20 – Australia and New South Wales, April 2014
19. Real labour cost escalation forecasts to 2021/22 – Australia and Queensland, July 2015.
20. Utilities sector and construction industry wage forecasts to 2022 – Australia and Victoria, October 2016.
21. Cost escalation forecasts to 2024/25, June 2018
22. Utilities & construction wage forecasts to 2024/25, October 2018

Reports used in this study that were not used in the 2019 SAPN Draft Decision

For convenience, **Table 4** summarises all of those reports used in this study that were not considered by the AER in the 2019 SAPN Draft Decision.

Table 4: Reports used in this study in addition to those considered in the 2019 SAPN Draft Decision

| FORECASTER | REPORT TITLE |
|------------|--|
| DAE | Labour price growth forecasts, 28 February 2019 |
| | Labour price growth forecasts, 24 June 2019 |
| | Outlook for wages, contract services and customer connections expenditure to 2014/15: South Australia, May 2009. |
| | Real labour cost escalation forecasts to 2017 –Victoria and New South Wales, November 2011. |
| | Real labour cost escalation forecasts to 2017 – Australia and Victoria, September 2013. |
| BIS | Real labour and material cost escalation forecasts to 2019/20 – Australia and New South Wales, April 2014 |
| | Real labour cost escalation forecasts to 2021/22 – Australia and Queensland, July 2015. |
| | Utilities sector and construction industry wage forecasts to 2022 – Australia and Victoria, October 2016. |
| | Cost escalation forecasts to 2024/25, June 2018 |

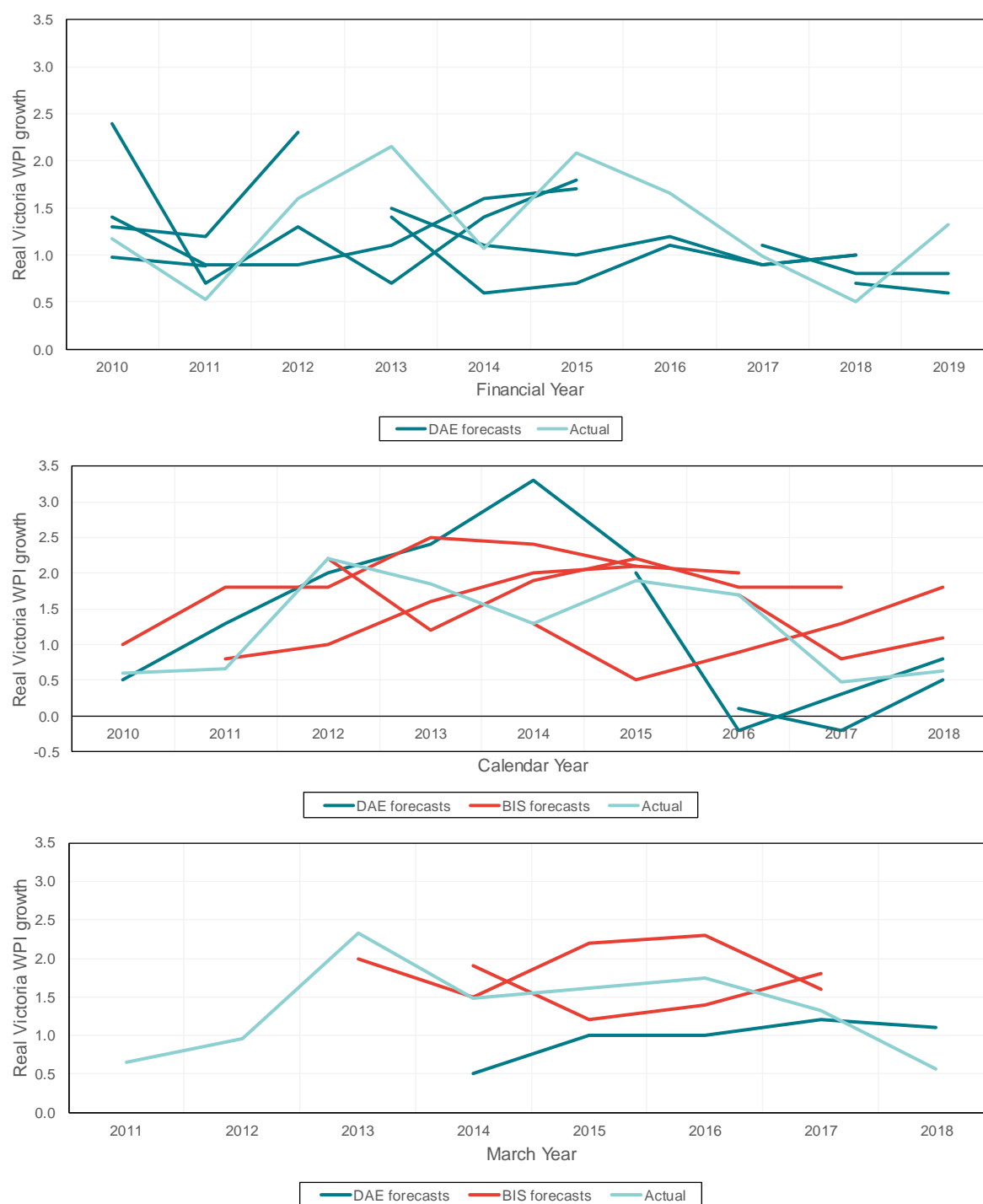
| FORECASTER | REPORT TITLE |
|------------|--|
| | Utilities & construction wage forecasts to 2024/25, October 2018 |

Source: *Frontier Economics*

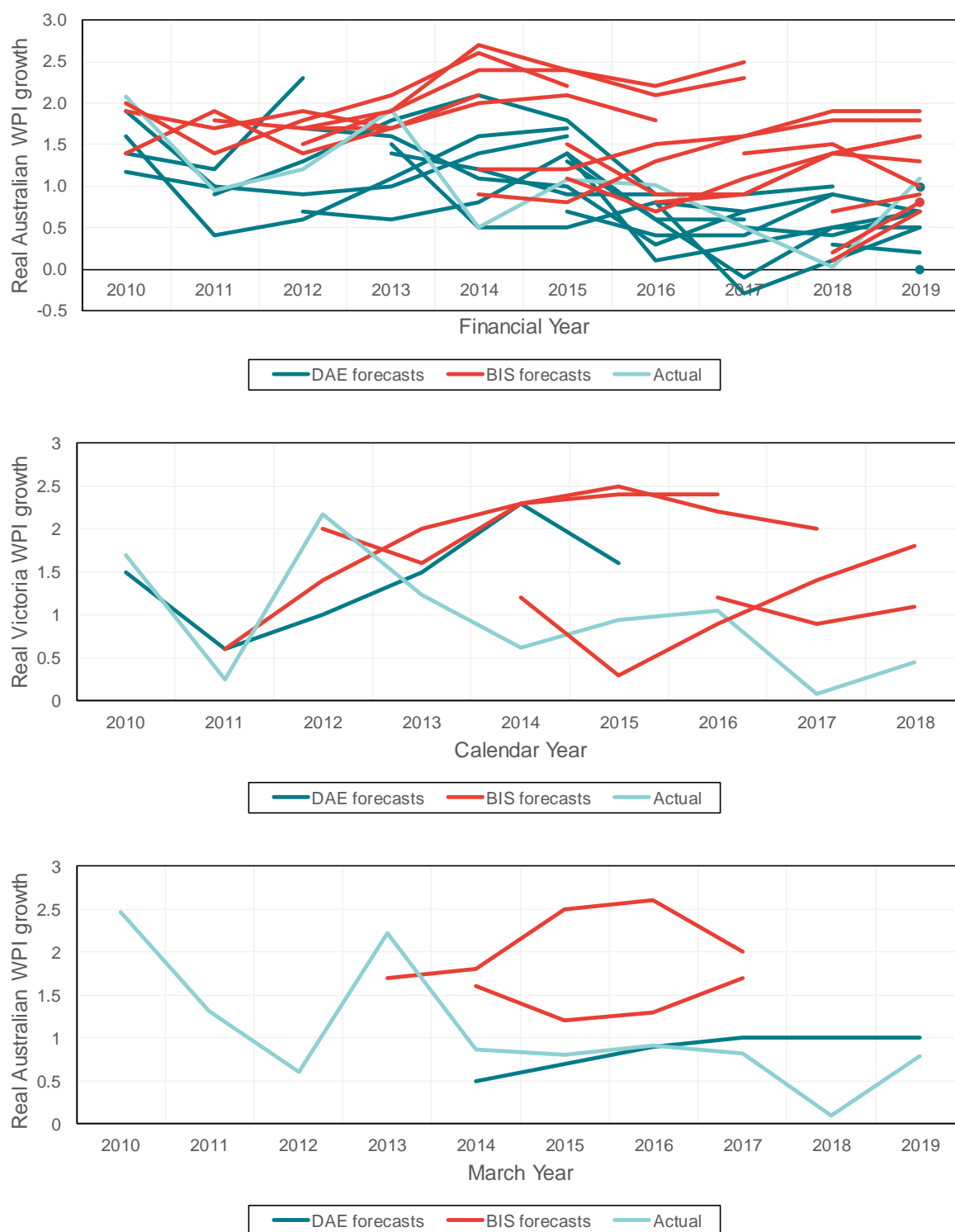
C DAE AND BIS FORECASTS AGAINST ACTUALS

The Figures below compare DAE's and BIS's real forecasts of the EGWWS WPI growth rates to outturns, for Victoria and Australia.

Figure 4: DAE and BIS forecasts vs actuals – real EGWWS WPI growth, Victoria



Source: Various DAE and BIS reports; Actuals derived using ABS data

Figure 5: DAE and BIS forecasts vs actuals – real EGWWS WPI growth, Australia

Source: Various DAE and BIS reports; Actuals derived using ABS data

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